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Scientific Evidence for Pre-Columbian Transoceanic Voyages

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SCIENTIFIC EVIDENCE FOR PRE-COLUMBIAN TRANSOCEANIC VOYAGES TO AND FROM THE AMERICAS

John L. Sorenson[1] and Carl L. Johannessen[2]

INTRODUCTION

This paper is an expanded version of a presentation given at a conference, “Contact and Exchange in the Ancient World,” held at the University of Pennsylvania, Philadelphia, May 5, 2001. The conference was organized by Victor H. Mair of the Department of Asian and Middle Eastern Studies at the University of Pennsylvania. He is also editor of the volume of papers from that conference in press at the University of Hawaii Press in 2004.

Since our initial paper was submitted for inclusion in that volume, we have made further discoveries. The present book incorporates the new materials, constituting a revision and extension of the original paper. Because much of the literature that enters into our argument in the extended paper is interpreted here in ways other than biologists conventionally do, for readers’ convenience we give in the Appendix précis of our reference materials on each species discussed. Selected illustrations and a bibliography for both the text proper and the Appendix follow.

Support for the preparation and presentation of the original paper was provided by the Institute for the Study and Preservation of Ancient Religious Texts, at Brigham Young University, and the Center for Ancient Studies of the University of Pennsylvania. We express gratitude to those organizations, but, of course, we authors alone are responsible for the views expressed and for any errors. Our appreciation also goes to Linda S. McElroy for her helpful editing of the present manuscript.

ABSTRACT

Examination of an extensive literature has revealed conclusive evidence that nearly one hundred species of plants, a majority of them cultivars, were present in both the Eastern and Western Hemispheres prior to Columbus’ first voyage to the Americas. The evidence comes from archaeology, historical and linguistic sources, ancient art, and conventional botanical studies. Additionally, 21 species of micro-predators and six other species of fauna were shared by the Old and New Worlds. The evidence further suggests the desirability of additional study of up to 70 other organisms as probably or possibly bi-hemispheric in pre-Columbian times. This distribution could not have been due merely to natural transfer mechanisms, nor can it be explained by early human migrations to the New World via the Bering Strait route. Well over half the plant transfers consisted of flora of American origin that spread to Eurasia or Oceania, some at surprisingly early dates.

The only plausible explanation for these findings is that a considerable number of transoceanic voyages in both directions across both major oceans were completed between the 7th millennium BC and the European age of discovery. Our growing knowledge of early maritime technology and its accomplishments gives us confidence that vessels and nautical skills capable of these long-distance travels were developed by the times indicated. These voyages put a new complexion on the extensive Old World/New World cultural parallels that have long been controversial.

THE PROBLEM

In general, scholars concerned with the ancient culture history of the Americas believe that there were no significant connections by voyaging between the Old World and the New World before 1492. To the contrary, our data from an extensive literature that hitherto has been inadequately searched demonstrate that fauna and flora were extensively shared between the Old and New Worlds before Columbus' discovery of the Americas. The only plausible explanation for this bi-hemispheric distribution is that those shared organisms moved across the oceans via intentional voyages that took place during the eight millennia or more immediately preceding Columbus' discoveries. This book presents and documents the evidence for our position. We believe students of the human past are obliged to adopt a new paradigm for the role of long-distance sea communication in history and culture.

In the past, arguments for transoceanic contacts have relied mainly on evidence from cultural parallels (Sorenson and Raish 1996). Some of those parallels are indeed striking, but scholars generally have rejected their value as evidence that significant pre-Columbian contacts took place with the Americas across the oceans (see, *e.g.*, Kroeber 1948, 538–71; Rands and Riley 1958). Over a century ago, Tylor (1896) compared details of the Aztec board game, *patolli* (*e.g.*, the board's layout, the sequence of moves, and cosmic associations of the pieces and moves), with the game called *pachisi* in India. Even Robert Lowie, an influential anthropologist who was usually critical of diffusionist (voyage-dependent) explanations for such similarities, accepted that in this case “the concatenation of details puts the parallels far outside any probability [of having been invented independently]” (1951, 13). Still, tentative acceptance by some influential observers, like Lowie, of the possible historical significance of the cultural parallels has always ended up being rebutted by a demand from critics for ‘hard,’ or ‘scientific’ evidence for voyaging. Often, the sort of evidence demanded was demonstration that numbers of plants were present on both sides of the oceans before Columbus' day (Kidder *et al*. 1946, 2).

Data from the life sciences now provide that desired evidence, not only for the flora, but for fauna as well. The largest body of data is on plants. (See Tables 1, 2, and 3, below.) We will also deal with shared infectious organisms as evidence for voyaging (see Tables 4 and 5), as well as some larger animal forms (see Tables 6 and 7).

An example from the history of health-damaging organisms demonstrates our approach while illustrating the power this kind of evidence can provide in the study of human history and prehistory. The hookworm *Ancylostoma duodenale* causes one of the most widespread human ailments. The long-term prevalence of the hookworm in East and Southeast Asia makes that area the obvious source from which the organism reached the Americas.

A. duodenale was at first assumed to have been introduced by slaves brought from Africa. Early in the 20th century, Fonseca (not fully published until 1970) discovered the parasite in an isolated Amerindian population in the Amazon basin. Shortly afterward, microbiologist Samuel Darling (1920) pointed out that the hookworm apparently had infested South American tropical forest peoples since before Columbus arrived. If a date for the parasite in the Americas before European discovery could be proven, he observed, then the only explanation for the parasite in the New World would have to be that it arrived anciently via infected humans who had crossed the ocean—“storm-tossed fishermen,” he ventured.

His reasoning sprang from facts about the life cycle of this worm. In one stage it must inhabit warm, moist soil (in a climate no colder than that of North Carolina today). At a later stage, the worms from the soil penetrate a human host's body and settle in the digestive tract. Immigrants who came to the New World in slow stages via Beringia would have arrived hookworm-free because the cold ambient conditions would have killed the parasite in the soil (Soper 1927; Ferreira *et al*. 1988).

The hookworm's pre-Columbian presence in the Americas was established authoritatively by Allison *et al*. (1973), who found traces of the pest in a Peruvian mummy dated about AD 900. Evidence from other mummies and human coprolites has since repeatedly confirmed the initial find (Araújo 1988; Reinhard 1992). In 1988, Brazilian scientists identified this parasite from remains excavated in eastern Brazil. A series of radiocarbon dates fixed the age at about 7,200 years ago. Given the inland remoteness of the site, the organism’s arrival on the coast of the continent must have occurred centuries earlier.

Can these findings be said to establish conclusively that early human voyagers crossed the ocean to the Americas? Is there some explanation for the presence of the worm in the New World due to natural forces, independent of human beings? Absolutely not. There is no alternative explanation. Modern microbiologists continue to assure us that Darling’s assessment was correct. Ferreira, Araújo, and Confalonieri (1982) say, “Transpacific migrants from Asia by sea must be one component of the ancient American population.” Fonseca (1970) asserts, “shared species of parasite … make it inescapable that voyagers reached South America directly from Oceania or Southeast Asia.” Ferreira and colleagues (1988) agree: “We must suppose that [the human hosts for the parasite] arrived by sea.” Araújo (1988) confirms, “The evidence points only to maritime contacts” (emphases added).

This kind of fact, or secure inference, is vital in our present study. First, since *A. duodenale* could have arrived in the Americas only in the bodies of (presumably) Asians who came by sea, we can be certain that elements of some particular culture, as well as a set of Asian genes, arrived with them. Second, vessels capable of crossing or skirting the Pacific were already in use by the 6th millennium BC, and at least one of those craft actually reached South America, where its occupants passed the hookworm on to subsequent inhabitants.

A second species, *Necator americanus,* also called ‘hookworm,’ has been found in Brazil in prehistoric human remains of the same age (Ferreira *et al.* 1980, 65–7). Its reproductive cycle is similar to that of *A. duodenale*. Presence of this second organism confirms the fact that millennia ago nautical technology that would allow successful voyages across or around the Pacific existed in Asian waters.

Subsequently, archaeologists and paleo-pathologists have found decisive evidence in the Americas for the presence of 18 other infectious organisms from the Old World (see Table 4). Most of them could not have come with early Bering Strait migrants, and the others very likely did not. They include additional parasites, bacteria, viruses, fungi, and other micro-predators. Beyond the primary 20, there is enough evidence of transfer across the ocean of another 18 disease-causing organisms to call for further research on their pre-Columbian distribution.

The zoological literature also identifies six animal forms (see Table 6) documented as present in both hemispheres, and possibly 6 more (see Table 7).

The volume of evidence about plants obviously greatly exceeds that on fauna. We will first present salient data on the former, after a short methodological orientation.

Organisms, whether plant or animal, have special significance for the history of long-distance human movements. Biologists believe that a given species arises only once in the course of evolution because any new species develops within a unique set of environmental parameters that is found in only a single geographical location (see Zohary 1996, 156; for changes in thought on this topic, see Blumler 1992; 1996). Plant geographer N. Polunin (1960) stated the governing principle very clearly: “The chances that two isolated populations will evolve in exactly the same way are incalculably low,” since, as Wulff (1943, 56) put it, “no two localities on earth are exactly alike in all … physico-geographical conditions” governing the evolutionary process. Stephen Gould (1994, 3) echoed the thought: “I regard each species as a contingent item of history …. [A] species will arise in a single place [and time] ….”

When the same species is found to have lived before Columbus in the New World as well as an ocean apart in Oceania, Asia, Europe, or Africa, that departure from the norm demands rational explanation. One might hurriedly conclude that certain seeds moved inter-continentally by the actions of winds or waves; however, few seeds are equipped to survive long while floating or to move great distances via wind (and no disease organism spreads in such a way). The odds for successful natural transport of plants are so slim (Guppy 1906, following De Candolle; Fosberg 1951) that anyone who claims a passive, natural mode of transport is obliged to demonstrate the possibility in the immediate case rather than merely to assume or assert it. By the same token, the explanation that humans transported some plant overseas requires empirical and logical support.

THE PLANT EVIDENCE

Table 1 lists 98 plant species for which there is what we consider decisive evidence that the organism was present in both Eastern and Western Hemispheres before Columbus' first voyage. Table 2 gives 19 more species for which the evidence is significant, though less than decisive, and Table 3 adds 18 more species that deserve further research to determine their possible bi-hemispheric presence.

What do we consider decisive evidence? It can come from the discovery through archaeology of actual plant remains—macrofossils, pollen, phytoliths, DNA—manifesting the presence before AD 1492 of a particular species in the hemisphere where, according to botanists, it did not originate. A second source of evidence is historical documents—references to or descriptions of plants in ancient texts, explorers' reports, or lexicons of appropriate date that show knowledge of the species in the hemisphere where it did not originate. Detailed representations of plants in ancient art can be determinative also. Conclusive information may also come through well-informed inferences by botanists, based on such data as where a plant's relatives and possible wild ancestor grew (Zohary and Hopf 1993, chap. 1).

TABLE 1

PLANTS FOR WHICH THERE IS DECISIVE EVIDENCE OF TRANSOCEANIC MOVEMENT

Species	Common Name	Origin	Moved To
Adenostemma viscosum		Americas	Hawaii,
Agave americana	agave	Americas	India
Agave angustifolia	agave	Americas	India
Agave cantala	agave	Americas	India
Ageratum conyzoides	goat weed	Americas	India, Marquesas?
Alternanthera spp.		Americas	India
Amaranthus caudatus	love-lies-bleeding	Americas	Asia
Amaranthus cruentus	amaranth	Americas	Asia
A. hypochondriacus	amaranth	Americas	Asia
Amaranthus spinosus	spiked amaranth	Americas	South Asia
Anacardium occidentale	cashew	Americas	India
Ananas comosus	pineapple	Americas	India, Polynesia
Annona cherimolia	large annona	Americas	India
Annona reticulata	custard apple	Americas	India
Annona squamosa	sweetsop	Americas	India, Timor
Arachis hypogaea	peanut	Americas	China, India
Argemone mexicana	Mexican poppy	Americas	China, India
Aristida subspicata		Americas	Polynesia
Artemisia vulgaris	mugwort	Eastern Hemisphere	Mexico
Asclepias curassavica	milkweed	Americas	China, India
Aster divaricates		Americas	Hawaii
Bixa orellana	achiote, annatto	Americas	Oceania, Asia

Species	**Common Name**	**Origin**	**Moved To**
Canavalia sp.	swordbean, jack bean	Americas	Asia
Canna edulis	Indian shot	Americas	India, China
Cannabis sativa	hashish	Eastern Hemisphere	Peru
Capsicum annuum	chili pepper	Americas	India, Polynesia
Capsicum frutescens	chili pepper	Americas	India
Carica papaya	papaya	Americas	Polynesia
Ceiba pentandra	kapok, silk cotton tree	Americas	Asia
Chenopodium ambrosioides	Mexican tea, apazote	Eastern Hemisphere	Mesoamerica
Cocos nucifera	coconut	Eastern Hemisphere	Colombia to Mexico
Couroupita guianensis	cannonball tree	Americas	India
Cucurbita ficifolia	chilacayote	Americas	Asia
Cucurbita maxima	Hubbard squash	Americas	India, China
Cucurbita moschata	butternut squash	Americas	India, China
Cucurbita pepo	pumpkin	Americas	India, China
Curcuma longa	turmeric	Eastern Hemisphere	Andes
Cyperus esculentus	sedge	Americas	Eurasia
Cyperus vegetus	edible sedge	Americas	India, Easter Island
Datura metel	datura, jimsonweed	Americas	Eurasia
Datura stramonium	datura, thorn apple	Americas	Eurasia
Diospyros ebenaster	black sapote	Americas	Eurasia
Erigeron canadensis		Americas	India
Erythroxylon novagranatense	coca	Americas	Egypt
Garcinia mangostana	mangosteen	Eastern Hemisphere	Peru
Gossypium arboreum	a cotton	Eastern Hemisphere	South America
Gossypium barbadense	a cotton	Americas	Marquesas Islands
Gossypium gossypioides	a cotton (genes)	Africa	Mexico
Gossypium hirsutum	a cotton	Mexico	Africa, Polynesia
Gossypium tomentosum	a cotton	Americas	Hawaii
Helianthus annuus	sunflower	Americas	India
Heliconia bihai	balisier	Americas	Oceania, Asia
Hibiscus tiliaceus	linden hibiscus	Americas	Polynesia
Ipomoea batatas	sweet potato	Americas	Polynesia, China
Lagenaria siceraria	bottle gourd	Americas	Asia, East Polynesia
Luffa acutangula	ribbed gourd	Americas	India
Luffa cylindrica	loofa, vegetable gourd	Americas?	India, China
Lycium carolinianum		Americas	Easter Island
Macroptilium lathyroides	phasey bean	Americas	India
Manihot sp.	manioc	Americas	Easter Island
Maranta arundinacea	arrowroot	Americas	Easter Island, India
Mimosa pudica	sensitive plant	Americas	India, China
Mirabilis jalapa	four-o’clock	Americas	India
Mollugo verticillata	carpetweed	Eastern Hemisphere	North America
Monstera deliciosa	a climbing aroid	Americas	India
Morus sp.	mulberry tree	Eastern Hemisphere	Middle America
Mucuna pruriens	cowhage	Americas	India, Hawaii
Musa x *paradisiaca*	banana, plantain	Eastern Hemisphere	Tropical America
Myrica gale	bog myrtle	Eastern Hemisphere	North America
Nicotiana tabacum	tobacco	Americas	South Asia

Species	Common Name	Origin	Moved To
Ocimum sp.	basil	Americas	India
Opuntia dillenii	prickly pear cactus	Americas	India
Osteomeles anthyllidifolia		Americas	China, Oceania
Pachyrhizus erosus	jicama	Americas	Asia
Pachyrhizus tuberosus	jicama, yam bean	Americas	India, China, Oceania
Pharbitis hederacea	ivy-leaf morning glory	Americas	India, China
Phaseolus lunatus	lima bean	Americas	India
Phaseolus vulgaris	kidney bean	Americas	India
Physalis sp.	ground cherry	Americas	China
Physalis peruviana	husk tomato	Americas	East Polynesia
Polygonum acuminatum	a knotweed	Americas	Easter Island
Portulaca oleracea	purslane	Americas	Eurasia
Psidium guajava	guava	Americas	China, Polynesia
Salvia coccinea	scarlet salvia	Americas	Marquesas Islands
Sapindus saponaria	soapberry	Americas	India, East Polynesia
Schoenoplectus californicus	bulrush, totora reed	Americas	Easter Island
Sisyrhynchium acre	a 'grass'	Americas	Hawaii
Sisyrhynchium angustifolium	blue-eyed 'grass'	Americas	Greenland
Smilax sp.	sarsparilla	Eastern Hemisphere	Central America
Solanum candidum / S. lasiocarpum	naranjillo	Americas	Oceania, Southeast Asia
Solanum nigrum	black nightshade	Eastern Hemisphere?	Mesoamerica
Solanum repandum / S. sessiflorum		Americas	Oceania
Solanum tuberosum	potato	Americas	Easter Island
Sonchus oleraceus	sow thistle	Americas	China
Sophora toromiro	toromiro tree	Americas	Easter Island
Tagetes erecta	marigold	Americas	India, China
Tagetes patula	dwarf marigold	Americas	India, Persia
Zea mays	corn, maize	Americas	Eurasia, Africa?

SOME PARTICULARLY SALIENT CASES FROM THE FLORA

We have not treated all the species at equal length. In this section, we present some especially cogent cases. Data of lesser interest are postponed in the interest of clearer presentation of the primary argument, but in the Appendix we present full data in our possession for every species.

Amaranthus spp.

The grain amaranths, *Amaranthus hypochondriacus* and *A. caudatus*, are both native to the New World (Sauer 1950, 612–13; 1967; Brücher 1989, 54–6), where they constituted important cereal crops. These plants have been grown for a long time in Asia as well.

Some of the significance of this American/Asian distribution was first presented in Jonathan Sauer's monograph on the grain amaranths, published in 1950 (588–614). He concluded (page 613) that "… there is a great, vaguely delimited grain amaranth region stretching all the way from Manchuria through interior China and the Himalaya to Afghanistan and Persia. *A. leucocarpus* [now known as *A. hypochondriacus*, from Mexico; see Brücher 1989, 56] and *A. caudatus* [from the Andes] are both grown throughout this

[Asian] area." Culinary uses were similar in Asia and the Americas; after being parched or popped, "the seeds were sometimes made into balls, like popcorn, using a syrup or other binder, or the seeds were ground and the flour was stirred into a drink or baked in small cakes."

Sauer also observed (page 588) that, "The crop is scattered so widely through Asia and is so firmly entrenched among remote peoples that it gives a powerful impression of great antiquity in the area;" in fact, it would seem to have been present "from time immemorial." Yet, "the available Old World specimens represent nothing but a small sample of the diversity present in the American grain amaranths." Hence, "The conclusion appears inescapable that the grain amaranths are all of New World origin." However, species of amaranths that are used as potherbs or for decoration (or that are mere weeds) are another matter; those that grow in Asia are Asian natives (Sauer 1967). (In his later publications, Sauer showed reluctance to accept the early transoceanic contact that his first results implied, although the facts of the matter remained unchanged.)

In Mesoamerica, the cultivation of a grain amaranth began as early as 4000 BC (García-Bárcena 2000, 14), and wild species there provide plausible ancestors for the earliest domesticated amaranths. No comparable ancestors for the grain amaranths are known from Asia. While grain amaranths appear to be historically old in Asia on the basis of the evidence mentioned by Sauer, exactly when the transfer of the grain amaranths from their American area of origin took place went unspecified in the literature for many years**.**

Sauer (1950) was impressed that Bretschneider (1896, 406) presented "what seems to be a clear reference to a grain amaranth" in a Chinese text. The reference is to the *Kiu Huang Pen Ts'ao (Jiu huang bencao*) (Bretschneider 1882, 49). That volume includes descriptions and woodcut illustrations for 414 plants, based on older printed works, plus the author's own observations. The editor/author, Zhou Ding wang, died in AD 1425. The source of his citation for amaranth was a document written about AD 950 or the Prince of Shu, in modern Sichuan. It recognized six kinds of *hien* (*xian*), a generic name for a group of related plants. A "modern record of grain amaranths from the same area … gives the same name," Sauer adds. The pre-Columbian presence of grain amaranths in Asia that was indicated by their wide distribution is thus confirmed by this 10th century mention.

Archaeology now has confirmed a dramatically earlier date for the grain amaranths in Asia. Seeds of *A. caudatus*, along with *A. spinosus*, a thorny weed that also grew in pre-Columbian Mesoamerica (Sauer 1967, 1007; Miranda 1952–53, I, 215), have been excavated in India. They date to the 1000–800 BC period at the site of Narhan (Gorakhpur Dist., Uttar Pradesh) (Saraswat *et al*. 1994, 282, 284, 331). Such a date is congruent with the distributional evidence in Asia as interpreted by Sauer.

The idea of an early movement of amaranths to Asia is supported by information on maize (*Zea mays*). In the 1960s, a "primitive maize" was found in cultivation in the Himalayan country of Sikkim. Botanists judged that it most closely resembled the "wild maize" of "ancient Mexico, a fossil specimen of which was uncovered [in 1960] in a lower level of San Marcos Cave in [the Tehuacán Valley of] Mexico" (Marszewski 1975–78, 132–34, *cf*. 162; Dhawan 1964; Gupta and Jain 1973). The date for maize of this type in Mexico is not entirely clear; it could be as early as the 5th millennium BC, or it may fall in the 3rd millennium BC (Johnson and MacNeish 1972, 21*ff*.; Long *et al*. 1989). (See more on maize in Asia below.)

We have seen above that from the point of view of nautical history we not only can, but must think of watercraft as capable of trans or peri-oceanic sailing as early as this time frame. In recent years, serious proposals about early sailing capability have been made by archaeologists and others involved in research on the question of the early settlement of the Americas. Some see early sailing to be thoroughly plausible (Dixon 1993; Center for the Study of the First Americans 1999). Data on navigation in Near Oceania and Australasia have shown that there was a spectacularly early capability to cross stretches of open ocean. Australia was reached from Papua New Guinea or Timor perhaps more than 50,000 years ago. The Solomon Islands were inhabited nearly 29,000 years BP (before present) after an open-sea crossing of over 100 miles (Gamble 1993, 214–30). Bednarik (1997) has argued convincingly that *Homo erectus* in island Southeast Asia had "almost habitual use of navigation" of some sort by 840,000 years ago! He and his associates constructed a craft on the island of Timor using only Lower Pleistocene stone-tool technology. They used the craft to cross to Australia (2001). For more recent times, researchers have established that trading voyages thousands of miles in length were carried on in the Pacific millennia ago (*Science News* 1996; Service 1996; Jett 1998; Dickinson *et al*. 1999).

Nautical history and modern experimental voyages have demonstrated that oceanic voyaging in early times was not as daunting as many moderns have supposed, at least not to certain types of people (Jett 1971, 16–19; Helms 1988). In modern days, oceans have been crossed hundreds of times in unlikely craft ranging from midget and small boats, rafts, rowboats, and canoes to even less conventional vessels (see Anthony 1930; Barton 1962; Borden 1967). The ocean is not nearly as severe and fearsome a barrier to technologically limited voyagers as landlubbers have been wont to suppose. One experienced sailor of small boats in the tropics went so far as to assert, "It takes a damn fool to sink a [small] boat on the high seas" (Lindemann 1957). Despite well-documented evidence for the ancient capability for oceanic travel, a negative attitude has persisted among scholars that has been called "American thalassophobia" (illogical aversion to {considering} the sea as a route) (Elkin and MacIntosh 1974, 181) and "intellectual mal de mer" (Easton 1992). This phobia "cannot abide sea-travel as a mode of communication" (Meggers 1976); its grip has kept virtually all New World archaeologists from even inquiring whether shipping could have spread ancient cultures and people over long distances (*e.g*., Chard 1958).

Recently, however, realization has grown among up-to-date scholars that voyagers using simple technology could have reached the New World millennia ago. Over 40 years ago, archaeologist G. Bushnell (1961) granted that there was nothing physically impossible about vessels coasting round the North Pacific at any time after 8000 BC. Since then, Fladmark has argued repeatedly for a similar thesis (1979; 1983; 1986). Dixon considered it "not unreasonable" (1993, 119) to assume that watercraft were capable of moving along the coast from Asia by 13,000 BP. Six years later (1999, 31), he had changed that estimate to 16,000 BP. Nowadays, the coastal voyaging position is supported with increasing frequency (Engelbrecht and Seyfert 1994; Gamble 1993; Borg 1997; Dillehay 2000). A respected archaeologist, Dennis Stanford of the Smithsonian, has even proposed that Late Paleolithic (Solutrean) hunting people from Western Europe made their way around the ice-bound edge of the North Atlantic to settle in Late Pleistocene North America (Holden 1999a).

Support has continued more restrained for the idea of voyages directly across the Pacific. The hypothesis put forward 40 years ago, that voyagers bearing ceramics of the Jomon culture of Japan reached Ecuador around 3000 BC (Estrada and Meggers 1961), was accepted by a number of prominent archaeologists (*e.g*., Willey 1971, 16; Kidder II 1964, 474; Jennings 1968, 176, but with some subsequent hedging). Edwards (1965; 1969) and Doran (1971; 1978) presented many details about the nautical capability of Chinese sea-going rafts and made patent that the rafts of coastal Peru and Ecuador were explicitly parallel in form and capability to those of China, Indochina, and India (*cf*. Needham *et al*. 1985, 48–9). The work of Edwards and Doran has been readily available but widely ignored. There is no question that those rafts (more accurately 'ships') were capable of direct transpacific voyages. Although the date for historical documents on these Chinese and Southeast Asian ocean-going vessels only goes back to the 1st century BC (Ling Shun-shêng 1956), the craft could easily prove to be much older (Edwards 1965, 98–100; Needham *et al.* 1971, 542–43).

In Peru, balsa rafts were in use along the shore by 2500 BC and ocean-going craft well before the 1st century BC (Norton 1987). Alsar (1973; 1974) demonstrated the feasibility of crossing the Pacific from east to west by sailing a fleet of three Ecuadorean-built rafts with a crew of 12 over 9,200 miles to Australia (the rafts even exchanged crew members at rendezvous points en route). Various forms of such rafts, in addition to large canoes, were used throughout much of Oceania (Clissold 1959). Our present state of knowledge about ancient nautics does not rule out voyages that could account for the early presence of amaranth, maize, the peanut, and other crops, as well as the hookworm, in both Asia and the Americas.

Arachis hypogaea

Early specimens of *Arachis hypogaea*, the peanut, have been found by archaeologists in China. Because the plant is a South American native, when specimens were found over 40 years ago at Neolithic-age sites in China, some biologists and archaeologists claimed that there was something wrong with the specimens or with the dates attributed to them (Harlan and de Wet 1973; Peng 1961). But the critics failed to examine the evidence carefully enough; the specimens were unquestionably peanuts, and the stratigraphy was sound.

TABLE 2

FLORA FOR WHICH EVIDENCE IS SIGNIFICANT BUT NOT DECISIVE

Species	Common Name	Old World	New World
Acorus calamus	sweet flag	Origin	North America
Amanita muscaria	fly agaric	Origin	Middle America
Chenopodium quinoa	quinoa	Easter Island	Origin
Erigeron albidus		Hawaii	Origin
Gnaphalium purpureum		Hawaii	Origin
Indigofera sp.	indigo	Polynesia, Asia?	Mexico, Peru
Ipomoea acetosaefolia		Hawaii	Origin
Mangifera indica	mango	Origin	Middle America
Musa coccinea	Chinese banana	China	South America
Nelumbo nucifera	East Indian lotus	East Indies, India	Tropics
Nymphaea nouchalli	Indian water lily	India, Egypt	Tropics
Phaseolus adenanthus		Polynesia	South America
Saccharum officinarum	sugar cane	Origin	South America
Salvia coccinea	scarlet salvia	India	Origin
Salvia occidentalis	a salvia	Marquesas	Origin
Smilax sp.	sarsaparilla	Eurasia	Middle America
Triumfetta semitriloba		Easter Island	Origin
Verbesina encelioides		Hawaii	Origin
Vitis vinifera	grape	Eurasia	Mexico

The peanut has since been discovered by archaeological excavation in caves on the island of Timor in Indonesia (Glover 1977, 43, 46). Nuts were found along with two other American plant species, the *Annona squamosa* fruit (custard apple) and *Zea mays* (maize), dated after the third millennium BC but before AD 1000, when the caves were no longer inhabited.

Safford had observed (1917, 17) that the kind of peanut found in graves at Ancón, Peru, was the same as that cultivated in China, Formosa, and India. Anderson (1952, 167) noted that "until the Peruvian excavations, the experts were certain that it [the peanut] came from the Old World, so widely is it disseminated there, with every appearance of having been grown for a very long time in Asia and Africa." More specifically, he added that "The most primitive type of peanut, the same narrow little shoestrings which are found in the Peruvian tombs, are commonly grown today, not in Peru, but in South China."

Towle (1961, 42–3) later noted that one of two kinds of peanuts from the [Peruvian] tombs found in coastal sites is “similar to one grown in the Orient today.”

Any question that Sinologists might have retained about the age of peanuts in China has been put to rest by more recent digging on the mainland. Some “10 or more” additional specimens of nuts have been found in the 3rd-century BC tomb of Western Han emperor Yang Ling in Xianyang, Saanxi (Chen Wenhua 1994, 59–60). Radiocarbon dates associated with the original two finds mentioned above put them as early as around 2800 BC (Chang 1973, 527). The more recent discoveries show the crop was still being grown two and one half millennia later, and use of the cultigen continues into modern times, as Anderson (1945) observed.

TABLE 3

FLORA FOR WHICH EVIDENCE JUSTIFIES FURTHER STUDY

Species	Common Name	Species	Common Name
Ageratum houstonianum	floss flower	*Indigofera tinctoria*	indigo
Annona glabra	pond apple	*Lonchocarpus sericeus*	
Cajanus cajan	pigeon pea	*Lupinus cruickshanksii*	field lupine.
Cassia fistula		*Lycopersicon esculentum*	tomato
Cinchona officinalis	quinine (bark)	*Nicotiana rustica*	wild tobacco
Colocasia esculenta	dry-land taro	*Ocimum americanum*	hoary basil
Cucumis sp.		*Paullinia* spp.	
Cyclanthera pedata	pepino hueco	*Sagittaria sagittifolia*	wapatoo
Datura sanguinea		*Sesamum orientale*	sesame
Derris sp.		*Sisyrhynchium acre*	
Dioscorea alata	yam	*Spondias lutyea*	
Dioscorea cayenensis	guinea yam	*Spondias purpurea*	hog plum
Dolichos lablab		*Synedrella nodiflora*	
Elaeis guineensis	guinea oil palm	*Tamarindus indicus*	tamarind tree
Gossypium brasiliense	a cotton	*Tephrosia* spp.	
Gossypium drynarioides	a cotton	*Trapa natans*	water chestnut
Gossypium religiosum	a cotton	*Vigna sinensis*	
Hibiscus youngianus			

Krapovickas (1967) compiled names for the peanut from Native American peoples in the Amazon Basin, the area where botanists think the plant was first domesticated. There, it bears such names as Tupí: *mandobi*, *manobi*, *mandowi*, *mundubi*, and *munui*; Pilagá: *mandovi*; Chiriguano: *manduvi*; and Guaraní: *manubi*. Black (1988) compared these terms with names for the peanut in India (taken from Kirtikar *et al*. 1935, 754–65) and found Sanskrit *andapi*; Hindi *munghali*; and Gujarati *mandavi*. These patent lexical parallels taken together with the plant specimens in Asia mean no less than that transoceanic voyaging was surely responsible for the plants and the names reaching Asia.

Erythroxylon novagranatense

The discovery of coca (*Erythroxylon* sp.) in Egypt was even more shocking. In western South America its leaves have been chewed for its chemical effect for more than 4,000 years (Plowman 1984; Shady S. 1997), although outside the Andean area where it is grown there is little evidence for consuming it. By what route the plant reached Egypt is unclear. Attempts to explain how its chemical signature came to appear in the Egyptian mummies without involving New World contacts seem outlandish.

About as strange as coca's use in the Near East is the fact that Peruvian mummies dating to before AD 200 have been found to contain both physiologically processed residues of tobacco and coca, as well as hashish (*Cannabis sativa*). Hashish is an ancient in the Old World (Parsche *et al*. 1993).

Despite the discomfort caused by having a paradigm upset, we must accept that the evidence is convincing for ingesting tobacco, coca, and hashish, at least in Egypt and in Andean South America by the beginning of the 1st millennium BC. The only explanations for that distribution involve voyages across the ocean.

Gossypium spp.

The early history of cotton (*Gossypium* spp.) in the New World is found, upon cytogenetic analysis, to be tied directly to Asian cotton. For over half a century most botanical models for the origin of the American cottons have depended heavily on the work by a group of cotton scientists led by Joseph Hutchinson with colleagues Silow and Stephens (1947). They argued that in order to rationalize the facts about the chromosome structure of later cottons, we must suppose that a diploid species, either *Gossypium arboreum* or *G. herbaceum*, had been carried from India to the Americas at an early date. Here, it hybridized with a Native American diploid lintless species to yield a tetraploid (having doubled the number of chromosomes in the diploid hybrid) cotton that had longer, more useful fibers. The genetic composition of all subsequent domesticated American cottons incorporates the Old World chromosomes of *G. arboreum* (or, alternatively, *G. herbaceum*) (the D genome) with A genome chromosomes from the American ancestor. Hutchinson *et al.* (1947) postulated that the first American hybrid subsequently became extinct, but that two of its descendant species, *G. hirsutum* and *G. barbadense*, became the bases for all subsequent domesticated cotton varieties in the New World.

So, when did *G. arboreum* reach the Americas? Archaeologists have found Mesoamerican specimens of *G. hirsutum* dating to the 4th or 5th millennium BC (MacNeish *et al.* 1967, 191), and *G. barbadense* was being grown in Peru by the mid-3rd millennium BC (Yen 1963, 112; Shady S. 1997). The time of arrival of the ancestral Asian diploid, of course, had to be earlier still, perhaps as early as the 5th millennium BC.

Before Columbus' time, American cottons were carried across the oceans to parts of the Old World. Historical documents from the Cape Verde Islands show that *G. hirsutum*, the Mexican species, had apparently reached the Guinea Coast of Africa, by means of some unrecorded voyage, before Columbus' first voyage. Cape Verdean records report that a cotton arrived there from West Africa some 25 years prior to 1492. Remnants of that cotton turn out to have the American tetraploid genetic structure (Stephens 1971, 413–14). (Arab sailors may have carried *G. barbadense* from the Americas to Africa, it was suggested by Jeffreys {1976}, perhaps along with corn, he thought.)

Cottons that evolved from the American tetraploid species were also found by the earliest European explorers when they reached islands in eastern Polynesia (Stephens 1947; 1963; Merrill 1954; Wendel 1989; Langdon 1982). (Johnson and Decker {1980} show that languages across the entire Pacific Basin have terms for cotton that also signify {fish}line.)

Recent genetic research has shown that a portion of the gene sequence of a local cotton species in southern Mexico, *G. gossypioides*, had one line of its ancestry direct from an African cotton (Wendel *et al*. 1995, 308–9). The genetic argument holds that some unknown but distinctively African cotton was introduced anciently to Mesoamerica. There, part of its gene sequence was incorporated by introgression into a pre-existing American species to yield *G. gossypioides*. We do not have direct evidence for a voyage, but no sequence of purely natural events can be conceived of to explain the arrival of the African element. Stephens (1971, 406–8) points out why an accidental, passive scenario for the spread by ocean drift of any variety of domesticated cotton is highly unlikely.

Despite the notable discoveries of the past half-century about the history of cottons, the comings and goings of those plants across the oceans still pose complex questions. The only answers that make sense, we feel assured, involve voyagers crisscrossing the oceans to an extent that no one anticipated 60 years ago.

Ipomoea batatas

The problem of the dispersion of the sweet potato has produced a huge literature over the past 75 years. At long last we have virtual resolution of several facets of the issue.

Ipomoea batatas has been found fossilized in a Peruvian cave dated perhaps as early as 10,000 BP (Brücher 1989, 5). The domesticated sweet potato was being grown in the precocious pre-ceramic city of Caral in the Supe Valley of Peru, a few miles from the coast, between 2700 and 2100 (calibrated radiocarbon dates) (Shady *et al*. 2001, 725). A name for *Ipomoea batatas* has been reconstructed for the proto-Mayan language in Guatemala before 1000 BC (Bronson 1966, 262 *ff*.) Later, common names for the plant in the Peruvian and Ecuadorian Andes, and probably on the coast as well, included variants of *cumara* or *cumal* (Patiño 1964, 62; Heyerdahl 1963, 29); speakers of the Chibchan family of languages in Colombia and Panama used a cognate name (see Kelley 1998, 73). Very similar names (see below) were applied later to the sweet potato in Polynesia. Although the claim was made as much as 75 years ago that the sweet potato spread into Polynesia only via Spanish exploring ships (Laufer 1929), traditions, linguistic studies among the island peoples, and explorers' historical records contradicted that position. Rather, those sources painted a picture of early canoe voyagers apparently carrying *I. batatas* tubers with them from the mainland to the islands (Dixon 1932), or else Amerindians were the carriers, westward. As late as the 1970s, passionate but ill-informed arguments (Brand 1971; O'Brien 1972) were still being offered to stifle the idea that Polynesian voyagers had reached the continent and obtained the sweet potato.

Yen (1974) capped a comprehensive investigation of the dispersion question by concluding that the data require transfer of the sweet potato from South America to Polynesia between AD 400 and 700 to account for its distribution. Since his study, archaeology has confirmed that view. For example, burnt tubers were found on Easter Island dated "early AD" by radiocarbon, while other evidence has also come to light for transfer to Polynesia prior to European exploration (Hather and Kirch 1991, 169; Yen 1998). Moreover, new linguistic studies have shown that American names for the tuber were brought into the eastern Pacific with the plant (Rensch 1991, 108; Kelley 1998). Rensch has found that the sweet potato reached Polynesia at least twice, once via introduction to Hawaii and once through Easter Island. Barthel (1971, 1165–86) reported deciphering an Easter Island text that refers to a directional model where the "path of the sweet potato" was from the east, while a "path of the breadfruit tree" signified from the west. Both fit botanical reality.

The sweet potato also reached Asia long ago, as Baker (1971) had thought. Bretschneider (1882, 38) reported that the Chinese document *Nan fang Ts'ao Mu Chan*g mentions the *I. batatas* plant. The author was Ki Han during the Tsin (Jin) Dynasty, between AD 290 and 307. We note now complementary evidence from India. Aiyer (1956, 71) cites the Sanskrit name, *valli*, and Pullaiah (2002, II, 307) gives two more: *pindalah and raktaluh*. Aiyer (1956, 71) also reports mention of *I. batatas* in the Hindu text *Silappadikaram*. Yen, in a 1996 personal communication to Johannessen, reported that the sweet potato had the same name in Sanskrit as it had in northwestern South America. Kelley (1998, 72) has studied plant names for sweet potato and concludes that "An Indonesian word for 'yam,' **kumadjang*, appears to have been borrowed by Quechuan and by Chibchan languages (of northwestern South America) and reapplied to 'sweet potato.'" From Quechuan it (the name) was "transferred to southern Polynesia, and from Chibchan it seems to have gone to Hawaii." It would seem that the voyages and botanical movements involving the sweet potato were complex, and that we have detected them only in part so far.

Nicotiana tabacum

The question of whether tobacco (*Nicotiana tabacum*), a plant native to the Americas, was found in ancient Egypt has arisen in the last quarter-century as a result of museum research. Fragments of tobacco were found about 30 years ago in the abdominal cavity of the mummy of Ramses II in a European museum (Bucaille 1990). In the intervening years, a large literature has arisen about the resulting controversy (the best survey is found in Jett 2003). In 1992, physical scientists in Germany used sophisticated instrumentation to examine nine Egyptian mummies in order to learn about the ancient use of hallucinogenic or narcotic substances. They found chemical residues of tobacco, cocaine, and hashish in the hair, soft tissues, skin, and bones of eight of the nine, including metabolically processed derivatives of the drugs, signifying that the drugs were ingested while the subjects were alive. (Cocaine and hashish, but not tobacco, were found in the ninth mummy.) The historical dates of the mummies ranged from 1070 BC to AD 395 (Balabanova *et al*. 1992a), indicating that the plants yielding the drugs were apparently continuously available, at least to Egyptian royalty, for over 1,400 years. Investigators have since found evidence of the drugs in additional mummies (Nerlich *et al*. 1995; Parsche and Nerlich 1995; Balabanova *et al*. 1997). Despite charges by critics that the analyses must have been faulty, the scientists involved have vigorously defended their work, and recent independent critiques give them good marks (Wells 2000; see also Pollmer 2000). All attempts to explain the unexpected findings without granting the presence of the American plants in the Old World have serious flaws (see, *e.g*., Buckland and Panagiotakopulu 2001; the critiques in Jett 2003 and 2004, and Wells 2000).

The nub of the controversy is, of course, that according to the standard paradigm of plant history, tobacco "should not" appear at all in Egypt or anywhere else in the Old World until after Columbus. Extravagant claims by Leo Wiener (1920–1922) about pre-Columbian tobacco in the Old World had been dismissed curtly by anthropologists and historians (*e.g*., Dixon 1920; 1921). But recently, Ashraf (1985) found that textual and artistic materials in India as far back as medieval times witness the presence and use of tobacco. The evidence includes a Sanskrit name, *tanbaku* (and/or *támrakúta*; Nadkarni 1914, 257), along with representations or mentions of the water-cooled pipe (*huqqa*, or hookah) for smoking, but other scholars do not seem to have paid attention to Ashraf's evidence. Now, the facts obtained from study of the Egyptian mummies leave no plausible explanation other than that *N. tabacum* was indeed used in antiquity in the Old World, and that could only be so if it was taken there at some early point in history by voyagers.

Zea mays

The literature on the question of whether maize (*Zea mays*) appeared in Eurasia before the time of Columbus has become large and contentious. Few botanists and even fewer archaeologists or historians have combed that literature exhaustively.

As noted above, field investigations have discovered odd sorts of maize growing in Asia (especially Sikkim Primitive in the remote Himalaya and 'waxy' varieties from Myanmar {Burma} all across China to the Korean peninsula), mostly away from coastal areas where 16th-century Iberian sailors are supposed to have first introduced maize. The characteristics and distribution of these grains cannot be explained in terms of post-Columbian introduction, because waxy varieties were not known in the Americas (Marszewski 1975–78, 1987; Johannessen and Wang 1998; Collins 1909; Stonor and Anderson 1949; Suto and Yoshida 1956; Dhawan 1964; Thapa 1966; Chiba 1968, 1969, 1970; Gupta and Jain 1973; The Wealth of India 1974). Yet, some unusual traits exhibited in these Asian maizes have close matches to corn known archaeologically from Peru (Towle 1961, 21–5), or that is still being grown by native groups in Peru, Colombia, Chile, Bolivia, and Argentina (Anderson 1945; Sarkar *et al.* 1974).

Utterly decisive evidence for the presence of American maize in the Old World has been found in Asian art and archaeology. Johannessen and colleagues (1998a; Johannessen and Parker 1989a) were the first to document extensively that maize ears were represented in sculptures of ears of corn—hundreds of them—on original temple walls in Karnataka State, southern India (details are found in the Appendix). This art usually dates from the 11th to the 13th centuries AD, but some representations are much older.

Gupta independently identified maize, as well as a number of other plants of American origin, sculpted on Indian temples and monuments. For example, at the Lakshmi Narasimha temple, Karnataka, "Nuggehalli, the eight-armed dancing Vishnu in his female form Mohini, is holding a corn cob [ear] in one of her left hands, and the other hands hold the usual emblems of Vishnu" (Gupta 1996, 176). At least one maize representation dates from the 1st century AD (Cave Temple III, Badami, where, uniquely, the cob is held horizontally and the stem of the ear shows; Johannessen and Parker 1987b, 4).

In India, four Sanskrit words for maize have been recorded (Watt 1888–1893**,** VI, Pt. IV, 327; Balfour 1871–73, V, s.v. "Zea"), while the *Garuda Purana* (1980, 925, 947, 1128), as well as the *Linga Purana* (1973, 58, 85) texts of the 5th century AD refer to maize. The common name for maize throughout most of India is similar to that for the same plant among Arawak-language speakers of lowland South America (Johannessen 1992).

From near Zhenghou, Henan province, China, comes a ceramic effigy of a bird that was found in an excavation of an imperial tomb of the Han Dynasty. Impressions left on the interior of the figure show that a de-grained corncob had been used as an armature around which wet clay was modeled in avian form and then fired. The cob had, of course, burned up in the kiln. The age of the tomb is about 2000 BP (Johannessen and Wang 1998, 28). The same authors have published a bas-relief showing maize on a wall panel from the Prambanan Temple complex, east of Jogjakarta, Java, dating before AD 1000.

In the Middle East, maize was grown too, as Jeffreys long argued (1953a; 1953b; 1971; 1975; 1976). An Arabian juridical tradition, recorded in Yahya ben Adam's *Kitab al Karaj* (about AD 800), lists maize among other grain and pulse crops on which a tax could justly be levied (Ben Shemesh 1958, 77). Meanwhile, there is considerable reason to believe that maize was in Europe before Columbus' time (see, *e.g.*, Finan 1948; C. Sauer in Newcomb 1963). Overall, there is not the slightest question remaining that maize was carried from the Americas to Asia millennia ago—at least once and perhaps multiple times.

OTHER SPECIES OF FLORA FROM TABLE 1

We next present summaries of key evidence for other plants listed in Table 1. For maximum documentation on the entire list, see the Appendix.

Agave sp.

The entire genus *Agave* is of American origin, yet it was represented in Old World biotas of several regions. Already by 1809, Lord Valentia, a traveler in India, observed that agave plants were "in such profusion that it is hardly possible to suppose it could have been introduced from America [*i.e.*, after Columbus]" (Desmond 1992, 201).

When agave plants have been observed growing in Eurasia in recent centuries, scientists have always assumed that they were imports via Iberian ships after AD 1500. Thus, the shock was understandable when Steffy (1985) reported in a premier archaeological journal the discovery of 'agave' fibers mixed with pine resin that served as watertight caulking (between the hull and a sheet of lead lining) in a 4th-century BC Greek ship that had sunk at Kyrenia, Cyprus. Queried by us about the apparent geographical anomaly of agave in the Mediterranean, Steffy responded (2001), "You wouldn't believe how many people have protested that statement, but I was only repeating the identifications made by professionals [botanists] in respectable laboratories," starting with the Royal Botanic Gardens, Kew. (The genus, but no particular species, was identified.) Furthermore, he has been told by other Mediterranean archaeologists that they too have excavated agave specimens but have not reported the discoveries in print (probably because they anticipated hostility to the implications about transoceanic voyaging). Some feel that a plant of this genus must have been growing somewhere in the Mediterranean basin, Steffy continued, although no specific botanical evidence for that view has been put forward of which we are aware.

The plausibility of Steffy's find was recently supported by a datum first reported over 70 years ago. A Mexican archaeologist discovered an apparent Roman figurine head while excavating a site of Aztec age in central Mexico (García-Payón 1961). Two Mexican scholars recently tracked down that object, along with the archived excavation notes. They established beyond question that the head had come from beneath sealed floors where it had been buried no later than the1400s, at least a generation before Cortéz arrived. A thermoluminescence dating test on the terracotta head put its age long before Columbus. Stylistic analysis by experts on Roman art put the date of manufacture around the 2nd century AD (Hristov and Genovés 1999). At the least, this information shows that a (presumably) Roman ship very probably reached Mexico; a return trip could have carried agave plants, or at least the fiber, to the Mediterranean.

Anacardium occidentale

Anacardium occidentale is the cashew nut. This tree, native to the Americas, was introduced to India in the 16th century by the Portuguese, but it is now clear that it was present long before. The distinctive fruit was clearly represented on a bas-relief at the Bharhut Stupa (2nd century BC). Images of the nut had been carved adjacent to renderings of annona (custard apple), another American fruit (Gupta 1996, 17; Watt 1888–1893, I, 259; Cunningham 1879). In addition, the cashew bore a name in Sanskrit, *bijara sala* (Balfour 1871–73, I, 107; III, 409).

Anana comosus (syn. *sativa*)

Anana comosus, the pineapple, originated in Brazil. It is shown in a sculpture of the 5th century AD at a cave temple in Madhya Pradesh, India, as well as at a site in Gujarat, also in India (Gupta 1996, 18). A pineapple fruit pictured in an Assyrian bas-relief of the 7th century BC was confidently identified by the Assyriologist Rawlinson ("The representation is so exact that I can scarcely doubt the pineapple being intended") and confirmed by Layard, the excavator of the relief (Collins 1951). The fruit is also represented on artifacts from Egypt (Wilkinson 1879) and in an Ankara museum (seen by Johannessen 1998). Its presence on a Pompeii mural has been claimed; Johannessen's search at the site failed to confirm it.

Annona spp.

At least three species of the annona have been identified in art and referenced in the mythic literature of India. Images of the fruit and leaves of *Annona squamosa* at Bharhut Stupa place the plant in India by the 2nd century BC (Gupta 1996, 19–20; Cunningham 1879). The fruit is also seen carved on the gateway at Sanchi, on sculptures excavated from Mathura (Pokharia and Saraswat 1998–1999), and at the Ajanta Caves (Watt 1888–1893, I, 259). Johannessen and Wang (1998, 16–17) illustrate an *A. squamosa* fruit in the hands of a goddess sculpted on the 10th-century AD Durga Temple at Aihole, Karnataka, India. The fruit is also depicted at other Hindu and Buddhist temples in the states of Madhya Pradesh, Karnataka, Bengal, and Andhra Pradesh. For example, Bussagli and Sivartamamurti (1978, 189, Fig. 216) picture an 8th-century sculpture of Varuna, lord of the waters, seated with his consort on a *makara* monster and holding in his hand an annona fruit. Archaeological discovery of annona seeds in a cave on Timor, prior to AD 1000 at the latest, further confirms the Indian art (Glover 1977, 43, 46).

The plant is mentioned also in the traditional literature of India, where it is widely called *sitaphala*, 'the fruit of Sita,' because of a popular belief that Sita, wife of Ramachandra of the *Ramayana* epic, subsisted on the fruit of this tree while in exile (Gupta 1996, 19). In Kerala, the tree is called *Ramachakkamaram*, "tree bearing the fruit of Lord Rama" (Nicolson *et al.* 1988, 50). In Sanskrit, a short name of the tree is *sita* (Watson 1868, 527); it also has a second Sanskrit name, *gunda-gutra*, or *gunda-gatra* (Watson 1868, 181, 527), and Nadkarni (1914, 38) lists two other Sanskrit names, *shubhâ* and *suda*.

Annona reticulata and *A. cherimolia* were also present in India. In Sanskrit, the former was also called *rama-sita*, in addition to three other names (Watt 1888–1893, I, 125; Watson 1868; Torkelson 1999, 1646; Int. Lib. Assoc. 1996, 559). Bishagratna (1907, 72) reads it in a text assigned to the 6th century BC. It is still widely cultivated in Kerala, where it bears the name *Ramachakkamaram* (Nicolson *et al*. 1988, 50). Johannessen (Johannessen and Wang 1998, 156–57, Fig. 7) reports that annonas, including *A. cherimolia*, are shown in the hands of multiple sculpted figures on the walls of Indian temples, including the Hoysala temple at Somnathpur, Karnataka (AD 1268). Yet, as noted earlier, the annonas originated in South America, where *A. cherimolia* is known archaeologically in Peru before the beginning of our era (Towle 1961, 38–9).

Argemone mexicana

The Mexican prickle poppy is another plant of American origin. Today, it is widespread in India. Saraswat *et al*. (1994, 262, 333, 334) report mention of this plant in the Sanskrit medical treatise *Bhava Prakasha* by Sushrutha (1st and 2nd centuries AD). An archaeological find of *A. mexicana* seeds at Narhan in Uttar Pradesh assures us that the plant was being grown in India, possibly as a medicinal drug, as early as 1100 BC (Pokharia and Saraswat 1998–1999, 90, 100).

Artemisia vulgaris

This fragrant tree was well-known in Europe and Asia anciently. It was also present in Mexico, where it shared parallel cultural meanings (including medicinal use) associated particularly with the goddesses Artemis (Greece) and Chalchiuhtlicue (Mexico). Both of them were especially concerned with women and childbirth, as well as associated with water and marshes (Mackenzie 1924, 201–4; Roys 1931, 310).

Asclepias curassavica

The milkweed, *Asclepias curassavica*, originated in the Americas. In India, it is thoroughly naturalized and occurs commonly as a weed (Chopra *et al*. 1956, 28). Some Indianists have considered it to be the *soma* plant of antiquity (Watt 1888–1893, I, 343). A Sanskrit name attests to its age (Int. Lib. Assoc. 1996, 560). In both areas it is much used medicinally.

Bixa orellana

The small tree, *Bixa orellana*, serves widely in the tropics as a flavorant for food and as a red colorant for food, body paint, and dye (Donkin 1974). It originated in Brazil (Newcomb 1963, 41). We know it was used earliest in Peru as shown by excavations at the spectacular city of Caral on the central coast, which dates to 2700–2100 BC (Shady *et al*. 2001). Early botanists in India assumed this was an indigenous plant because it was so completely naturalized (Donkin 1974). It is not surprising that they should think so, for its having a Sanskrit name (Balfour 1871–1873, I, 177) means that it has been present in India for at least 1,000 years.

Cannabis sativa

For a brief discussion of *Cannabis sativa*, an Old World source for the psychoactive drug hashish/marijuana, see the earlier section on tobacco and coca. Hashish has been discovered in prehistoric Peruvian mummies extending over a number of centuries. See full references for *Cannabi*s in the Appendix.

Capsicum spp.

Chile peppers, *Capsicum* spp., are also American plants. Yet they are mentioned in the *Siva Purana* and *Vamana Purana*, Indian sacred texts dated to the 6th through 8th centuries AD (Banerji 1980, 9–10). The Sanskrit name, *marichiphalam*, was applied to both *C. annuum* and *C. frutescens*, says Nadkarni (1914, 86). The *C. annuum* plant and its fruit are naturalistically depicted in stone carvings both at a Shiva temple at Tiruchirapalli, Tamil Nadu (Gupta 1996, 50), and on a bas-relief dated earlier than the 10th century AD at the Prambanan temple complex east of Yogyakarta, Java (Johannessen and Wang, 1998, 28).

In Oceania, chili peppers were reported growing in Tahiti in 1768 by Bougainville, who reached that island only eight months after Wallis, its European discoverer (Langdon 1988, 334).

Carica papaya

One variety of papaya, *Carica papaya*, was grown in the Marquesas Islands before the arrival of Europeans (Brown 1935, 190). Its name signified 'papaya of the people,' as distinct from a larger, 'Hawaiian papaya,' that tradition says Christian missionaries brought from Hawaii. Brown was confident that the former fruit was pre-European. Because this species is of American origin (Safford 1905, 215–16; Zeven and de Wet 1982, 188), the implication is that voyagers had brought it to Polynesia.

Several lines of evidence support voyaging as the mechanism for the plant's arrival. The ethnographer Handy (1930, 131) reported a Marquesan legend to the effect that a double canoe of great size left the islands anciently in search of lands to the east. They were said to have reached a large land called 'Jefiti,' where they left some of their crew before returning to the islands. Sinoto's (1983) excavations in the Marquesas revealed that "great vessels" were being built there in the 9th century AD. Gifford (1924) considered that the use in the Marquesas of knotted cords as mnemonic devices is "strongly reminiscent of the Peruvian kipu," an idea previously put forward by von den Steinen (1903). Pérez de Barradas (1954) saw parallels in sculptural styles and in an unusual type of stone bead shared between San Agustín, Colombia, and the Marquesas. Heyerdahl (1996, 149–57) came across a stone statue in the Marquesas (Hivaoa) of a non-Polynesian style (stone sculpture in Polynesia is otherwise virtually unknown) that von den Steinen had earlier discovered there. It showed long-tailed quadrupeds that represent felids (Polynesia, of course, had no cats) and whose nearest analogs were on the monuments of San Agustín. The radiocarbon date on charcoal from beneath the Marquesan statue was *ca*. AD 1300. We have no hesitancy in accepting the early papaya as having been carried across the 4,400-mile ocean gap from the American mainland.

Ceiba pentandra (syn. *Bombax malabaricum*)

Ceiba pentandra is the kapok or silk-cotton tree of American origin. Brücher (1989, 146–47) considers the center of radiation for the species to be Central America, where it played a significant role in the cosmological myths of the Maya people. A name for the tree has been reconstructed in the proto-Mayan language of the 2nd millennium BC (Bronson 1966, 262 *ff*.). It also grew in Peru (Yacovleff and Herrera 1934–1935, 283).

In 1935, De Prez published a representation of the *ceiba* carved on a monument from Djalatounda, near Sourabaya, Java. This led him to characterize the species as "Indo-American." That monument is considered to date to AD 977 . Moreover, Chinese records report the tree growing during the Tang Dynasty (AD 618–907) on Hainan Island, where its fibers were being woven into fabric by the Li people (Schafer 1970, 64). At least five Sanskrit names for this species have been reported in India (*e.g.*, Nadkarni 1914, 59; Pullaiah 2002, I, 147).

Chenopodium ambrosioides

Commonly known as 'Mexican tea,' *Chenopodium ambrosioides* has a clear record of ancient cultivation in Asia. When Fa Hien returned to his Chinese homeland in AD 414 from a long journey to Buddhist countries, his spotting this species under cultivation was one of the assurances by which he knew he was actually in China again (Bretschneider 1892, 261–62). But the plant was also ancient in India, for it has three Sanskrit names (Chopra *et al*. 1956, 61; Torkelson 1999, 1684; Int. Lib. Assoc. 1996, 562). Furthermore, the plant was known in Mesopotamia under the Arabic name, *natna* (Thompson 1949, I, 416–36). Yet the species was widespread in Mesoamerica. It was found archaeologically in southern

Mexico as early as the beginning of our era (Martínez 1978, 123), and it bore a pre-Columbian name in Yucatec Mayan, *llucum-xiu* (Roys 1931, 262).

Cocos nucifera

The place of origin of the coconut, *Cocos nucifera*, has long been controversial. Early on, Cook (1901, 261–87) argued that the species was native to America, and other botanists agreed (Guppy 1906, 67; Bailey 1935). Counter arguments, however, later persuaded most plant historians that Asia or the western Pacific was its home (Hill 1929; MacNeish 1992, 259).

Those favoring an Asian homeland extended their argument to claim that the tree was wholly absent from the Western Hemisphere until the Spaniards introduced it. However, Heyerdahl (1965, 461) presented evidence that the tree was being planted for economic purposes on Cocos Island, near the west coast of Panama, before the first Europeans arrived there. Furthermore, traces of coconut fiber had been found in tombs at Ancón, Peru (Harms 1922), and representations of the coconut palm are seen in Peruvian art (Heyerdahl (1965, 461).

Patiño (1976, 54) documented at least five locations on the Pacific coast of the Americas where the coconut was reported by Spanish chroniclers to have been growing shortly after the Conquest and, presumably, before, also. Hernández, the 16th-century Spanish naturalist, casually reported the coconut in Peru and Mexico as being the same as in the Old World (1942–1946 [before 1580], II, 507–10). Balboa found coconuts on the Pacific Ocean side of Panama in 1513 (Mendez P. 1944). Even anti-diffusionist Merrill (1954, 267) judged the presence of the nut in pre-Columbian America to be "most certain," agreeing with cultural historian Julian Steward (1949), who accepted the ancient American occurrence of the coconut to have been "established beyond reasonable doubt." Most recently, and most definitively, Robinson *et al.* (2000) excavated coconut remains in Guatemala dated around AD 700, confirming a previous archaeological find at Copán, Honduras, that dated three centuries earlier. These data leave no question that the coconut was widely grown in the Americas before Columbus' time.

But might the tree have reached the Americas from across the Pacific by drift nuts that washed ashore and sprouted? Despite off-the-cuff claims that coconuts can drift long distances and remain viable when cast ashore, experimental research has shown that there is a limit of about 3,000 miles (Dennis and Gunn 1971). Pacific islands with coconuts are all more distant from the Americas than that. Ward and Brookfield (1992) did the definitive review of the literature, but it remains inconclusive on the question. They also did an extensive computer simulation of coconut drift that shows that it is highly unlikely that drift nuts would have reached the Americas from the nearest Pacific Island loci. (The coconut was absent from the Atlantic Ocean/Caribbean region until introduced there by the Portuguese—see Sauer 1993, 188). Whether drift nuts could successfully sprout and mature into trees on the strand has also been disputed contentiously.). Heyerdahl carried nuts both atop the raft *Kon-Tiki* and attached to the raft in the water, but only those that were on top germinated after the voyage (Heyerdahl 1950, 104, 204). Furt5hemore, no cases are known of coconuts having grown on Australian shores (Ward and Brookfield 1992). Carriage of the nuts by Pacific voyagers and intentional planting at an American destination is the explanation preferred by the best-informed scientists, and we think it is the only convincing scenario (Harries 1978, 271; Dennis and Gunn 1971).

Couroupita guianensis

The 'cannon-ball tree,' *Couroupita guianensis*, is native to South America and the West Indies. It now grows in South India where it is called *naga lingam* and has a unique meaning in Hindu symbolism. The tree bears flowers that grow directly out of the trunk and main limbs. Stamens and pistil of the blossom fuse in a manner that gives the appearance of a miniature lingam (stylized penis, symbol of cosmic generative power) facing the hovering hood of a *naga* (cobra). *Naga lingam* flowers in India today are left as offerings before sacred stone lingams in temples to honor Shiva (Johannessen, personal observation, 1996). The only reason one can imagine for anybody's transporting this New World tree to

India would be that a worshipper of Shiva visited the Americas, where he saw the unique flower (no doubt with astonishment) and felt that it ought to grow in India, the homeland of Shiva. No non-Shivaite would have paid particular attention to the blossom, and indeed the plant plays no role in Mesoamerican iconography as far as we know.

Gupta (1996, 58) names four temples in Tamil Nadu state where the *naga lingam* flower is carved in stone. On the basis of this art, she considers that the plant reached India in "very early times."

Cucurbita **spp.**

Four species of American cucurbits were present in pre-Columbian Asia: *Cucurbita ficifolia*, the chilacayote; *C. moschata*, the crookneck squash; *C. pepo*, the pumpkin; and *C. maxima*, the winter, or Hubbard, squash.

That the *moschata* was an inter-hemispheric transfer has unusually clear evidence. The species' American origin is unquestioned. Archaeological remains in Peru go back to the 5th millennium before the present (Yarnell 1970, 225; Towle 1961, 69), and the plant may be earlier yet in Mexico (Brücher 1989, 260–61).

C. moschata (Chinese, *nangua*) is mentioned in medieval Chinese medical recipes, for example, as recorded by Jia Ming (1966) in a text dated to AD 1473 (see Johannessen and Wang 1998, 25). Furthermore, the moschata squash shows up in Chinese paintings by Shen Zhou, who died in 1509 (before Magellan's arrival in Asia). Effigy pots modeled in the characteristic shape of moschata squash date to the Song (AD 960–1279) and Tang (AD 618–905) Dynasties (Johannessen and Wang 1998, 25, Fig. 10).

Vernacular names in use in India in the 19th century for this economically important plant included *kumhra* and *kumra* (Watt 1888–1892, II, 640), while from Yucatan we find the Mayan botanical term "*Kum*, or *Kuum*, *Cucurbita moschata*, Duch." (Roys 1931, 258). Roys quotes an early Spanish record that, "There are [in Yucatan] the *calabazas* [bottle gourds] of Spain, and there is also another sort of native ones [sic], which the Indians call *kum*," that is, the cucurbits (Roys 1931, 258). The similarities of names for the same species in Mexico and India strongly suggest, although of course they do not prove, that direct contact tied the areas together linguistically as well as botanically.

For another American cucurbit, *C. pepo*, the pumpkin, there is also good evidence that it grew in both hemispheres. Levey (1966, 315) discovered in a 9th-century medical text from India mention of the pumpkin as an ingredient (at least the term that was used was the one later applied to the pumpkin). Furthermore, the plant had three Sanskrit names (Watson 1868, 319, 327). Common names for the pumpkin in India also echo the *kum* root in Mayan: *cumbuly*, *kumbala*, *kumhra*, *kúmara* (Watt 1888–1893, II, 641; Watson 1868, 92, 119, 310, 311). And texts by the 16th-century Chinese botanist Li Shizhen, which were based on classic Chinese botanical and medical texts (Bretschneider 1882, 59), also mention the pumpkin. The writing of Jia Sixie in the 6th century does so too (Bretschneider 1882, 77–9).

Cucurbita ficifolia was once thought to be of Afro-Asiatic origin, but Whitaker (1947) showed that the species derived from a Central American wild cucurbit, and *C. ficifolia* also carried Native American names. In fact, Bronson (1966, 262 *ff.*) reported that a name for the species has been reconstructed for the proto-Mayan language dating to the 2nd millennium BC. Excavated specimens were found dated to the 3rd millennium BC at Huaca Prieta, Peru (Yarnell 1970, 225; Towle 1961, 90).

C.O. Sauer discussed this plant's presence as a crop (often grown for yak feed) in India, Tibet, and western China (Newcomb 1963, 29). In Asia, it is grown over an extraordinary range of environmental conditions, and accordingly its forms vary greatly, suggesting a long period of adaptation. The New World cucurbit does not vary so much. The Old and New World plants are morphologically indistinguishable and are fertile when crossbred. How and when did this cucurbit reach Asia, and how long did it take to adapt to such a wide range of environments there? Quite surely, that process required more than the four or five centuries since it might have been introduced to Asia by 15th- or 16th-century European ships (Newcomb 1963, 29). To us, the most believable explanation for the transfer involves a transpacific voyage to India that carried *C. ficifolia* along incidentally with more valuable cucurbits.

Cucurbita maxima is another plant that originated in the Americas but was grown in Asia. Its remains have been found by archaeologists in Peru dating before the beginning of our era (Towle 1961, 90), and Brücher (1989, 262–64) speaks of “irrefutable proofs” of its South American origin.

Nadkarni (1914, 129) gives Sanskrit, *punyalatha* and *dadhiphala*, for *C. maxima*, and its widespread cultivation and adaptation in Asia confirm its considerable antiquity. Levey (1966, 315) confirms *C. maxima*’s pre-Columbian presence by finding the species mentioned in another 9th-century Indian medical text.

Mellén Blanco (1986, 211) interprets the account of the 18th-century González expedition to Easter Island as showing that *C. maxima* was growing there at the time of European discovery.

Curcuma longa

Curcuma longa, the turmeric plant, is of Southeast Asian origin (Newcomb 1963, 61; Brown 1931, 162–63). In Asia, it carried Sanskrit names, as well as terms in Hebrew, Arabic, and Chinese (Watson 1868, 189, 205–6, 248; Watt 1888–1892, II, 659; 1892, 1–3, 231, 417, 432). Nevertheless, the plant was grown and used by people in the remote eastern Andes in South America, where it was used in the same ways as in Asia (Sopher 1950).

Datura

One or more American species of *Datura* were used in Eurasia from ancient times as a medicinal, aphrodisiac, and hallucinogenic drug. The taxonomy of this genus has been confused, as historical sources have referred to its several species variously and imprecisely. But at least *Datura metel* (syn. *meteloides*, syn. *innoxia*, syn. *fastuosa*, syn. *alba*) and *Datura stramonium* (syn. *tatula*, syn. *patula*) were definitely present (Watt 1888, III, 40–1; Burkill 1966, I, 778–79). At least five Sanskrit names are known for one form or another of datura (Nadkarni 1914, 140–45; Chopra *et al*. 1956, 91; Chopra *et al*. 1958, 134; Torkelson 1999, 1711–12; Int. Lib. Assoc. 1996, 564; Watson 1868, 257). A fragment of a datura plant was excavated from the site of Sanghol in the Punjab that dates to between the 1st and 3rd centuries AD (Pokharia and Saraswat 1998–1999, 90). The Greeks are thought by some to have used a datura at Delphi to induce oracles, and the Romans are believed to have used *D. metel* (Burkill 1966, I, 778–79).

Meanwhile, several *Datura* species were commonplace in Mesoamerica and western North America (Hernandez 1942–43 [before 1580], II, 442; DuBois 1908, 72; Ramírez 2003). At least *D. stramonium* is thought to have had an American origin (Nicolson *et al*. 1988, 247). Reko (1919, 115) saw significance in the similarity between the Náhuatl (Aztec) name, *toloache*, and Chinese *tolo-wan* for *Datura* spp., while Kroeber considered that a coastal California cult that involved the practice of ingesting datura might have arrived from “islands of the Pacific” (Kroeber 1928, 395; DuBois 1908, 72).

Helianthus annuus

Helianthus annuus, the sunflower, is an American native, as hinted by the occurrence of a name for sunflower in the proto-Mayan language of the 3rd millennium BC (England 1992, 161). Furthermore, new archaeological finds of plant remains in southern Mexico (of the 3rd millennium BC; see Lentz *et al.* 2001) fix the domestication of *H. annuus* in Mesoamerica. Previously it had been supposed first domesticated in eastern North America.

Images of sunflower blossoms have been discovered by Johannnessen and Wang in the sacred sculptural art of India (Johannessen 1998b). In both the art and references in texts—some going back as much as two millennia—there is a strong association of this plant and its flower with the sun.

When sculpted in sacred Hindu art, the flower played a role in the cultural context of ancient Indian astronomy where it marked pivotal moments in the annual cycle of the sun. Given this ritual setting for the sunflower, it is no surprise that a Sanskrit name for the plant, *suria-mukhi*, was known (Watt 1888–1893, IV, 209; Torkelson 1999, 1749; Chopra *et al.* 1956, 131). Shivaite Hindu temples, especially those of the 11th to 13th centuries AD, were sometimes oriented to sunrise or sunset points on the horizon on key calendar dates. The flowers were also engraved on temple doorways and on images of Nandi, the bull that served as Shiva's steed, and by implication symbolized Shiva himself (Johannessen 1998b). (The fact that Heyerdahl {1986, 2, 176} found carved sunflowers designs on stones in the Maldives, located precisely at the equator, also could be part of this complex of ideas.)

Live sunflowers were known to Indian artists, which is particularly confirmed by a carving on a temple pillar at Pattadakal, Karnataka State (Johannessen and Wang 1998, 15–6). A long-tailed Indian parrot is shown sitting atop a large seed head, from the edge of which the bird has plucked a few seeds. No other seed-head looks like this nor has a stem capable of supporting a parrot. Gupta (1996) also discusses and illustrates sunflowers decorating Indian temples.

Johannessen has observed that maize images occur in temple statuary along with sunflowers, tying two American species together in a single ritual context. In Karnataka, sculptured female figures on temples are depicted holding ears of maize (see the discussion above), and they also have sunflower blooms below the bottoms of their skirts. (Different figures show whole, half, or quarter images of the flowers; Johannessen suggests that these images communicated information about the ritual calendar—see Johannessen and Wang 1998.) Moreover, a sunflower carved beneath the tail of a sculpted recumbent Nandi in the doorway of Halebid Temple in Karnataka is fully illuminated at each solstice sunrise (from alternate sides, winter and summer). The same Nandi allows dawn light to pass over the sunflower between its horn and its ear so as to penetrate deep into the temple and shine on the Shiva lingam in the inner sanctum, at equinox. Also, the carved blooms on the support for the tail of Nandi are completely shaded on the equinox (Johannessen 1998b, 354–60). At other Shiva temples, the solar azimuths differ, but the sculpted art typically involves the sunflower at sunrise or sunset as a calendrical indicator.

Lagenaria siceraria

The bottle gourd, *Lagenaria siceraria*, was discovered by Bird (1948) in pre-ceramic levels on the coast of Peru dating to the 3rd millennium BC. Its discovery was hailed by diffusionists as proof that ancient voyagers had crossed the Pacific (Carter 1950). Botanists previously had assumed that the species had not reached the Americas until imported by the Spaniards. Whitaker was the botanist who first identified *L. siceraria* at the archaeological site of Huaca Prieta, Peru (Whitaker and Bird 1949). He considered that, since bottle gourd plants from both hemispheres are closely comparable and occurred early in Peru, the burden of proof lay on those who, until then, had claimed that it had been colonial-era Europeans who introduced it from the Old World. It is also reported that the bottle gourd appeared in Mexico as early as perhaps 9000 BC; in Peru, by other researchers (Brücher 1989, 265; Heiser 1989, 475).

However, the species was found in 5th-Dynasty Egyptian tombs (Whitaker and Carter 1954, 697–700), and in India it bears Sanskrit names (Nadkarni 1914, 213; Pullaiah 2002, II, 323). Lathrap (1977) and Schwerin (1970) proposed that fishing boats bearing gourds drifted westward from Africa to South America at a very early date (14,000 BC according to Lathrop and 5700 BC according Schwerin). But there is no evidence for domesticated plants in West Africa at times even close to those dates. Patiño (1976, 244) and also Mangelsdorf, MacNeish, and Willey (1964, 441) doubted an Atlantic natural drift hypothesis because the bottle gourd was unknown in the Antilles or eastern South America. Brücher (1989, 265–66) wondered rhetorically "why it did not arrive before the Pleistocene, if the natural dispersal of floating fruits was so easy? Furthermore, "if *Lagenaria* had in one or another way come from Africa, the puzzling question remains how it crossed the whole American continent and appeared so early [in pre-2500 BC Peru] on the Pacific side?" Clearly, there is no good answer to Brücher's questions, so the plant's arrival via voyaging remains the superior explanation.

Considerable experimentation has gone into the question of whether the bottle gourd could have floated across the ocean, arrived in viable condition, and become self-established on shore (Towle 1952; Carter 1953; Whitaker and Carter 1954). Results of experiments on how long floating gourds remain viable have been inconclusive, perhaps because some experiments were carried out in tanks, where a gourd would not have been subjected to the boring organisms that are encountered in the open sea. The results are summarized by Camp (1954) to the effect that, while a gourd might have crossed from Africa and might have sprouted on shore in the Americas, there would still be no satisfactory explanation of how the offspring became established in the plant's normal habitat, which is inland.

Most recently, Whistler (1990, 1991) concluded that, contrary to the picture that resulted from early misidentifications, *L. siceraria* never grew in western Polynesia, although it was common in eastern Polynesia. (That the mid-Pacific had no gourds casts doubt on the drift explanation of this plant's dispersal by that means.) "The most likely hypothesis," Whistler concluded, "is that it was introduced [by voyagers] to eastern Polynesia from South America." The coconut "may have moved eastward on the same roundtrip Polynesian voyage as the bottle gourd."

Despite uncertainty as to which ocean the gourd crossed and exactly how, we can be sure the plant was used in both hemispheres long before Columbus. That man played the key role in its ocean-crossing history is the position that best fits the evidence.

Luffa cylindrica (syn. *aegyptiaca*)

Luffa cylindrica is an Old World plant known as the 'vegetable sponge.' It was grown in South and Southeast Asia (Brücher 1989, 267) where it played a significant role in medicine (Nayar and Singh 1998, 14–15). It has also been cultivated for a long time in the Americas, according to Heiser (1989; 1985); he allows that it might have traveled by ship across the Pacific. Kosakowsky *et al.* (2000, 199) excavated pottery on coastal Guatemala dating around 1200 BC that had been decorated by daubing the pot's surface with paint using as a tool the unique cut stem end of *L. cylindrica*.

Macroptilum lathyroides

The minor pulse, *Macroptilum lathyroides*, has the English vernacular name of 'phasey bean.' It has been considered part of a distinct group within the genus *Phaseolus* but has recently been made a separate genus. Like several species of *Phaseolus*, which we will discuss below, the phasey bean is of American origin (Smartt 1969, 452). Along with two other American beans, *M. lathyroides* has been excavated by Pokharia and Saraswat (1998–1999, 99) at several Neolithic and Chalcolithic sites in India of the 2nd millennium BC. Phasey bean specimens have also been recorded by Vishnu-Mittre, Sharma, and Chanchala (1986) from deposits of the Malwa and Jorwe cultures (1600–1000 BC) at Diamabad in Ahmednagar Dist., Maharashtra state, India.

Manihot sp.

Pullaiah (2002, II, 346–47) points out two Sanskrit names, *darukandah* and *kalpakandah*, for *Manihot esculenta*, *i.e*., manioc, or cassava. This is surprising since there is no other evidence yet for its transfer to India. To be confident that it was taken there by voyagers will require more data, although no other explanation for the Sanskrit names is apparent.

The first European botanists to discover it growing on Easter Island found that it was called by the same name, *yuca*, by which it was known widely in the Americas (Langdon 1988, 326–28; Mellén Blanco 1986, 13). For that reason we suppose that a voyage carried the plant there from the continent (Heyerdahl 1964, 126). It may also have been known in the Marquesas, for in 1939, young Heyerdahl and his bride, living on Hivaoa, were taught by relatively unacculturated natives how to grow bitter manioc and process its starch (Heyerdahl 1996).

Maranta arundinacea

The tuberous shrub, *Maranta arundinacea*, arrowroot, has been found to have grown in Central America up to 6,000 years ago (Piperno 1999, 126). It is a vegetatively reproduced plant, so it could not have crossed the Pacific by floating. Yet in India, Aiyer (1956, 44) has recorded the Sanskrit term, *kuvai*, for the species, and Pullaiah (2002, 348) gives *tavakshiri* and *tugaksiri*. Furthermore, it is mentioned in South India in the Tamil-language texts, *Malaipadukadam* and *Mathuraikanji*, that were written long preceding the arrival of Portuguese ships in India.

Mimosa pudica

Mimosa pudica, the ‘sensitive plant,’ was probably native to Brazil. It is called ‘sensitive’ because its leaves abruptly fold up when they are touched. It was known to the pre-Spanish Maya (Roys 1931, 267). Yet there were three Sanskrit names for it (Watson 1868, 347; Nadkarni 1914, 233). That means that it was known in India centuries before European voyagers could have brought it from the Americas. The same plant was present in the Marquesas, though perhaps nowhere else in the eastern Pacific; it very likely reached those islands by a separate voyage from the Americas.

Mirabilis jalapa

The widely-appreciated flower, *Mirabilis jalapa*, is called the ‘four o’clock’ from its habit of opening its blossoms only in the late afternoon. Zeven and de Wet (1982, 177) report that South America is the center of this genus’ diversity and its apparent place of origin. Roys (1931, 291) documented a pre-Columbian Mayan-language name for it, and Hernandez (1942 [before 1580], I, 194–95) identified two varieties that were growing on the Mexican Mesa Central in the 16th century.

Once again, however, we find a plant of American origin in ancient India. Three or four Sanskrit names were in use for the four o’clock. Torkelson (1999, 1786) provides *krishnakeli*; Balfour (1871–1873, III, 282) and Watson (1868) give *bahu-bumi* and *sundia-ragum*; and Pullaiah (2002, 361) reports *sandhya-rága*, *trisandh*, and *krsnakeli* (*sic*). To explain such a proliferation of names, we must suppose that the four o’clock was present in India from an early time. It is not credible to suppose that its presence in Asia, only in India, was due to fortuitous oceanic drift from half way around the world.

Mollugo verticillata

The carpetweed, *Mollugo verticillata*, is shown by Chapman *et al.* (1974, 411–12) to have been found in archaeological digs in both North America (it was also distributed in Middle and South America) and Europe, yet the plant’s origin is said to be China (MOBOT 2003). It is one of those weeds whose favorite habitat is the disturbed ground that results from husbandry.

Monstera deliciosa

The large climbing aroid, *Monstera deliciosa*, is native to Central America. It is represented on sculptures of medieval age in India. Gupta (1996, 108–9) describes and pictures temple scenes where not only do the distinctive leaves of this giant philodendron provide background for scenes of sacred art, but the distinctive fruit is also visible. In one such scene, the fruit is shown on a plate held by an aide to Vishnu. The fruit tastes like a mixture of pineapple and banana and was much esteemed in both hemispheres (Lundell 1937, 35; Burkill 1966, II, 151).

Morus alba

The white mulberry, *Morus alba*, has long been one of the plants essential to Chinese civilization. Its leaves have been used to feed silkworms for at least 3,000 years, and mulberry bark was used to manufacture paper (Bretschneider 1892, 128; Watt 1888–1893, V, 280). The genus originated in the Old World.

Soon after the Spaniards subdued the native people of the Antilles, they launched a plan to raise silkworms there in order to take advantage of the strong European market for silk. In central Mexico, too, the conquistadors launched a silk industry, utilizing worms and trees imported from the Mediterranean area (Borah 1943, 5–14). Nevertheless, Las Casas, who died in 1522, said, concerning the Antilles, where he was a planter before his ordination as a priest, that there were “as many mulberries as weeds” already growing in those islands before the intentional importation of the European trees (1875–1876, IV, 379–80). Presumably, they grew on the mainland also. So at least one species of *Morus* was in Middle America before the Spaniards arrived, although its modern botanical identification is uncertain. Nevertheless, Von Hagen (1944, 67) considered that all three of the *Morus* species most often recognized, *M. alba*, *M. nigra*, and *M. rubra*, “may … have been present in Mexico and used for their bark.” Tozzer (1941, 195) translated Bishop Landa’s account (*ca*. 1566) of life in Yucatan as reporting the presence of “two kinds of mulberry plant, very fresh and fine.” The two kinds he referred to may have been *M. alba* (the most common species) and either *M. nigra* or *M. rubra*.

Making paper from bark had a long history in Mesoamerica. Von Hagen noted that trees whose bark was made into paper (in colonial days) by the Otomí Indians, a relatively unacculturated native people of central Mexico, included one “which has been identified [in the taxonomy of over 60 years ago] as *Morus celtifolia*, a paper mulberry similar to the plant used by many Asiatic papermakers” (1944, 50, 51, 58–59, 67).

Making bark cloth and paper of mulberry bark is of particular significance because of a pair of exemplary studies by Paul Tolstoy (1963, 1966). He demonstrated that the bark cloth/paper complex of Mesoamerica was parallel in great detail to bark-processing methods in island Southeast Asia. Meanwhile, MacNeish *et al.* (1967, 85) excavated a stone bark beater in the Tehuacán Valley of Mexico that they considered so similar to beaters of Java and the Celebes that they found it “extremely difficult” to account for the degree of similarity by “independent invention” (the only alternative explanation for the similarity, of course, being transmission of the artifact form and function across the Pacific). Mulberry tree starts probably accompanied the bark-beater when Asian voyagers carried knowledge of the complex across the Pacific by voyagers in “the early part of the 1st millennium BC” (Tolstoy 1963). (When ancestors of the Maori left central Polynesia to settle New Zealand, they considered bark cloth so essential they carried mulberry starts with them; see Von Hagen 1944, 23.) While the *Morus* species involved in the Mesoamerican industry still need to be identified definitively, it is evident that at least one species crossed to the Americas with Asian or Oceanian voyagers who not only brought the plant but also carried the complex technology of turning bark into cloth and paper. We are supposing here that the most likely species was the Chinese mainstay, *M. alba*.

Meanwhile, if, as Brücher (1989,132) suggests, *Morus rubra* had an American origin, then the additional question arises, how did it reach Asia, where it was not uncommon?

Mucuna pruriens

Mucuna pruriens (syn. *M. prurita*) is commonly called ‘cowhage,’ or ‘cow-itch’ in English (Oxford English Dictionary, 2nd ed., 1082). The pods are covered with barbed hairs that cause severe itching. The hairy part was sometimes ingested as a vermifuge, while the plant’s roots served to make a tonic. The seeds have been considered aphrodisiac in India since Sanskritic times (Watt 1888–1893, V, 286; Watson 1868, 263). Balfour (1871–1873, III, 394–95) listed the Sanskrit name, *atmagupta*, for cowhage; Watson (1868, 11) added *alkushee*, and Nadkarni (1914, 242–43) gives *kapikachchu*. Banerji (1980, 26, v, vii) also has *adhyanda*. Such a varied lexicon indicates that the plant was long familiar in India. That is further confirmed by Banerji’s note of its mention in the *Satapatha Brahmana*, a text dated in its earliest form before the rise of Buddhism.

However, the plant is of tropical American origin. For Mayan, Roys (1931, 235) gives the name, *chiican*, for it and says, “This is the English cow-itch.”

***Musa* spp.**

The terms 'banana' and 'plantain' have been a source of confusion in botanical discussions because the two corresponding 'species,' *Musa sapientum* and *Musa paradisiaca*, were never established as bona fide species. Cytogenetic analysis demonstrated in the1950s that most of the bananas or plantains commonly grown contain varying proportions of genomic contributions by hybridization from two base species, *M. balbisiana* (B-genome) and *M. acuminata* (A-genome) (Simmonds 1966; Nicolson *et al.* 1988, 297). In this paper, we speak of a single species, *Musa balbisiana x acuminata*, covering what the earlier literature termed both 'bananas' and 'plantains.' (Some other 'bananas,' however, did not originate from those two genomes.)

A notion commonly held by scientists and historians is that there were no bananas or plantains in the Americas before the Spaniards introduced them. However, when Sapper (1934) studied Native American names for *Musa*, he concluded that bananas/plantains had to have been present in South America no later than the 1st millennium AD to account for the diversity and distribution of names. Smole (1980) reached about the same conclusion from ethnographic and ecological study of plantains among peoples of Brazil and Venezuela. Moreover, a word has been reconstructed in the proto-Mayan language dating to the 2nd millennium BC that is glossed by Kaufman and Norman (1984; followed by England 1992, 25) as *plátano*, banana. Ethno-historical documents also attest to pre-Columbian cultivation of the crop(s) in Mexico and Guatemala (McBryde 1945, 36; Spores 1965, 971–72; Roys 1931, 218). Archaeological finds of probable banana leaves from Peruvian tombs (Harms 1922, 166) seem to confirm these data.

The invalidity of the claimed isolation of the New World in relation to the banana/plantain was clear enough to persuade E.D. Merrill (1954; see also Heyerdahl 1964, 123) to grant that "We may reasonably admit that one, or a few, of the numerous Polynesian plantain varieties may have … " reached the Amazon Basin before Columbus. Considering its source, this statement constitutes an admission of the strength of the evidence for the pre-Columbian presence of the genus *Musa* in the New World.

Myrica gale

Bog myrtle, *Myrica gale*, is found on both sides of the North Atlantic, although it is now absent from Iceland and Greenland. Its pollen is found in Iceland in excavation layers from saga times, and possibly also in Greenland (Thorarinsson 1942, 46). It is often supposed by biogeographers that various plants growing on both sides of the North Atlantic, including this species, date back to Cretaceous times, before continental drift widened the North Atlantic Ocean gap. Nevertheless, Thorarinsson supposes that the Norse brought this particular plant to North America because they sometimes used it instead of hops to brew their beer. Since no other scenario for the plant's North American distribution makes sense to him, Thorarinsson suggests medieval voyaging as the means. We agree.

***Pachyrhizus* spp.**

Data are unavailable to allow us to distinguish consistently and certainly in the literature between *Pachyrhizus erosus* (called'yam,' but of the family *Fabaceae*, not *Dioscoreaceae*) and *P. tuberosus* 'yam bean'), both of which are called *jícama* in Hispanic America. Today's favored view is that *P. tuberosus* is native to the headwaters of the Amazon in northwestern South America (Brücher 1989, 44). It was commonly cultivated in ancient Peru, fossil remains having come from tombs at Paracas (before our era). The plant is also shown in Nazca-period art (Yacovleff and Herrera 1934–1935, 281–82). Several biotypes of *P. erosus* grow wild in Mesoamerica (Brücher 1989, 84–85). The Mayan name is *chicam* (from which the word *jícama* was derived). Patiño (1976, 33) has mapped the distribution of both species in South America at the time of the Spaniard's arrival from the earliest accounts.

One or the other species is cultivated in the Philippines and China to such an extent that it has been claimed to be of East Asiatic origin (MacNeish 1992, 260). Watt (1888–1893, VI, Pt. 1, 3) said the same thing for *P. angulatus* (syn. *P. erosus*), based in part on the fact that the plant bore a Sanskrit name, *sankhálu*. Both data suggest that transfer from the Americas took place rather anciently.

P. tuberosus is called *doushu*, or *tugua*, in modern China (Johannessen and Wang 1998, 26–27). A text dated AD 1736 describes this plant accurately as having a “root … quite big, greenish-white in color” which “tastes sweet and fragile or soft-crunchy to eat.” The name of the plant was already in use in the Song Dynasty (before AD 1182) to denote a plant whose description was so similar that it cannot be anything but the currently recognized species. Archaeologist K.C. Chang (1970, 177) and other Chinese scholars accept that *P. tuberosus* was present in China in pre-Columbian times.

***Phaseolus* spp.**

The common, or kidney, bean, *Phaseolus vulgaris*, and the lima bean, *P. lunatus*,) also had an American origin. Specimens of *P. vulgaris* are known at *ca*. 6000 BP in Mexico (Pickersgill and Heiser 1978, 810–11) and before 4000 BP in Peru (Yen 1963, 112). The orthodox view is that they reached the Old World only when Portuguese traders brought them to Asia around AD 1500.

All botanists have not agreed, however, that these beans were absent from the Eastern Hemisphere. In connection with their landmark research on cotton, Hutchinson, Silow, and Stephens (1947, 138) accepted a bi-hemispheric distribution of *Phaseolus* and considered the widespread use of beans in Asia to constitute satisfactory evidence for pre-Columbian contact. Hutchinson was reported in 1961 to be still “working on the genetics of American beans” (Bushnell 1961). His research was never published.

However, now the problem is resolved definitively. *Phaseolus vulgaris, P. lunatus*, and the phasey bean, *Phaseolus lathyroides* (reclassified as *Macroptilium lathyroides*, per Walker 1976, 598*)*, have all been discovered in multiple archaeological sites in India of the 2nd millennium BC.

Pokharia and Saraswat (1998–1999, 99) report that *Phaseolus* “… beans of American origin have been encountered from proto-historic sites in peninsular India.” *P. vulgaris* was recorded from the pre-Prabhas and Prabhas cultures at Prabhas Patan, Junagadh Dist., Gujarat, dated from 1800 BC to AD 600. They also came from Chalcolithic Inamgaon (about 1600 BC), Pune Dist., Maharashtra, and from Neolithic Tekkalkota, Bellary Dist., Karnataka, with a radiocarbon date of 1620 BC. *P. vulgaris, P. lunatus*, and the phasey bean have also been recorded by Vishnu-Mittre, Sharma, and Chanchala (1986) in deposits of the Malwa and Jorwe cultures (1600–1000 BC) at Diamabad in Ahmednagar Dist., Maharashtra. The phasey bean was also found at the Sanghol site (Pokharia and Saraswat 1998–1999, 99), dated in early AD times. Plant names agree. Levey (1973, 55; see also Levey 1966, 16) found that “The medieval Arabic term for kidney bean [*i.e*., *P. vulgaris*] is *lubiya.* It is *lubbu* in Akkadian and *lu.úb* in Sumerian …. In Sanskrit and Hindustani, however, it is *simbi* and *sim* respectively ….”

It may be noted at this point that we have presented direct evidence for the presence in Asia long before Columbus of the four classic foods in the Mesoamerican diet: maize, cucurbits, chiles, and beans.

***Physalis* spp.**

The ground cherry, or winter cherry, (or husk tomato) seems to refer, at least in the older literature, to more than one species of *Physalis*. The literature reporting presence of the plant is not consistent in its terminology (see the sources cited under *Physalis lanceifolia* in the Appendix). *P. lanceifolia, P. philadelphica* (Hernández 1942–1946 [before 1580], I, 283; Brücher 1989, 276), *P. pubescens, P. lanceolata* (Index Kewensis), *P. indica* (Nadkarni 1914, 298), *P. alkekengi* (Bretschneider 1882, 32), *P. angula* (MOBOT 2003; Roys 1931), and perhaps *P. minima* (Gunther 1934, 468–71) sometimes may be conspecific. Although the origin of the genus was unquestionably in the Americas, these fruits (if this synonymy is correct) were known in India (Bretschneider 1882, 32; 1892, 43; the plant had a Sanskrit name, *rajaputrika*, {Chopra *et al*. 1956, 191; Torkelson 1999, 1808}), China (Bretschneider 1882, 1892), and Greece (Gunther 1934, 468–71). If the synonymies are not all correct, there remains a major question of how the taxonomy and distribution of the ‘ground cherry’ is to be explained.

Physalis peruviana

Physalis peruviana, the winter cherry, commonly called the 'Cape gooseberry,' or 'Brazil cherry,' seems also to have reached Asia as well as Polynesia before European influence. Balfour (1871–1873, IV, 562) cites *P. peruviana* as also growing in India, meanwhile noting its American origin (also on origin, see Brücher 1989, 275–77; and Zeven and de Wet 1982, 181). Furthermore, this species had a unique Sanskrit name (Chopra *et al*. 1956, 192).

Occurrence of *P. peruviana* in the Marquesas, Easter Island (Heyerdahl 1996; 1964, 126), and Hawaii (Hillebrand 1888, 310) most plausibly was due to a voyage from the Americas to the islands (Brown 1935, 257–58).

Polygonum acuminatum

Polygonum acuminatum is an aquatic species found on Easter Island, where it floats on the surface of the lakes inside two volcanic craters (Heyerdahl 1961, 26). *P. acuminatum* is used for medicinal purposes on the island, as it is in the Titicaca Basin, Bolivia. It is an American plant. The species occurs nowhere else in Polynesia.

Of the flora, Skottsberg (1920, I, 412) said, "The presence of a neo-tropical element (on Juan Fernández and Easter Island) is surprising." The "mode of occurrence and ecology oblige us to regard" *P. acuminatum* as "truly indigenous," or else "intentionally introduced in prehistoric time during one of the mythical [*sic*] cruises which, according to Heyerdahl, put Easter Island in contact with Peru. A direct transport of seeds across the ocean without man's assistance is difficult to imagine…." Skottsberg adds (page 425) that, contrarily, for the Marquesas "there is no neo-tropical element [that he detected] in spite of the prevailing direction of winds and currents." Dumont *et al.* (1998) update the matter by reporting analysis of a core from Rano Raraku crater lake on Easter Island. Five (stratigraphic) zones are identified. The last three of these are separated by waves of immigration. The researchers argue that a first, or South American, wave, dated to the 2nd half of the 14th century by radioactive dating, may represent a visit by South American Indians. They found the top 85 cm. of sediment to include *Polygonum acuminatum*. Because of the synchronous appearance of multiple floral taxa from the Americas, Dumont rules out passive introduction. "The island is so remote, and such a small target, that mechanisms of passive dispersal were ineffective for populating it" (with flora). Besides, there are no freshwater birds on the island. "We therefore propose that humans introduced these neo-tropical biota, in one single event."

Portulaca oleracea

Purslane, *Portulaca oleracea***,** was common in Roman gardens in Pliny's day (Leach 1982, 2). It grew throughout the warmer parts of the Old World and was also mentioned in Egyptian texts. Nevertheless, Gray and Trumbell (1883, 253) demonstrated over a century ago that the species is actually of American origin. In North America, it was growing as early as 2,500–3,000 years ago (Chapman *et al.* 1974, 412). It thrives best in the disturbed soils of gardens, which indicates that the plant may well have accompanied a transoceanic transfer of horticulture.

A number of Sanskrit names for purslane are known: *lonika*, or *loonia* (Balfour 1871–1873, IV, 660); *ghotika* (Pullaiah 2002, II, 426); and *mansala* (Chopra *et al.* 1958, 521–23). Furthermore, Bretschneider (1882, 49–53, 57–61) notes the mention of the plant in a Chinese treatise by *Zhou Ding wang*, an imperial prince who died in AD 1425; he had seen the plant growing in Henan province (Bretschneider 1892, 428). Another work, *Zhu Zi yulei*, by the famous Song-period neo-Confucian scholar, Zhu Xi (AD 1130–1200), mentions purslane as *machixian*, a term that is still used for *P. oleracea* today (personal communication from V. Mair, 2002).

Psidium guajava

More than 100 species of the genus *Psidium*, which includes the guava, are native to Tropical America (Brown 1935, 200). Bailey (1966, III, 284) concurred that the genus originated wholly in the Americas. Towle (1961, 73) documented a fruit of *P. guajava* in a burial from Ancón, Peru (dated BC), and fruits have also been found in remains from the Gallinazo phase (early centuries AD) and the following Mochica phase.

Historically documented names provide evidence for the pre-Columbian presence of the guava in India. In Sanskrit, it was known as *amruta-phalam* (*cf*. Arabic and Persian: both *amrúd*) (Watt 1888–1893, VI, Pt. 1, 351–53). Pullaiah (2002, 433) has Sanskrit, *péràlà*, as well as *mansala*, for this species. Sharma and Dash (1983, 518) identify the guava as the ‘Paravata fruit’ mentioned in the *Caraka Samhita* text (between 900 BC and the 4th century AD) (Aiyer 1956, 36; Pullaiah 2002, 2). Of linguistic interest is the fact that the name of the guava in the Mysore area of India involves the root *bidji* (Watson 1868, 134), while in Yucatec Mayan the same fruit is called by the near-equivalent, *pichi* (Roys, 1931, 231, 276).

Sapindus saponaria

The soapberry tree, *Sapindus saponaria*, is another Native American species (Zeven and de Wet 1982, 178; Knoche 1925, 102–23) that has spread throughout the tropics. Its antiquity in the Americas is certain (Tozzer 1941, 197; Hernández 1943 [by 1580], II, 529–30). In the Casma Valley of northern Peru it has been found in middens dating to 1785 BC (Ugent *et al.* 1986).

An equivalent tree was common in India under the scientific name *S. mukorossi* in northern India and *S. trifoliatus* in the south. They are now equated with *S. saponaria* by Index Kewensis. Three Sanskrit names are known: *phenila* and *arushta* for *S. trifoliatus* (Nadkarni 1914, 350; Int. Lib. Assoc. 1996, 572), and *urista* for *S. mukorossi* (Int. Lib. Assoc. 1996, 572). The soapberry trees of India are also distributed in China (Watt 1889, VI, Part II, 468).

The same tree was in use on Easter Island at discovery, and it was widespread in some other (but not all) Polynesian islands as well (Heyerdahl 1963, 31; Langdon and Tryon 1983, 43; Brown 1935, 160–61).

Schoenoplectus californicus

A bulrush, or sedge, *Schoenoplectus californicus*, grows on Easter Island in close association with *Polygonum acuminatum* (see above) on the surface of the island’s crater lakes. It too, is of American origin, found up and down the Pacific Coast of both American continents. The same species grows in Hawaii with a name nearly parallel phonetically to that on Easter Island (Rapanui, *nga?atu*; Hawaiian, *nanaku*) (Langdon 1988, 330, 334; Langdon and Tryon 1983, 43). The uses to which it was put were very nearly the same too in South America and Easter Island (Heyerdahl 1961, 23–5; Towle 1961, 26–7). As with *P. acuminatum,* Dumont *et al*. (1998, 410, 418) conclude that the evidence is strong that this plant was brought from the mainland in the 14th century by voyagers, while no other explanation stands up.

Sisyhynchium angustifolium

The small lily (commonly called a ‘grass’), *Sisyhynchium angustifolium*, is fundamentally North American in distribution, although it has also been found at the site of the ruins of Norse settlements in Greenland (Faeggri 1964, 344–51; Polunin 1960, 181; Thorarinsson 1942, 45–6). Here is botanical evidence in support of the historical and archaeological facts on the Norse migration to the American Vinland.

Solanum spp.

Solanum candidum is one of a set of fruit-bearing trees that inhabit Middle and South America, Oceania, and Asia, and overlap taxonomically in an intriguing way. American *S. candidum* is so close to *S.*

lasiocarpum of Western Oceania that they may be the same species, and the two areas share certain uses. Meanwhile, on the American side, *S. candidum* is virtually conspecific with *S. quitoense*. We consider that the similarities are such that two transoceanic transfers were accomplished, either *S. candidum* or *S. lasiocarpum* making one voyage and *S. repandum* or *S. sessiliflorum* another.

A similar situation is true of *S. candidum* and *S. lasiocarpum* of Southeast Asia. In South America, the former has so nearly the same characteristics as the Asian tree that their relationship demands an historical explanation. No plausible one has been offered by those who have studied the botany. We believe that the Pacific voyaging this paper documents can account for the derivation of one species from its near relative across the ocean as no other scenario does.

Solanum repandum, which is spread from Fiji to the Marquesas, is so similar to South American *S. sessiliflorum* that Whalen *et al*. (1981; *cf*. Whistler 1991, 41–66) suspect the two may be conspecific. The uses to which each is put are essentially the same. (See details in the Appendix.). Moreover, the name of *repandum* in the Marquesas, *kokoua* or *koko’u,* is enough like a South American name for the species, *cocona*, that on the basis of the name alone one may be justified in seeing a direct transfer before Europeans came on the scene. We agree with Whalen and Whistler that voyages between the Americas and the islands make more sense than any other possible explanation for these relationships.

The species *Solanum nigrum*, known as ‘black nightshade,’ today is widely distributed throughout temperate and tropical regions of the world. In the Americas, the Maya knew *S. nigrum* as *ich-can*, or *pahal-can* (Roys 1931, 248, 272). It was also used medicinally in Peru (Yacovleff and Herrera 1934–1935, 281). After mentioning medicinal uses of the nightshade in ancient Assyria, India, and China, Thompson (1949, 143) observed, “it is obvious that the *S. nigrum* is a very popular drug in the East.” Watt (1888–1893, VI, Pt. III, 263–64) reported *S. nigrum* growing throughout India and Ceylon. Pokharia and Saraswat (1998–1999, 90) found nightshade seeds in material excavated from the Sanghol site in India (1st to 3rd centuries AD). Its berries are described in Sanskrit works of medicine where the plant’s name is *kákamáchai* (Nadkarni 1914, 373), or a variant thereof. Dioscorides’ 1st century AD Greek herbal catalog identified the plant (Gunther 1934, 467). Maimonides (1974; Meyerhof and Sobhy 1932) described it in 12th-century Egypt. We see no way to account for the inter-hemispheric transfer except by voyagers over two millennia ago.

Solanum tuberosum, the potato, was found on Easter Island by early European visitors, as Jeffreys (1963a, 11–23) and Mellén Blanco (1986, 133) demonstrate using explorers’ accounts. Of course, the potato is very old on the mainland, but it is absent elsewhere in Polynesia and points west.

Sonchus oleraceus

S. oleraceus in some sources is called ‘chicory’ although true chicory is *Cichorium intybus*. It was a potherb and source of medicine among the Maya (Tozzer 1941, 146) and in Peru (Yacovleff and Herrera 1933–1934, 299). Chroniclers’ accounts place it so early in the Americas that there is no question of the Spaniards having brought it. Yet, it was an Old World native that was extensively cultivated in Europe and Asia (Balfour 1871–1873, V, 482–83; Bretschneider 1892, 179; Watson 1868, 259; Watt 1888–1893, II, 285). Those facts can only be explained by supposing that it was carried from Eurasia to the Americas before Columbus.

Sophora toromiro

Sophora toromiro was the only wild tree in the flora of Easter Island. Its wood served the islanders for canoes and to make other carved items. Knoche (1919) considered it to have been introduced from the outside and a ‘cultivated’ plant (syn. *S. tetraptera*). A native tradition told to the early Christian missionaries (Mellén Blanco 1986, 135; *cf*. Heyerdahl 1963, 26–7) said that this *toromiro* tree was among the plants brought by ancestral settler/voyager Hotu Matu’a. It is now extinct. According to Skottsberg (1920, 421) it, or a close relative, has been recorded by botanists only from Chile, Juan Fernandez Island (off Chile), Easter Island, and New Zealand. He also thought its natural transport to Easter Island was not a satisfactory explanation for its presence there.

Tagetes spp.

Tagetes erecta is the common marigold and *T. patula* the dwarf marigold. They both originated in Mexico (MacNeish 1992). Hernández (1943 [before 1580], II, 644-52) illustrated ten varieties of *Tagetes* in 16th-century Mexico, including one that Linnaeus later would dub *T. erecta*. The botanists who prepared the 1943 edition of Hernández suggested two of the other nine varieties that could represent *T. patula*. Roys (1931, 279) added that the dwarf species grew abundantly in the Maya area as a weed.

Levey and Al-Khaledy (1967, 192) identify one or more of the marigolds in texts from Persia and India dated to the 13th century. The blossom is known as the 'flower of the dead' in both Mexico and India today. Neher (1986) has published an eyewitness account by Harlan of a harvest festival in an Indian village whose ritual and symbolism revolves around the marigold and directly recalls Mexican customs. It is hard to believe that the transfer of postdated European influence on India and, indeed, two Sanskrit names for the marigold, *zanduga* (Chopra *et al*. 1956, 239) and *sthulapushpa* (Int. Lib. Assoc. 1996, 574), could account for the parallels. Rather, they appear to ensure that the genus has been on the subcontinent for many centuries. We suppose that since both *Tagetes* species are found in India today and had Sanskrit names (Pandey 2000, 271), one or both having become 'naturalized,' that probably both arrived together anciently.

The species listed in Tables 1, 2, and 3 that are not discussed to this point are treated in the Appendix.

MICROFAUNA

An earlier discussion under the heading, "The Problem," established that two species of 'hookworm,' *Ancylostoma duodenale* and *Necator americanus,* were brought to South America by voyagers in the 6th millennium BC or before. Nineteen other species of infectious organisms that also appear to have crossed with voyagers are shown in Table 4. The occurence of the diseasese which these organisms cause demonstrate that actual human beings, acting as their hosts, landed in the Americas as voyagers and passed on the imported organisms (plus genetic contributions) to their successors. We discuss those here. In addition, 18 further organisms that possibly were transported by ship are listed in Table 5, but they are discussed only in the Appendix.

Ascaris lumbricoides

Ascaris lumbricoides is the large roundworm known to have infested Egyptian mummy Pum II; for instance, dating to 170 BC. It has been found also in other Old World locations in antiquity (Cockburn *et al.* 1998, 79–80). Pictorial evidence exists for ascariasis in ancient Mesopotamia, and prescriptions in ancient Egypt have *A. lumbricoides* as a target of treatment (Kuhnke 1993, 457). Moreover, this nematode was known to ancient pre-Columbian writers in China, India, and Europe. It was also present in pre-Columbian America (Patterson 1993, 603). Although it was once thought to be a post-Columbian arrival, it has been shown recently to have plagued pre-Columbian South American populations (Verano 1998, 221).

TABLE 4

MICROFAUNA FOR WHICH THERE IS DECISIVE EVIDENCE

Species	**Common Name or Caused Disease**
Ancylostoma duodenale	a hookworm
Ascaris lumbricoides	roundworm
Bordetella pertussis	whooping cough bacterium
Borrelia recurrentis	relapsing fever spirochete
Entamoeba hystolytica	amoeba that causes dysentery
Human (alpha) herpes virus 3	cause of shingles, chicken pox, etc.
Human (gamma) herpes virus 4	cause of mononucleosis, etc.
Microsporum spp.	cause of ringworm of the body
Mycobacterium tuberculosis	bacterium causing tuberculosis
Necator americanus	a hookworm
Pediculus humanus capitis	louse
Pediculus humanus corporis	louse
Piedreaia hortai.	a fungus that infests the hair
Rickettsia prowazekii	bacterium that causes typhus
Rickettsia rickettsii	bacterium that causes spotted fever
Streptococcus pyogenes	cause of scarlet and rheumatic fever, etc.
Strongyloides sp.	threadworm nematode
T cell lymphotropic (retro) virus (HTLV–I)	lymphotropic virus
Trichosporon ovoides	a fungus infesting hair of scalp or beard
Trichuris trichiura	whipworm
Yersinia pestis	the plague bacillus

Bordetella pertussis

Bordetella pertussis is the bacterium that causes whooping cough. It originated in the Old World, as did all the other species discussed under the “Microfauna” heading. However, antibodies for pertussis bacilli occur in the blood of isolated, unacculturated Brazilian Indians. Furthermore, it “may have been present in the Southwest [of the United States] before arrival of the Spaniards” (Stodder and Martin 1992, 62). Van Blerkom (1985, 46–7) concludes, “If not pertussis, then some close relative of it probably occurred in the New World as well as the Old …. Perhaps different strains existed in the two hemispheres.” But what “close relative” would that be unless one that also arrived from the Eastern Hemisphere where alone it would have evolved? To Hare (1967, 119, 122), “It is highly improbable that any of these organisms would have become established in a scattered community with a Palaeolithic culture” and thus that they could have crossed to the Americas with early hunters via Beringia. The transfer of *B. pertussis* would of necessity have waited until an infected person from a more densely populated agricultural society crossed the ocean as a voyager.

Borrelia recurrentis

Relapsing fever is caused by the spirochete, *Borrelia recurrentis*. It is vector-borne, not transmitted from person to person. The infection is acquired by crushing an infected louse, *Pediculus humanus corporis,* so that its body fluids contaminate a bite wound or an abrasion of the skin (Chin 2000, 421–22).

Since *B. recurrentis* occurred in the Old World initially, the primary question becomes, how did the vector organism reach the New World? Van Blerkom (1985, 62–5) thought that louse-borne relapsing fever dates only to the rise of urban centers in the Old World (3000 BC?). Hare (1967, 118) says that cases closely resembling relapsing fever were described by Hippocrates *ca*. 400 BC. This dating rules out arrival of the disease by early Beringian migrants. Yet Alchon (1991, 22, 25) reports that relapsing fever, both the endemic type (transmitted by ticks) and the epidemic type (carried by lice), was present in pre-Hispanic coastal Ecuador. The only plausible scenario for this occurrence is the arrival in the Americas of lice (and ticks?) with human transoceanic voyagers. We will see below that this immigration is directly confirmed.

TABLE 5

MICROFAUNA FOR WHICH EVIDENCE JUSTIFIES FURTHER STUDY

Species	Common Name or Caused Disease
Flavivirus spp.	organism causing yellow fever
Giardia lamblia	*protozoan causing giardiasis*
Influenza viruses	influenza viruses
Leishmania sp.	protozoa causing Leishmaniasis
Mycobacterium leprae	bacterium causing leprosy
Onchocerca volvulus	nematode causing onchocerciasis
Plasmodium falciparum	sporozoan causing malaria
Rickettsia typhi	bacterium causing typhus murine
Salmonella enterica serovar Typhi	typhoid bacillus
Schistosoma sp.	cause of snail fever
Shigella dysenteriae	causes of bacillary dysentery
Staphylococcus x *aureus*	bacilli causing impetigo, carbuncles, etc.
Streptococcus pneumoniae	a cause of pneumonia
Treponema pallidum	organism causing yaws, pinta, and syphilis
Trichophyton concentricum	fungus causing ringworm of the body
Trychostrongylus sp.	helminthic parasite
Tunga penetrans	chigger, nigua
Wuchereria bancrofti	nematode causing filiariasis

Entamoeba hystolytica

Amoebic dysentery is caused by *Entamoeba hystolytica.* Transmission is mainly by ingestion of fecally-contaminated food or water (Chin 2000, 11–13). Van Blerkom (1985, 19) maps amoebic dysentery reaching Persia from India by 480 BC, thence to Africa. Again, the key issue is the presence of the particular amoeba in pre-Columbian America. Stodder and Martin (1992, 62) say that amoebic dysentery was probably present before European contact. Saunders *et al.* (1992, 118) approvingly cite Newman (1976) who considered that pre-European-contact diseases included both bacillary and amoebic dysentery.

Alchon's (1991, 20) detailed study using ethno-historic sources on diseases in Ecuador concluded that amebiasis was present before the Spaniards arrived. An unidentified (as to species) *Entamoeba* cyst was found in a Peruvian mummy dating to about AD 1500 (Pike 1967, 185). Van Blerkom considers that this date leaves the case in the range of possible Spanish contamination. Most Andeanists, however, suppose that Spanish influence was unlikely to have had any effect on this desiccated body (Pike 1967).

Moreover, Van Blerkom observes (1985, 19), it is now known that the amoeba alone is incapable of inducing the disease state, which requires the concomitant presence of a certain bacterium (citing Schwabe 1967). She thinks it is likely that the amoeba, but not the bacterium, was present in the New World. From our non-epidemiological point of view, the crucial question is only, did any organism reach the New World from the Old, not was the disease manifest? The sources convince us that the amoeba was here. Again, we cannot imagine any means of that transfer except by an infected voyager.

Herpes zoster; varicella-zoster virus VZV

Human (alpha) herpes virus 3 is the cause of chicken pox, shingles, etc. Chicken pox (*varicella*) is an acute, generalized viral disease. Herpes zoster, or shingles, is a local manifestation of latent *varicella* infection. The infectious agent for both chicken pox and shingles is human (alpha) herpes virus 3 (Chin 2000, 91–93). Transmission from person to person is by direct contact or airborne (droplet) spread of fluids from an infected person.

Human (gamma) herpes virus 4

This is the Epstein-Barr virus, which is involved in infectious mononucleosis and other disease manifestations such as simplex (cold sores) and cytomegalovirus, a mononucleosis-like infection. Type 4 is closely related to other herpes viruses, similar morphologically but distinct serologically (Chin 2000, 350–51). The agent for both type 3 and 4 can remain latent within the human body for years after the initial attack (Alchon 1991, 23).

To Hare (1967, 121), “It is highly improbable that any of this class of organisms would have become established in a scattered community with a Palaeolithic culture.” (In his day herpes viruses had not yet been identified in the Americas.) Actually, while nothing is known about the early history of chickenpox, there is no doubt about its comparative antiquity in the Old World. It was reported by the 1st century AD (Hare 1967, 120). Still, these viruses were endemic in the pre-Spanish Ecuadorean population according to Alchon (1991). They leave no evidence on skeletons; thus their existence cannot be checked archaeologically. But they have been found in isolated populations of Amazonian natives, implying pre-Columbian incidence. Stodder and Martin (1992) also believe that herpes was present in the Southwest of the United States before the Spaniards arrived.

Van Blerkom (1985, 27–9) thought that since *varicella* is endemic in Brazilian tribes and is also known in wild primates, that herpes zoster in humans in the Americas must have been derived from the ancient primate virus. But because the wild primate population in the Americas has limited interaction with humans, one would hope for real evidence that American monkeys have been shown to be infected and that native populations did, or could, receive it from that source. It is far more persuasive to us that one of the voyages from the Old World to the New, such as that (or those) that brought hookworms, probably tuberculosis, and also Old World plants to South America, was the medium by which humans introduced these organisms from the Eastern Hemisphere.

Microsporum spp.

Several fungi cause ringworm of the human body. The species differ depending on the area of the body infested (head, beard, groin, body, foot, or nails) (Chin 2000, 147–53). For the most common forms of the disease, *tinea corporis* (ringworm of the body) and *tinea cruris* (ringworm of the groin and perianal region), the reservoir for these agents is humans. Most species of *Microsporum* and *Trichophyton* (as well as *Epidermophyton floccosum*, *Scytalidium dimidiatum*, and *S. hyalinum*) cause ‘dry type’ *tinea corporis* in tropical areas of the Americas as well as the Old World; thus they are potential additional species to demonstrate transfer by voyagers.

Fonseca (1970, 40–5, 147 *ff*.), the discoverer of the disease in South American indigenes, called it *tinha* (or *tinea*) *imbricada* as well as, in the older literature, *toquelau*, or *tokelau* (in Oceania), and *chimbêrê* (in Brazil). European explorers in Brazil reported its presence from the beginning. The disease is also known in central Mexico, Guatemala, and El Salvador, but it is totally absent among native peoples of North America, Alaska, and Canada. The area of incidence in the Old World is most of Polynesia, Micronesia, Melanesia, and Malaysia, as well as Formosa (the indigenous population) and Indochina, and, with less frequency, south China, Burma, Ceylon, and the south of India (but not Africa).

Fonseca (1970, 44–5, 195–96, 216–17) presented a conclusive ten-point argument supporting the proposition that this parasite was introduced to South America by ancient immigrants. The Brazilian tribes who were first discovered (by Fonseca, in 1924) to bear the disease were virtually isolated and untouched by European influence.

Mycobacterium tuberculosis

Tuberculosis is caused by *M. tuberculosis*. It is one of a complex of organisms that includes *M. africanum*, primarily from humans, and *M. bovis*, primarily from cattle (Chin 2000, 523–24). Transmission is by exposure to tubercle bacilli in airborne droplet nuclei produced by people with pulmonary or laryngeal TB when coughing or sneezing.

The origin and history of tuberculosis in the Old World is but dimly understood. Hare (1967, 117) points out that *M. tuberculosis* has never been isolated from wild animals, nor has it ever become established as a human parasite. It has infected (Old World) dairy herds since before the Christian era. Because Paleolithic societies did not domesticate cattle, it is improbable (or rather, impossible) that this organism caused infection at the time when migrants to the Americas presumably entered via Beringia. But the disease could have existed in Neolithic and more recent societies. The earliest sure evidence for pulmonary tuberculosis in the Old World is late in the 2nd millennium BC—in India, China, and Egypt. Bones with lesions suggestive of tuberculosis may go back as early as 3700 BC, although that date may somehow be deceptive. “It was never found in the thousands of mummies from Egypt and Nubia examined by Dawson, Smith *et al.* (Hare 1967, 125–26).” Klepinger (1987, 52–3) says that “Current paleo-pathological evidence would suggest that the mycobacteria responsible for the New World disease were not carried over by the Beringian trans-migrants but more likely arose *de novo* in the Western Hemisphere.” However, to accept a second “*de novo*” origin of a particular species of bacterium requires more faith in parallel evolutionary processes than we can muster.

Allison *et al*. (1973) first established the presence of *M. tuberculosis* in a Peruvian mummy. Since then, additional cases in the Americas have been documented beyond any question (Allison *et al.* 1981; Karasch 1993, 537; Powell 1992; Salo *et al* 1994; Verano 1998, 217–19). In fact, Alchon (1991, 23–4) maintains that archaeological evidence indicates that acute respiratory infections were the most frequent cause of death among pre-Columbian Andean residents, anciently the same as today.

So how are we to explain tuberculosis in the Americas? Buikstra (1981, 13) says, “In the absence of appropriately-timed migrations from the Old World, we must develop and defend a reasonable model for the origin of this disease in the absence of [New World reservoirs of] domestic herd animals such as cattle.” Yet no model has been offered that does not contradict vital facts. So Lovell’s (1987, 53) interrogative stands: “But where did that organism come from?” There is no satisfactory answer, unless one accepts, as we have shown that one now must, that voyagers from the Old World intruded into pre-Columbian America and quite probably carried *M. tuberculosis* bacilli in their lungs.

Pediculus humanus spp.

Two species of lice, *P. humanus capitis* and *P. humanus corporis*, were shared by Native American peoples and those of Oceania. That these organisms arrived in the Americas by sea is the only sensible explanation. Lice are host specific; those of lower animals do not infest humans. Transmission is by direct contact with infested persons or objects used by them. Lice can survive for only a week without a food source (Chin 2000, 372–73).

Fonseca (1970) particularly has discussed the distribution of “*Pediculus pseudohumanus*,” as *P. humanis* was once known. It is “a form of louse found solely in indigenes of the Americas and of Oceania and in American macaques.” Fonseca quotes Ferris (1935), who described its distribution as “extremely peculiar” (see also Ferris 1951, 275)—specimens from the Marquesas and Tahiti in Polynesia were identical down to morphological details to lice from Guatemalan and Panamanian villagers and from mummified heads from Ecuador and Yucatan. More modern writers assure us of similarities on an even wider scale. Sandison (1967, 178–83) says lice of the same species are known from pre-Columbian Mexico and Peru, as well as from the Mediterranean through China. Karasch (1993, 538) notes that lice have been identified on mummies from Chile and Peru. According to chroniclers, the poor in the Inca Empire (as a control measure) had to “pay tribute in the form of small containers of lice.” “Not surprisingly,” Karasch continues, typhus was “a very common disease in ancient Peru.” Alchon (1991, 22) believes “One can build a strong case for the existence of both endemic (flea-borne) and epidemic (louse-borne) typhus in the New World, based on lice on Peruvian and Chilean mummies.” (Compare Zinsser 1960, 254–61, who also believed that historical evidence involving lice found on mummies suggests that typhus was present in South America.) Meanwhile, Van Blerkom (1985, 4) summarizes: “The lice found on pre-Columbian American mummies are of the same species (with only slight differences, on the order of a subspecies) as those on Old World humans (El-Najjar and Mulinski 1980, 111).”

Linguistic evidence anchors the case for the transfer of lice by direct contact, from Oceania at least. Roys (1931, 341) cites the authoritative 16th-century Mayan Motul dictionary for the term “*Uk*. The louse found on man and quadrupeds.” Schumacher *et al*. (1992, 18) reports from Oceania that the ethnically-Papuan Austronesian-speaking Buma tribe, on Vanikoro, eastern Solomon Islands, have *uka* for louse, while in the western Solomons, the Austronesian Ontong Java people call the louse *uku*.

Piedreaia hortai

This fungus causes *piedra* (*negra*), a disease of the hair. “Piedra is characterized by black, hard ‘gritty’ nodules on hair shafts” (Chin 2000, 147–48). According to Fonseca (1970, 262), the disease is especially characteristic of South American natives in the interior of the continent. It is found very rarely in North America. On page 264, Fonseca observes that this disease is also found in Southeast Asia—Thailand, Vietnam, Burma, Malaya, and Indonesia. In all those regions it presents exactly the same clinical, epidemiological, and parasitological characteristics with which it appears on the South American continent. There are a variety of names for the disease in the Guaraní and Tupí language families in lowland South America. This disease was introduced to the Americas by pre-Columbian migrations of natives from Oceania, he argues, using a variety of evidence. It is missing in northern Asia and North America, so any migration across the Bering Strait could not have brought it. Nor does the disease exist in Europe or Africa. Because it was widely distributed in South America, among many language groups, it must have arrived long ago, Fonseca continues.

Rickettsia prowazekii

The body louse can be infected with *R. prowazekii* by feeding on the blood of a host with acute typhus fever. People in turn are infected by rubbing louse feces or crushed lice into the bite or into superficial abrasions. The body louse is involved not only in outbreaks of epidemic typhus but also epidemic relapsing fever caused by *Borrelia recurrentis* (Chin 2000, 372, 541–42).

As noted above, Alchon (1991, 22) has argued that both endemic (flea-borne) and epidemic (louse-borne) typhus probably were present in the New World, based on the fact that Peruvian mummies were infested with lice. Head and body lice were common on mummified remains. Most native households (at least in the Andes) included several guinea pigs in the family’s living quarters; these animals can be reservoirs for the typhus rickettsiae. Infected fleas can easily jump from rodent to human, thereby transmitting the endemic form of the disease. There are pre-Conquest traditions of epidemics occurring during periods of social turmoil—wars, famines, and natural disasters—supporting the assertion that typhus existed in the Americas before the 16th century. For example, Peruvian chronicler, Guaman Poma, described two epidemics that took place long before the Spanish Conquest. Cabieses (1979) believes that typhus was common in pre-Columbian Peru. Guerra (1966, 330–32) maintained that the two most important aboriginal Aztec disease entities were *matlazahuatl* and *cocolitztli*. They caused major epidemics. Translation of the terms remains unclear; Guerra’s analysis of the symptoms indicates that the former was exanthematic typhus. Ackerknecht (1965, 53) interpreted the reported (by tradition) epidemic of 1454 on the plateau of Mexico as in all probability typhus. Goldstein (1969) agreed with Ackerknecht, Bruce-Chwatt, and Sandison, who say that typhus probably occurred in the Americas before Columbus. Villacorta C. (1976) too is confident that exanthematic typhus was present anciently.

Where did the infectious organism come from? It may have been earlier in the Old World than in the New, but that is uncertain. Hare (1967, 118) believes the first outbreaks known in European medical history occurred in Italy only in 1505. Epidemic typhus is therefore a comparatively modern disease and, on chronological grounds alone, could not have come across Bering Strait. However, typhus was much older in Asia and Oceania than in Europe, judging from the wide distribution. Nicolle (1932) drew attention to the Asian/Oceanic distribution of typhus that supports the idea that pre-Columbian migrations reached the Americas from Oceania, bringing typhus (probably along with fleas and lice). Fonseca cites a large literature (Mooser, Gay, Miranda, Gaitán, Nicolle) representing what he (1970) refers to as “most authors” who have written on this point, to conclude that exanthematic typhus indeed existed in pre-Columbian America.

In the nature of the evidence of ancient epidemiology, we cannot be absolutely certain of the presence of many diseases, including typhus, because they leave no physical indication visible on skeletal remains to prove that the corpse had been infected. Nevertheless, we agree with Alchon that the evidence is strong for the presence of this rickettsial organism in the ancient Americas. No alternative explanation for the presence of *R. prowazeki*, other than voyaging by humans, is apparent. From the plant evidence already cited, it is clear that numerous transoceanic voyages to the Americas took place from the Asian home where so many diseases were endemic.

Rickettsia rickettsii

Rickettsia rickettsii is the infectious agent that causes spotted fever. According to Chin (2000, 372), the disease is one of a group of clinically similar diseases caused by closely related *rickettsiae*. They are transmitted by ixodid (hard) ticks, the tick species differing by geographic area. Newman (1985; 1976, 669) considered that pre-European-contact diseases in the Americas included rickettsial fevers. Saunders *et al*. (1992, 118) acquiesce. Ackerknecht (1965) considered that petechial typhus (spotted fever) was at least as old as AD 1083 in Mexico, as he reads the Aztec traditions.

This evidence is not quite as firm as for *R. prowazeki* (see above), but any alternative explanation for typhus having reached the Americas is impossible. It seems most plausible to us that this rickettsial disease agent was brought across the Pacific Ocean at the same time as *R. rickettsii*.

Rickettsia typhi (ex. *Rickettsia mooseri*)

This organism produces typhus murine, *i.e*., endemic typhus. Murine typhus is similar to louse-borne typhus but milder. It is found where humans and rats live together. Rats, mice, and other small mammals form the reservoir. Infective rat fleas (usually *Xenopsylla cheopis*) defecate rickettsiae while sucking blood, which contaminates the bite site and other skin wounds. Once infected, fleas remain so for up to their one year of life (Chin 2000, 544–45).

Fonseca (1970, 333–36) said that murine typhus was at first assigned primarily to two distinct geographic areas: 1) certain regions of North America (Mexico, Guatemala, and the southern United States), and 2) the Far East and Pacific—India, Malaysia, China, Manchuria, Formosa, Australia, New Guinea, New Zealand, and Hawaii. Nicolle (1932) recognized the presence of murine typhus in Mexico and Guatemala, the same as in Southeast Asia. He considered the possibility that typhus murine might have come via the Vikings, yet thought it far more logical that it reached the Americas via rats on Polynesian vessels. Alchon (1991, 22) too accepted pre-Columbian presence of the disease in South America, *i.e.,* Ecuador, again based on ethnohistoric records.

Among diseases Newman (1976, 669) thought were “part of man’s primate ancestry” and that either crossed the Bering Strait cold-screen or “were acquired” in the Americas were “various rickettsial fevers,” including typhus. He thought so because the Aztecs had a name, *matlazahuatl*, for the disease, and depicted it in conventionalized pictures of suffering Indians. But we cannot see how the typhus vector could have passed the Arctic cold-screen, and neither is it clear from where the supposed settlers of the Americas via the Arctic could have ‘acquired’ the disease.

Streptococcus pyogenes

Streptococcus pyogenes causes scarlet fever, strep sore throat, and rheumatic fever. Pre-Columbian American skulls have been found showing evidence of acute infection of the mastoid from *S. pyogenes*. Hare (1967) accepts that *streptococcus* was present in the New World. To explain the fact is not easy. If the disease came via Bering Strait, as Van Blerkom supposed (1985, 77–8), then the concept of a cold-screen at Beringia becomes of doubtful value. Newman’s aside that *streptococcus* infection was “acquired in the Americas” (1976, 669) is without meaning, absent an explanation of how the organism reached the Americas in order to be “acquired.” Transoceanic voyaging as an explanation manages both the mastoid infection in pre-Columbian Amerindian skulls and our extensive evidence for transoceanic journeys (above). In fact, it might seem surprising if the infection had not reached the Western Hemisphere by that means.

Strongyloides sp.

The antiquity and origin of the hair worm, or threadworm, nematode, *Strongyloides*, as an Old World genus is shown by the fact that an Egyptian mummy had larval forms of the worm in its intestines (Sandison and Tapp 1998, 40). Patterson (1993b, 1016) says it occurred around the world with a range similar to that of the hookworms, although it was once thought to be absent from the New World. However “the presence of *Strongyloides* is now confirmed from (Peruvian) mummy study” (Verano 1998, 221). Moreover, from Antelope House, New Mexico, traces of this parasite were recovered from a coprolite (Reinhard 1988, 359). Again, the voyaging mechanism is indicated as the only plausible explanation.

T cell lymphotropic (retro)virus (HTLV-I)

Only a small number of peoples in Tropical America show infection with this virus. The group studied in the greatest detail is the Noanama Amerindians in the high mountains of southwestern Colombia; their geographical and social isolation reduces the chance of any contact with the slaves of African origin brought to Colombia by the Spaniards (León *et al*. 1996). This study combined sero-epidemiologic, genetic, virologic, molecular, anthropological, archaeological, and oceanographic data that led the authors to conclude that this virus could have arrived from Kyushu Island in Japan more than 5,000 years ago through direct voyaging.

An earlier study of 13 genetic markers around the world revealed that the Noanama had very close relations with Samoans on the one hand, and Japanese—especially Ainu—on the other. Furthermore, recent genetic studies on native South Americans showed that their ancestors possessed genetic markers related to the histo-compatible leucocyte antigen (HLA), as do the Japanese of Kyushu. A direct voyaging contact from Japan to Colombia would explain this relationship, because populations of North and Central America are totally without the HLA markers. At a mitochondrial DNA level, study of the deletion 9 bp in the human genome has shown it to be Asiatic in origin; however, it is being found in North American Amerindians and Polynesians (citing Torroni). Yet it is not present in the (Jomon-derived) Ainu people, and the 9 bp deletion is also absent among the Noanama (as well as on the coasts of

Chile and Peru a thousand years earlier). This suggests an intrusion of people from Japan. León *et al.* (1995) cite the proposal of Meggers *et al*. (1965) concerning the intrusive Valdivia culture of Ecuador as confirming their position about the disease.

Finally, León *et al* point out that Japanese investigators have voyaged across the Pacific to Colombia by the North Pacific route, which the authors suppose was used anciently; the Japanese researchers used vessels similar to those of prehistoric times. This nautical experiment demonstrates that it was possible to make such a voyage, which is seen as bearing this disease (Errazurriz and Alvarado 1993).

Trichophyton spp.

In the genus *Trichophyton*, there are eleven species of fungi that are cosmopolitan, seven of which are anthropophilic (Ajello 1960, 30). The *Trichophyton concentricum* fungus is a cause of ringworm of the body. *T. concentricum* (the cause of *tinea imbricata*?, as Fonseca called the disease) is endemic in Southeast Asia and also widespread among the inhabitants of Polynesia and countries bordering the western shores of the Pacific. However, it only occurs sporadically among Indians living in the tropical forests of Brazil, Guatemala, and Mexico. The disparity in prevalence between the Asian endemic areas and those of Latin America has led to the interpretation that the fungus was introduced from Asia into the New World (Ajello 1960, 30). Since the fungus can only have been transferred on a human body, no other explanation than the arrival of voyagers can be accepted for its American incidence.

Trichosporon ovoides

T. ovoides is present in Brazil and Asia. It is a fungus that causes a disease (known in Brazil as *piedra branca*) consisting of white or clear nodules that develop on individual hairs of the beard or scalp. Fonseca (1970) describes it, gives its distribution, and argues that it had to have arrived by sea-borne travelers across the Pacific.

Trichuris trichiura

The whipworm, *Trichuris trichiura*, like the hookworm, requires warm, moist climatic conditions for the completion of its life cycle and reproduction. It is particularly incident in Asia and Oceania. Finding the human-specific parasites in the Americas is circumstantial evidence for transpacific contact (Reinhard 1992, 231–45) because the cold of the Bering Strait route would kill the infectious organism in the stage when it is excreted from the human host. Coprolites from coastal Peru show the whipworm present by 2700 BC (Verano 1991, 15–24). According to Ferreira *et al*. (1988, 65–7), the whipworm has been identified along with the two hookworm species (see above) in human coprolites from Boqueirão do Sitio da Pedra Furada, Brazil, in a stratum dated to 7320±80 BP.

Yersinia pestis

Some epidemiologists might assert that *Yersinia pestis*, the plague bacillus, is simply zoonotic in origin and as such has no relevance to the history of humans in the Americas. But that dodges the question of how the infectious bacillus came to be in the Americas at all. Either an infected animal or an infected human must have come carrying it from its original home in the Old World. Chin (2000, 381–83) says it is endemic in East and South Asia and sub-Saharan Africa. The reservoir is wild rodents, especially ground squirrels, and also rabbits and hares. Transmission occurs as a result of human intrusion into the zoonotic (sylvan or rural) cycle, or by the entry of sylvatic rodents or their infected fleas into human habitats. Domestic pets may carry plague-infected wild rodent fleas into homes. The most frequent source of exposure that results in human disease has been the bite of infected fleas (especially *Xenopsylla cheopis*, the oriental rat-flea). Although human plague is commonly zoonotic in origin, it can be transmitted from man to man, with or without the agency of vector fleas, and humans can also act as a reservoir of the disease (Van Blerkom 1985, 48, 50–9). Person to person transmission by *Pulex irritans* fleas, the 'human' flea, is presumed important in the Andes area (Chin 2000, 381–82).

Many (Schwabe {1969, 282} calls it a consensus) believe that sylvatic plague is indigenous in the Americas. Van Blerkom considers the most compelling evidence in favor of pre-Columbian plague to be the existence of several sylvatic foci in both North and South America, with the largest being in western North America in rodents. Also, it is focused in eastern Siberia and western Canada. This distribution suggests that plague is an ancient and widely distributed disease of rodents diffused across the Bering Strait. But Van Blerkom disagrees. Besides, Hare (1967) reports that there is no evidence that the disease occurred in the Eastern Hemisphere at any time during the pre-Christian era. (Ergo, it could not have reached the Western Hemisphere via early Holocene settlers traversing the Bering Strait.)

How it was transmitted to the Americas is clarified by Van Blerkom's (1985, 58) observation about the distribution of this organism. There are three subspecies: *Y. p. orientalis*, endemic in India, Burma, and South China; *Y. p. antiqua*, carried by rodents in Central Asia and Africa; and *Y. p. mediaevalis*, or the Black Death in Europe, which is today found only in West Africa. If New World sylvatic plague was an indigenous disease of the rodents of this hemisphere, one would expect it to be the same strain found on the other side of the Bering Strait, *Y. p. antiqua*, the parent of the other strains. However, American plague is derived from the urban strain found in Southeast Asian seaports, *Y. p. orientalis* (Alland 1970, 101–2; Hull 1963, 534). This suggests that plague was carried by ship to the Americas from Southeast Asia. In fact, any other explanation seems impossible.

Van Blerkom (1985, 58) believes that transmission to the Americas occurred only during the last pandemic. That was in China in 1855. She supposes that only later was plague found in wild American rodents, and it seems to have spread rapidly into wild reservoirs from the original murine foci in seaports (Hull 1963, 547–54). But her scenario presumes an unbelievable rate of spread to a wide variety of rodents (up to 200 species in the New World; so, Van Blerkom 1985, 56) over a wide geographical range. Rather, we suppose that the extensive presence of *Y. p. orientalis* in the Americas can be explained much more economically by supposing its arrival on a pre-Columbian voyage from some seaport in Southeast Asia with then sufficient time to spread to many rodents. This seems to be the only scenario that takes account of all the facts of the case.

TABLE 6

OTHER FAUNA FOR WHICH THERE IS DECISIVE EVIDENCE

Species	Common Name
Alphitobius diaperinus	lesser mealworm
Gallus gallus	chicken
Littorina littorea	a mollusk
Meleagris gallopavo	turkey
Mya arenaria	American soft-shell clam
Stegobium paniceum	drugstore beetle

OTHER FAUNA

Beyond the flora and the microfauna already discussed, evidence of communication across the oceans also comes from the distribution of various faunal species that are not agents of disease. As a simple term of reference for this miscellany we use “Other Fauna.” The 6 species in evidence are listed in Table 6. Six possibilities to be investigated further are listed in Table 7.

TABLE 7

OTHER FAUNA NEEDING ADDITIONAL STUDY

Species	Common Name
Cairina moschata	Muscovy duck
Crax globicera	curassow
Cicada sp.	cicada
Dendrocygna bicolor	fulvous tree duck
Lasioderma serricorne	tobacco, or cigarette beetle
Rhyzopertha dominica	lesser grain borer

Alphitobius diaperinus

This pest of Old World origin has been discovered in a very similar mortuary context in both hemispheres. It is called in the vernacular, the ‘lesser meal worm.’ Panagiotakopulu (2001, 16) reports it in the British Isles in a 2nd-century AD burial and in Egypt with a mummy at 1350 BC. In Peru, the same worm has been found in an AD 1240 mummy bundle (Riddle and Vreeland 1982).

This dual association of pests with burial practices in both hemispheres appears less startling when we realize that chemicals from the consumption of American tobacco and coca plants were discovered in Egyptian corpses dating from the 2nd millennium BC to the 5th century AD (see above). Further, residues of *Cannabis sativa*, an Old World plant, has been found in Peruvian mummified corpses. It is not surprising then, that a beetle and a worm from Eurasia should show up in Peru. Since drugs associated with corpses have been found in both hemispheres, logically, contaminant pests could just as well have been shared also. Culture-bearing humans traveling on boats provide the only plausible means by which the two areas, halfway around the world from each other, could have been so linked.

Canis familiaris

The dog is commonly assumed to have been brought to the New World by early hunter-gatherers via Beringia, but there is very slim evidence for this. Mair’s (1998) data from Asia suggest that dog-in-the-company-of-humans in the Old World is not very old. The earliest domestication (or taming) occurred in the Near East (during the Natufian era) only around 12,000 years ago. Dogs in the European Mesolithic period date to the order of 9000–6000 BP. The earliest dogs in China are around 6000 BP. Moreover, the common hypothetical root word for dog in ancestral language groupings like Nostratic and Afro-Asiatic appears to date “closer to 6000 BCE than to 10,000 BCE” (Mair 1998, 22–3). Turner (2002, 144) says a dog skull dated to 12,000 BC was found in a cave in the Altai Mountains, but it was not associated with evidence for human presence in the area. These data mean that it is a stretch to imagine domesticated dogs being available in northeastern Asia to accompany the first migrants who came to the New World via Bering Strait. So where did the American dogs come from? (Of course, they might have been independently domesticated from wild canids, although evidence—even hints—of that are all but absent (*cf*. Turner 2002 144–45).

C. Sauer (1969, 29) says: “The great hunters of the upper Paleolithic had no dogs. It has been noted that these appear archaeologically first with Mesolithic folk.” “The Swiss zoologist Studer began a series of studies in the comparative anatomy of the dog and its relatives …. These make a strong case for the monophyletic origin of the dog. The conclusion is that the dog, in several ways less specialized than the wolves, cannot be derived from the latter, as on grounds of comparative anatomy man cannot be derived from the apes.” (30.) “The dog is considered therefore as originating from a wild dog, native to Southeastern Asia, living in forested monsoon lands ….”

As many as three varieties, or breeds, of canines might have reached the New World from the Old as a result of ocean travel.

The voiceless, hairless dog. Covarrubias (1957, 93) reported that early in the 1st millennium BC, or before, an edible dog occurred in both China and at Tlatilco, Mexico, of identical appearance. Coe (1968, 59) found physical evidence for consumption of small dogs at the site of San Lorenzo in southern Mexico around 1000 BC. Fiennes and Fiennes (1968, 26, 53–55, 103–110) told of a special breed of hairless, or ‘toy,’ dogs that were kept and bred in China and also in west Mexico and Peru as temple and sacrificial animals as well as for consumption. Campbell (1989, 360–367, 385) noted the presence of dogs for eating in the Chorrera phase in coastal Ecuador about 1500–500 BC; they appeared alongside such Asiatic traits as house effigies, roller and flat stamps, and ceramic pillows. Tolstoy (1974) considered the hairless dog of Mexico to have been derived directly from Asia (along with chickens and several plants).

A Viking dog? Friant and Reichlen (1950,1–18) concluded that “the Inca dog was not domesticated from a South American wild form but was brought from elsewhere already domesticated.” Subsequently, Friant (1964–1965, 130–35) examined mummified dog remains, including skulls in Inca burials, and found that they compared closely with dog remains in Denmark from the late Neolithic. They postulated that the similarity must be due to the hybridization of Viking dogs with those of the 'Indians' (Incidentally, Adelsteinen and Blumenberg {1938} suggest on genetic grounds the possibility that certain cat populations of the northeastern United States originated from a Viking/Norse introduction.) Further research may or may not confirm their speculation.

Dogs kept for wool. Lord (1866, II, 215–17) discovered on the American Northwest Coast a few tribes that kept peculiar dogs "differing in every specific detail from all the other breeds of dogs belonging to either coast or inland Indians" on secluded islands, where they could not interbreed with regular canines. These special dogs had long white hair that was shorn annually. The hair was then woven into rugs, sometimes mixed with wool of the mountain goat, or duck feathers, or finely carded wild hemp. The practice dated from before European contact. Lord was sure these dogs were not indigenous but had been brought from elsewhere. He thought they were likely from Japan, where a small, longhaired dog had been reported. It is not clear to us how more evidence might be obtained to establish this notion.

At least, we believe the most plausible explanation for the 'toy' dog of the Americas is transfer by voyage from Asia. It is highly unlikely that such a breed would have been developed separately in two areas. A mechanism for how transfer could have taken place is suggested by Xu's (2002) report of a Chinese inscription on an artifact from La Venta (the Olmec site in southern Veracruz). This inscription was first noted by Chinese scholars while inspecting artifacts in a museum in Mexico. Xu had previously discovered Chinese characters, also like those of the Shang era in China, on other ceremonial objects from La Venta (Xu 1996; 2002). Chinese experts on Shang-period writing have confirmed a number of Xu's readings (personal communication to Sorenson from M. Xu, 2002).

Gallus gallus

Conventional wisdom among zoologists holds that chickens were absent in the New World until introduced by the Spaniards. If that had been the case, the chickens in the hands of Amerindians after the Conquest ought to have been strictly of the Mediterranean type, as Carter (1971; 1998) points out, but they were not. Many of them looked like Chinese or Malay chickens, very different in appearance, color of eggs, and behavior from the Mediterranean class of chicken. Evidence from physical characteristics of fowls, documentary history and ethnography, the uses to which the fowls were put, and the distribution of vernacular names combine to establish that the reputed introduction of the chicken by the Spaniards is contrary to the facts. Instead, multiple introductions of fowls across the oceans, in addition to the Spanish importation, are indicated.

Latcham (1922, 175) observed that in Chile, Bolivia, and Peru, at least three indigenous domesticated varieties or species were known. The Spanish terms for 'cock,' or 'chicken,' had not been adopted for them by the Amerindians "because they have their own names." Their three kinds were definitely present before the Spanish Conquest and are still represented among the fowls kept by the Araucanian Indians of Chile. Some lay blue and olive-green eggs, are tailless, and have tufts of feathers in the form of a ball at the sides of their heads, as do fowls in China that also lay blue eggs. Finsterbusch (1931) agreed that these were pre-Columbian chickens. Castello (1924) went so far as to identify four types of Chilean chickens which differed from the common European fowl but showed Asiatic features. For instance, blue-egg layers are distributed from Chile to Ecuador and Mexico, he reported. Hartman (1973) surveyed the literature to his point in time, paying particular attention to cultural meanings of fowl and their uses in Asia and throughout the Americas. She concluded that Asiatic voyagers probably introduced black-boned, black-meated (BB/BM) chickens to the New World before Columbus.

C.O. Sauer (1952) summarized some of the evidence for the aboriginal presence in South America of a BB/BM chicken. Its breast meat is dark, a melanotic sheath surrounds the bones, and it bears tufts on the side of its head. It also has raised hackles, a black tongue and legs, and characteristic coloring of the feathers that mark it as distinctively Southeast Asian.

Subsequently, Johannessen's fieldwork found that the BB/BM type was still being kept in several locations (Johannessen 1981; Johannessen and Fogg 1982; Johannessen, Fogg, and Fogg 1984). The recent distribution of the melanotic fowl is from Mexico southward to Brazil, Peru, and Chile. This is a non-flocking chicken, displaying the social psychology characteristic of the chickens of Southeast Asia that leads them to stay apart from others when feeding.

At least among the groups that speak Mayan languages, the BB/BM chicken is not normally eaten but is used ritualistically in divination or medicinal treatments in essentially the same manner as the Chinese recorded in AD 1530 in their first encyclopedia of medicine. These treatments are esoteric. For instance, in highland Guatemala the chicken is cut sagitally, bound against the soles of the feet of an ill person, and left there for two or more hours during which time it is said to absorb the pulmonary problems resulting from an asthma attack. It is also used to cure ‘women’s problems.’ The curer intones specific incantations that are in a non-Mayan jargon recited while candles and copal incense are burned and rum is blown onto the patient’s bare skin (providing a shock effect). Other rituals involving the BB/BM chicken take the fowl’s blood and life in order to protect a house, family members, tools, and even ships against hexes. These beliefs and practices also correspond to Chinese ways with BB/BM fowls in Asia.

It seems likely that successful transfer of these cultural patterns must have involved explicit teaching over a considerable period by Asian carriers of the original bird stock. Such rites and beliefs could hardly have been imported via ephemeral contact, say with people off the 17th-century Manila galleons. And it is only speakers of Maya who received, or at least have carried on, the practices involving the BB/BM chickens. No Chinese (or any other non-Catholics) were legally allowed to settle in early colonial Mexico or Central America, so these esoteric practices mush have originated earlier.

What appears to be a very ancient presence of chickens in the Americas has recently been pointed out by historical linguistic study (Wichmann 1995, 76). Wichmann has established that the reconstructed proto-Mixe-Zoquean language of southern Mexico, which dates to the 2nd millennium BC in the area occupied at that time by the Olmec civilization, contained the term **ce:we*(*kv?*)(*n*) ‘chicken, hen.’ The same term continued in the succeeding proto-Zoquean language in the following millennium, where it meant ‘hen.’ The linguist also reconstructed the expression **ná’w-ce:wy* for ‘cock.’ (The word for ‘turkey’ is completely different from either of the above.) Guillemaud’s (1947, 112) list of Mixe terms is generally confirmatory, giving *tseuk* for the Spanish *gallina*, ‘hen,’ and *tsag-naj* for the Spanish *gallo*, ‘cock.’

Littorina littorea

The mollusk, *Littorina littorea*, is native to Northern European waters. Spjeldnaes and Henningsmoen (1938) suggest that it was introduced to North America by Norse settlers about AD 1000. There is no other way to account for its presence on both sides of the Atlantic. They noted that it is a hardy species that could survive for a long time in water in the bottom of an open boat.

Meleagris gallopavo

It is now clear that that quintessentially American fowl, the turkey, was being kept in Europe in the late Medieval Period. In 1940, an observer claimed that an American turkey could be seen in a painted frieze at Schleswig Cathedral, which had been built about AD 1280 (Hennig 1940). That claim was rebutted by Stresemann (1940; Rieth 1967) who showed that the mural had been restored in the1800s and 1900s; hence the rendering of the turkey as it existed in 1940 could have depended on knowledge acquired after Columbus (Bökönyi and Jánossy 1959; Varshavsky 1961). Nevertheless, findings since that time have restored the plausibility of a pre-Columbian origin for the Schleswig representation. Hungarian archaeologists found bones of a turkey in the 14th-century royal castle at Buda. Turkey bones have also been excavated from a carefully dated 14th-century-site in Switzerland (Bökönyi and Jánossy 1959). Other Hungarian sites of the 10th to 13th centuries have yielded signet rings engraved with images of this fowl, that show the fleshy pendent growth on the turkey’s neck. Furthermore, a letter written in 1490 by Hungarian King Matthias, who died later that year, requested through an envoy that the Duke of Milan send him turkeys (“galine de Indie”). The king wanted to acclimatize the bird in Hungary. He also asked that a man who knew how to care for turkeys be sent with the birds (Bökönyi and Jánossy 1959). Obviously, the fowl was in Europe before Columbus’ first voyage.

Confirmation of the late medieval European distribution of the turkey appears in a comment in a *Relación* (report of inspection) from Mérida, Yucatan, from about 1579. “There are many turkeys in the mountains which differ little from those in Spain, very good to eat, very timid birds" (Tozzer 1941, viii, 186; emphasis added). The conventional view is that the turkey was brought from the Americas to Spain by the returning conquistadors probably no earlier than 1523. It seems doubtful that their progeny in Iberia would have multiplied in 50 years to such an extent as to be spoken of in the off-handed manner of this *Relación*.

Mya arenaria

The case of *Mya arenaria*, the soft-shelled clam, is probably tied to the Norse voyages in the North Atlantic. Previously thought only to occur in American waters, this species was recently found offshore of Denmark (Peterson *et al.* 1992). A radiocarbon date on the shells falls in the 13th century, leaving only a slight possibility that the clam could have reached European waters after Columbus. Of course, the transfer to European waters had to have been by ship (perhaps in bilge). Not surprisingly, the investigating scientists decided that the mollusk "could have been transferred from North America to Europe by the Vikings." In the absence of credible alternative scenarios, we think the case should be put more firmly than that.

Stegobium paniceum

The beetle species, *Stegobium paniceum*, a pest usually found in dried, stored vegetable matter, is documented as discovered in both Egyptian and Peruvian burials. Greater incidence and earlier recognition of the species in the Old World favors that hemisphere as the place of origin. However, in Peru, *S. paniceum* was also found with mummies dated at least to the 13th century AD (Riddle and Vreeland 1982). Burials in Egypt as early as 3400 BC have revealed this same 'drugstore,' or 'biscuit,' beetle (Buckland and Panagiotakopulu 2001, 6), and it was present also in both Roman (Hall and Kenward 1990) and Bronze Age England (Panagiotakopulu 2000, 16).

Additional evidence for possible bi-hemispheric species of fauna can be found in the Appendix.

TURNING PARSIMONY AROUND

As we view all the evidence, it seems clear that a total approaching 100 plant species were moved across the ocean to or from the Americas before 1492. Furthermore, it is plausible that additional plants will be shown to have crossed as well; we cannot imagine that our present list is exhaustive. Tables 2 and 3 list additional candidates from the flora that ought to be further researched. Of the microfauna, 21 species show what decisive evidence of prehistoric transoceanic movement, and another 18 species deserve more study in that regard. Of other species of fauna, we count 6 as conclusively demonstrated to have been distributed in both hemispheres, and 6 others are possible.

This evidence puts a new complexion on long-standing questions about transoceanic movements of humans and associated flora and fauna. The outdated stance was illustrated by Spinden's statement (1933) that, "the fact that no food plant is common to the two hemispheres is enough to offset any number of petty puzzles in arts and myths" [such as the *patolli/pachisi* game]. Thirty-eight years later the same argument was still being invoked: "There is no hard and fast evidence for any pre-Columbian human introduction of any single plant or animal across the ocean from the Old World to the New World, or vice-versa" (Riley *et al.* 1971, 452–53). The logic of those days held that since "the bulk of the evidence" from biology was generally construed as being against any direct inter-hemispheric contact, every item of evidence in apparent contradiction to the orthodox view ought to be discarded or held in abeyance.

As late as 1985, Willey tried to tighten screws on the evidence even further by insisting that, "No Old World manufactured object has yet been found in an indisputable, undisturbed New World context. If nothing concrete can be shown in the next 50 years, proponents should stop talking about it." But no arbitrary stricture like this can be imposed on the question. Evidence speaks for itself, whether it consists of a shared "manufactured object" or a natural feature.

In the light of our findings, parsimony should now be interpreted quite differently from what it formerly was. Given that so many organisms were demonstrably shared between the hemispheres before Columbus, "the bulk of the evidence" today actually supports a voyaging explanation. Not only can we expect additional confirmation to come from further study of the flora and fauna (including DNA studies, archaeology, and more careful study of ancient art), but we may also find that many of the "petty puzzles" in culture, formerly rejected as proof of contact, now will turn out to be in agreement with "the bulk of the (new) evidence." It thus deserves careful consideration instead of perfunctory dismissal.

CULTURAL FREIGHT

It is obvious that cultural (as well as human genetic) features had to have been transported with the flora and fauna on transoceanic voyages. A full discussion of the significance of the biological facts must take account of concomitant cultural sharing.

Domesticated plants and animals are almost never successfully transplanted by human agency to a strange area without appropriate care being given to the specimens being moved. Cultural norms for the preservation and exploitation of new organisms must be transmitted along with the crop plants if they are to survive and flourish in their new setting. That essential knowledge comprises botanical data, agricultural practices, culinary technology, and other measures needed to ensure that the transported plants are correctly cultivated and usefully employed on the new scene.

Moreover, the skills essential for making ocean voyages generally involve navigational, astronomical, and calendrical lore—concepts that could well survive at the destination. We can be confident also that a substantial body of myth, beliefs, and ritual practices would have accompanied the voyagers. A new linguistic and artistic repertoire would also have been introduced by the newcomers.

Speculation that people arriving from abroad would automatically be killed or their cultural baggage rejected is not supported by historical cases. The notion that such would have been the fate of voyagers probably owes more to Victorian stereotypes about 'cannibals' eating Christian missionaries than to ethnographic reality. Curiosity is the response to new arrivals at least as often as hostility.

Thus, not only does our documentation of the transport of flora and fauna across the oceans open the door for further studies in biological science (for example, we have noted few of the possibly large number of weeds inadvertently transported by voyagers), it also demands reconsideration of cultural parallels that have heretofore been categorically thrown out of court by almost all scholars when treating the issue of Old World/New World contacts.

Let us examine a single geographically focused setting for inter-hemispheric contact in order to appreciate how biological facts might connect to cultural data. The data in this book show that as many as 50 species of plants definitely, or very possibly, were transferred between the American tropics and India, or vice versa, before Columbus' day. While we cannot tell how many voyages this long process involved, there must have been several score—or maybe several hundred—stretched over millennia. Given the apparent scale of biological contact, one would *a priori* expect substantial cultural interchange as well. For decades researchers have been spelling out data that they consider show a connection between ancient civilizations in India and Mesoamerica, although the nature, timing, and significance of the influences at play have remained vague. (We recognize that considerable cultural evidence that has been offered has been of poor quality and deserves to be ignored.)

As mentioned earlier, Tylor's 19th-century (1896) identification of striking parallels between the South Asian *pachisi* and the Mexican *patolli* board games has never had a satisfactory explanation in terms of parallel, independent invention. In the 1920s, G. Elliot Smith added more cultural parallels between the two areas (see especially his 1924 book that treated elephant symbolism; the Mexican and Buddhist 'purgatory' ordeal; the *makara*, or 'dragon;' and miniature ritual vehicles bearing sacred figures drawn by animals). A series of articles by Milewski (1959, 1960, 1961, 1966) pointed to many conceptual parallels between deity names in Sanskrit on the one hand, and Aztec (Náhuatl) and Zapotec names on the other. Giesing went on (1984) to compile 50 pages of names and epithets for the Hindu god, Siva/Shiva, with which names and titles for the Aztec god, Tezcatlipoca, prove to be congruent. The fire-god complexes of India (Agni) and of central Mexico (Xiuhtecuhtli) were meticulously compared by Cronk (1973), who found extensive and startlingly detailed parallels.

Kelley (1960; Moran and Kelley 1969) argued that much that was basic in Mesoamerican calendrics, cosmology, and mythology is traceable to India of the last centuries BC and to nowhere else as clearly. Durbin (1971) was sufficiently impressed with Kelley’s proposals that he suggested a set of lexical links between Prakrit, Sanskrit-derived languages of India, and proto-Mayan in Central America. Mukerji (1936) claimed to demonstrate specific astronomical correlations between the Maya and Hindu calendars. Kirchoff (1964a, 1964b) laid out large blocks of material on conceptual and structural features of the calendars and mythology of Eastern and Southern Asia, also apparently in Mesoamerica. Barthel (1975a, 1975b, 1982, 1985) did a series of intricate studies of Mesoamerican codices and calendars which he believed confirm that a Hindu ‘missionary’ effort reached Mexico, only to be obscured by a later ‘re-barbarization’ of the transplanted concepts. The sacred figures who hold ears of corn on temple sculptures in India do so with hands in symbolic positions, or *mudra* gestures, while Mesoamericanists have noted a repertoire of *mudras* shared by Indian and Mesoamerican art (Martí 1971; Medvedov 1982). And Compton (1997) has pointed out elaborate parallels between Aztec and Buddhist etiological myths involving the rabbit and the moon.

These studies, plus many more that could be cited, have typically been presented by diffusionists at a high level of abstraction, as though disembodied elements of ‘Indian culture’ or ‘Mesoamerican civilization’ were somehow wafted across the ocean where they lodged in the minds of the locals. Protagonists of diffusion have rarely proposed, let alone documented, plausible historical scenarios that would account for the parallels they propose. That is, they have not hypothesized actual voyages in which culturally knowledgeable persons with believable motives are supposed to have boarded specific kinds of vessels to travel along nautically feasible routes and then arrive at particular locations in the opposite hemisphere, where they significantly affected existing cultures. But the time is at hand when such plausible scenarios can be proposed.

Concrete data on biology has the potential to help relate cultural features to dates and locations. The degree of concreteness this would furnish to investigations of cultural parallels may allow researchers to formulate focused and convincing hypotheses about when, where, and how sharing took place. For example, the fact that important American crops were represented in Indian art, mentioned in texts, and found in excavations, might provide concrete chronological and material settings to relate to, say, Kelley’s, Cronk’s, and Barthel’s hypotheses about Indian intellectual and religious influence on Mesoamerica in the late BC centuries. Yet India is only one area of influence to which the evidence points.

We emphasize that by momentarily focussing on the India/America interchange, we do not consider other origin/destination pairs non-credible. The evidence is strong for South America/Polynesia, Mesoamerica/Hawaii, several American scenes connected to Southeast (especially Indonesia) and East Asia, and Mediterranean/Mesoamerican links. But those are matters to be delineated elsewhere.

SUMMARY POINTS

For now, the following summary points are apparent from our analysis of the biological data. Each bypasses old conceptions and opens up new avenues of inquiry.

- 1. A wide variety of (mostly tropical) floral and faunal materials was carried across the oceans over a long period of time. The movements must have had significant ecological and economic impacts on the receiving areas in both hemispheres.
- 2. A considerable number of voyages were required to accomplish these transfers. Views of nautical history quite surely must expand from what they have been.

- 3. Travel took place across the oceans in both directions. A large number of American plants reached Asia, at least. That fact challenges not just previous interpretations of the American past, but also ideas about the history of various Old World areas.
- 4. The evidence for transoceanic interchange of fauna and flora imply also human gene exchange and generally a more complex biological history of humankind than has been considered until now. The history of disease is a connected subject that calls for new lines of investigation in the light of our findings about the unexpected ancient distribution of microfauna.
- 5. It has frequently been postulated—and more frequently assumed—that parallel cultural or social evolutionary processes moved societies independently in Eastern and Western Hemispheres toward the same basic form of 'civilization.' But since developments in both hemispheres must now be seen to have been significantly interconnected, theoreticians would be on weak ground to continue supposing that what transpired in the New World can serve as a separate control by which it is possible to identify general principles, or 'laws,' of evolutionary process. There have been many cultures and civilizations, but it is now apparent that there was to a considerable degree a single ecumene (Sorenson 1971) spread over much of the world in pre-Columbian times. Consequently, after five centuries of use, the expressions 'Old World' and 'New World' have outlived whatever usefulness they initially possessed, or at least their accuracy in cultural/historical discourse. We need to move on to clearer geographical, as well as cultural/historical, specification.
- 6. The time-depth of many cultural developments is probably more remote than has been commonly thought. For example, the evidence presented above—of major plant and, by inference, also of cultural transfers between the Americas and Asia by the 3rd, or even the 4th, millennium BC—renders highly unlikely the prevailing view that civilization in Mesoamerica and the Andean zone began only in the late 2nd millennium BC. The challenge to archaeology is obvious.
- 7. If there is to be further progress toward an honest history of humankind, greater curiosity needs to be manifested by investigators. Most of the evidence we have utilized has been around in the literature for years (illustrating A.N. Whitehead's dictum, "Everything of importance has been said before by somebody who did not discover it.") Why the importance of these data has not been grasped previously can be attributed largely to the constriction imposed on scientific and scholarly thought by dogmatic acceptance of a single paradigm for the history of human development. Scholars have seen a broadly evolutionary schema as representing the 'truth' instead of as *merely* a heuristic device.
- 8. At the level of public awareness and education, the fact that we have established that ocean-spanning voyages were many and took place both early and late as well as from multiple origins to numerous destinations, casts a new light on the inherent capabilities of the world's varied peoples. The transoceanic movements that we have identified do not show 'superior' folks diffusing 'civilization' to benighted 'primitives.' Rather, we detect a poly-cultural tapestry, although still but dimly perceived. It was woven by people of courage and wit of many origins and colors. The tapestry's integration came from the fact that from time to time voyagers undertook history-changing communication with lands distant from their own.

But we do not intend that our findings spawn new dogma of any kind. Rather, we hope that intellectual curiosity and openness, disciplined by sound research and logic, will prevail among the next generation of investigators, so that they may go beyond, not only where the old paradigm of culture-history allowed, but also beyond the perspective we have reached.

BIOGRAPHICAL NOTES

1. **John L. Sorenson** is emeritus professor of anthropology at Brigham Young University, where he founded work in that discipline in the 1950s. He was attracted from the physical sciences (he holds an M.S. degree from the California Institute of Technology) to anthropology by way of archaeology, but after beginning study for the Ph.D. at UCLA, his focus shifted to sociocultural anthropology with emphasis on its applications to problems of modern society.

After completing the Ph. D. degree, he went to BYU. In 1964–1969 he went as head social scientist to General Research Corp., a Santa Barbara, CA, think tank. In 1969, he founded Bonneville Research as a subsidiary of GRC, in Provo, UT, before returning to the BYU faculty in 1971. He served as chair of the department of anthropology for eight years before retiring in 1986. Since then, he has returned to his early interests in Mesoamerican archaeology and transoceanic contacts, seeking to engender in those studies some of the rigor he learned from doing 'hard science.'

2. **Carl L. Johannessen** is emeritus professor of biogeography in the Department of Geography at the University of Oregon at Eugene. He taught at that university from 1959 to 1994. His M.A. in zoology and Ph.D. in geography came from the University of California at Berkeley.

He studied the distribution of human-modified wild vegetation in Latin America first, but after a decade, the domestication process became his focus. That work led to a search for how human-caused modifications in flora and fauna were accomplished and what were the resultant distributions. By the 1980s, his interest had come to center on evidence for the movement of organisms by voyagers across the oceans before Columbus.

He has made many research trips to India, China, Europe, the Middle East, Polynesia, and Latin America in pursuit of evidence in the literature and in the field of the distribution of plants (domesticates and weeds) and animals transferred long distances by humans. Most recently, he has expanded that topic to include the entire process of transoceanic diffusion in human history.

APPENDIX

Detailed Documentation

In this section, we give references and abstracts or paraphrases of relevant contents in sources that we have used in constructing the argument in the preceding text. A full bibliography appears after this Appendix and selected Illustrations.

It is obvious that the presentation above required weighing the value of the data on the various species as evidence for transoceanic voyaging. We tried to utilize a somewhat objective framework for our evaluation by reverting to the procedure familiar to us as professors who have to grade student papers. That is, we laid out a scheme of factors we thought significant in arriving at the worth of information on each species. We then agreed on a score reflecting how convincing each element of information is. Definitive archaeological work demonstrating the appearance of the species in the hemisphere where it did not originate was assigned a high score. Other scores were given if a pre-Columbian historical document mentioned the (imported) species; if a lexical source assured us that the species name was known anciently; if pre-Columbian art clearly represented the species in the hemisphere where it did not originate; etc. We then added together those factorial scores to yield an overall rating. Those species which earned grades of A, A minus, B plus, or B, we considered to have been supported by ‘decisive’ evidence; we have listed them in Table 1. Tables 2 and 3 list species deemed to rate less than ‘decisively evidenced.’ We followed a similar procedure in giving evidential values as shown in Tables 4 through 7.

For each species, we also give a short summary of the logic followed in the grading process. For those wishing to evaluate the evidence for themselves, we abstract the data at hand in each source. We are prepared to be shown how we may be in error of either fact or judgment. However, we do not think our conclusions will need revision as a result of such differing judgments.

FLORA

Acorus calamus

Origin: South Asia (?)
Summary: This plant had a long history of cultivation and use in Asia. Several Sanskrit names were used for it, and it was mentioned in Hindu texts dated no later than the 5th century AD. C. Sauer (1969, 56) reported the tuber used among (North) American Indians at the time of European discovery, and Pullaiah (2002) says, for whatever it means, that the plant is a native of both Asia and Western North America. However, unequivocal information on its American occurrence is too limited to arrive at any secure conclusion about significance, although the data are provocative as far as we understand them.
Transfer: Asia to the Americas (or vice versa?)
Time of transfer: pre-Columbian
Grade: C

Sources: *Acorus calamus*—sweet flag
Torkelson 1999, 1630. Sanskrit: *bhadra*. Chinese: *shui chang*
Nadkarni 1914, 16–17. Eng.: sweet flag, indigenous to India and Burma
Pullaiah 2002, I, 27. Sanskrit: *vacha, ugragandha, bhutanashini*; “Native of South Asia, and Cent. and west North America”
Banerji 1980, 84. Occurs in Sanskrit as *vaca*, in the 4th century AD
Aiyer 1956, 67. Sweet flag is mentioned in the *Charaka Samhita,* between 900 BC and the 4th century AD.
Sauer 1969, 56. One of several plants associated with man in the Americas, which also grew in Asia.

Adenostemma viscosum

Origin: Americas

Summary: The plant was found in Hawaii by Hillebrand, who considered it to have grown there before Europeans arrived, because it was growing throughout the low-elevation woods on all the islands of the archipelago within 75 years after Capt. Cook's arrival. A legitimate native name and established native medicinal usage confirm the age. Furthermore, Chopra *et al*. describe its distribution as "throughout India" with no hint that it could have been a modern introduction and still account for that distribution.

Case 1: Transfer: Americas to Hawaii

Time of transfer: pre-European discovery

Grade: A minus

Case 2: **Transfer:** Americas to India

Time of transfer: pre-European, sufficient centuries ago to explain distribution "throughout India."

Grade: C

Sources: *Adenostemma viscosum*

Hillebrand 1888, 192. A. viscosum, Forst. "A genus of few American species, of which the following is spread over many warm countries." Under the species entry he also notes: "Common in the lower woods of all [Hawaiian] islands. Nat. name: 'Kamanamana.' An infusion of the leaves is used as a remedy in fevers by the natives. The species is widely spread over the Americas, Polynesia, N. Australia, Asia, and Africa." Not marked to indicate a post-Capt. Cook import.

Chopra *et al*. 1956, 6–7. *A. lavenia* (syn. *A. viscosum*). "Throughout India."

Agave sp.

Origin: Americas

Summary: Since the plant is usually vegetatively reproduced, transoceanic movement must have been human-aided. Finding *agave* (species not identified) fiber in the ancient wreck of a Greek ship is conclusive evidence for America-to-Mediterranean transport of the genus. But we do not know which species this is, and it could have been any of seven or eight. This entry covers the indeterminate case meant to show that a minimum of one species was transferred.

Transfer: unidentified species from the Americas to the eastern Mediterranean

Time of transfer: before 300 BC

Grade: A

The widespread distribution of agave plants in India by 1800 is additional evidence for a pre-Columbian transfer. To simplify matters, we assume for the moment that the agave used in the Greek ship was probably one also growing in India, but we still do not know what species that is. (If the agave fibers from the Kyrenia ship can be located for further examination by botanists, we might be able to learn the exact species it represents.)

Sources: *Agave* sp.

Desmond 1992, 201. Re. *agave*, Lord Valentia in 1809 observed that "it is in such profusion [in India] that it is hardly possible to suppose it could have been introduced from America" [by Europeans in recent centuries].

Steffy (1985) reported in a premier archaeological journal the discovery of 'agave' fibers mixed with pine resin serving as watertight caulking on the 4th-century BC Greek ship that had sunk at Kyrenia, Cyprus. The hull was covered on the outside with large sheets of lead that were held in place by a compound of pine resin and agave fibers.

Steffy (2001) E-mail message. Date: Wed., 18 April 2001, 16:40:06–0500. From: "J. R. Steffy" rsteffy@pop.tamu.edu. Subject: *Agave*. To: John Sorenson john_sorenson@byu.edu. "You wouldn't believe how many people have protested that statement, but I was only repeating the identifications made by professionals in respectable laboratories. I am long retired and have given most of my records from the1970s [when the Kyrenia ship was excavated] to the university [Texas A&M]. I will have to contact

Michael Katzev to find out the names of the biologists who identified the agave, but I remember the first samples were identified by Kew Gardens in England. A second set was done later in the U. S. with the same results, but I can't remember which lab did it. At a conference a couple of years ago, I heard there were similar ancient analyses, but they couldn't tell me where they were published. I have also heard that one form of agave was native to the eastern Mediterranean. I am a ship construction specialist, not a biologist, so I can only repeat the information given to me in such cases. All I can confirm is that this stringy substance, when mixed with pine resin, makes a marvelous watertight underlayment; that was the only point I was trying to make."

J. Sauer 1993, 177. Two kinds of *agave*, henequen and sisal, have become important commercial fiber crops. They have been named as species, *A. fourcroydes* and *A. sisalana*, respectively, although they are really clones. Both were developed as cultivars in prehistoric Yucatan.

Addendum: Carter 2002, 254.

Beyond the evidence for simply <u>some</u> species having been transferred, the sources tell us about particular species. We list these separately.

Agave americana

(May be in addition to or the same as the "unidentified" species above.)
Origin: Americas
Transfer: Americas to India
Time of transfer: while Sanskrit was still lexically active (before AD 1000)
Grade: A minus

Sources: *Agave americana*

Balfour 1871–1873, I, 51–2. Common all over India, useful as a hedge plant and for fiber. 52. Sanskrit: *kala kantala*. I, 84. Two species of *agave*, the *A. americana* and *A. vivipera*, have become so naturalized in many countries and in India as to seem indigenous.

Reference to the *Flora of China:* this species is listed as "native" to China (presumably because of distribution MOBOT 2003. Distribution of *A. americana*, N., M., S. America and Carib. According to the MOBOT and traditions indicating a long history in country).

Torkelson 1999, 1634. *A. americana*, Sanskrit: *kantala*

Watson 1868, 250. *A. americana*, Sanskrit: *kantala*

Nadkarni 1914, 23. *A. americana*, Sanskrit: *kantala*; Eng.: "American aloe" (The vernacular English term used in India for *A. americana*, although in strict taxonomic terms, it is not an 'aloe.') Naturalized in many parts of India.

Pullaiah 2002, I, 34–5. *A. americanum*, Sanskrit: *kalakantala*. Century plant, aloe plant. It is propagated by suckers [which rules out any transfer across the ocean by natural means].

Agave angustifolia (syn. *vivipara*)

(May be in addition to or the same as the "unidentified" *Agave* sp. above.)
Origin: Americas
Transfer: Americas to India
Time of transfer: while Sanskrit was lexically active (before AD 1000
Grade: A minus

Sources: *Agave angustifolia*

Chopra *et al*. 1956, 9. *A. vivipera*. Naturalized in the sub-Himalayan tract, the outer Himalayas, and many other parts of India. Sanskrit: *kantala*.

Balfour 1871–1873, I, 51–2. Common all over India, useful as a hedge-plant and for fiber. 52. Sanskrit: *kala kantala*. I, 84. *A. vivipera* has become so naturalized in many countries and in India as to seem indigenous.

MOBOT 2003. Distribution of *A. vivipera*, Middle and South America.

Agave cantala

(May be in addition to or the same as the *Agave* sp. above.)

Origin: Americas
Transfer: Americas to India
Time of transfer: while Sanskrit was lexically active (before AD 1000)
Grade: A minus

Sources: *Agave cantala*

Chopra et al. 1969, 3. Sanskrit: *kantala*. Naturalized on the east and west coast, upper Gangetic plain, and parts of Punjab.

Chopra et al. 1956, 9. Sanskrit: *kantala*. "A native of America."

Zeven and de Wet 1982, 185. They treat as distinct species: *A. americana*, *A. atrovirons*, *A. cantala*, *A. fourcroydes*, *A. sisalana*, and others.

Balfour 1871–1873, I, 51–2. Common all over India, useful as a hedge-plant and for fiber. Sanskrit: *kala kantala.*

Ageratum conyzoides

Origin: Americas

Summary: This weed would probably have been introduced inadvertently. It was in Hawaii (and had a native name) before European explorers arrived there, according to both Brown and Hillebrand. In India, it was so widely grown that Balfour considered it indigenous, and Pandey says it is "naturalized throughout India."

Case l: Transfer: Americas to Hawaii
Time of transfer: pre-European contact with Hawaii
Grade: B

Case 2: **Transfer:** Americas to India
Time of transfer: pre-European contact
Grade: B

Sources: *Ageratum conyzoides*—goatweed

Brown 1935, 336. The (Hawaiian) native name is *meie parari*, or *mei rore*; used for leis, scent, and medicine. "Pantropic; of American origin, probably unintentionally introduced by early man in southeastern Polynesia."

Safford 1905, 176. *Ageratum conyzoides* ('goatweed'). "It is of American origin, but is now widely spread throughout the Pacific and has found its way to many tropical countries."

Balfour 1871–73, I, 52. Mentions *Ageratum coerulium* and *A. Mexicanum*, exotic flowering plants. "*A. conyzoides* is a native of India." [To be so considered would require naturalization over more centuries than since the Portuguese.]

Pandey 2000, 271. *Ageratum conyzoides*, from South America, is one species "naturalized throughout India."

Pullaiah 2002 I, 35. Sanskrit: *visamustih*. Used in the system of Ayurvedic medicine.

Chopra *et al*. 1956, 9. Throughout India up to 5,000 ft.

Hillebrand 1888, XCIII. The editor, W. F. Hillebrand (son of the author), notes that in the course of completing the book, his father changed his mind about some plants which he had assumed to have been introduced into Hawaii since Cook. Although he changed his mind—ending up of the opinion that they "may in reality have been of earlier [pre-Cookian] introduction"—he failed to go back and change the symbols [in the manuscript] indicating that fact. Here, young Hillebrand says, "Of 9 non-endemic species which existed before the discovery, 6, [including] one *Ageratum* (now diffused over most tropical countries) [plus five other species] are American …."

Ageratum houstonianum

Origin: Americas

Summary: Naturalized in parts of India and China. Assuming that *A. conyzoides* is an import, the accidental transport of this second *ageratum* at the same time would be plausible, although we cannot be sure at this time.

Grade: incomplete

Sources: *Ageratum houstonianum*—floss flower

Pandey 2000, 272. *A. houstonianum*, from Mexico, is another species “naturalized in some parts of India.” 284. Called the floss-flower.

MOBOT 2003. *A. houstonianum* is naturalized in China.

Alternanthera philoxeroides

Origin: South America

Summary: Four species of this genus, which is from South America, are naturalized in India and Southeast Asia generally. One of those is *A. philoxeroides*, which has two Sanskrit names. While botanists have assumed a recent introduction of the genus, there is no specific information to support that speculation. Rather, the mention by Rheede of the genus being in Malabar in the 17th century, along with the existence of the Sanskrit names, points to a much longer history of the genus in South Asia.

Transfer: South America to South Asia

Time of transfer: apparently while Sanskrit was still active, that is, before AD 1000

Grade: B

Sources: *Alternanthera philoxeroides*—alligator weed

Sivarajan and Mathew 1984, 49, 51. They deal with the species of *Alternanthera* Forsk. Five species of the genus have been reported. Another tropical American species, *A. tenella*, is reported here for the first time from India. These may be reduced to four good species because of duplication. Several explanations for the distribution are offered: (1) *A. sessilis* is commonly distributed in the tropics and subtropics of both the New and Old World and is common throughout India and thrives in a variety of habitats. (2) The Brazilian species, *A. philoxeroides*, commonly called ‘alligator weed,’ is of recent introduction to India, being first noted in 1964. (3) *A. sessilis* was suggested by Govindu as “brought to India by horses imported form the Middle East during the First World War. Since then, this [species] has spread to various other parts and is now fairly common throughout India.” [Yet, these authors note, disjunctively, that *A sessilis* “has been illustrated by Rheede in his ‘*Hortus Malabaricus*’ as early as in 1692.”] (4) *A. pungens*, “a tropical American weed now widely distributed in the tropics and sub-tropics of the world. In India it is naturalized.” (5) *A. philoxeroides* is “an American weed introduced into the Old World Tropics long ago and reported from Malesia, Indonesia, Burma and India.”

Pullaiah 2002, I, 47. *A. philoxeroides*. Sanskrit, *matsyahi, lonika*.

Amanita muscaria

Origin: Unclear

Summary: Whether the *Amanita muscaria* forest mushroom was transported by humans or discovered in place, uses and connotations for it are so much alike in Mexico, India, (and Siberia?) that it is plausible that at least the cultural complexes involving it are connected historically. Unless further study comes up with an alternative plausible scenario, we consider that only a physical transfer of this fungus can explain how transfer between the hemispheres took place anciently. That may have occurred by spores borne on the wind in boreal regions, but a tropical passage is more unlikely. However, human voyagers, whose existence we have established, could have moved the mushroom to Mexico along with accompanying beliefs and rites.

Transfer: Asia to Mesoamerica

Time of transfer: since the time when a detailed cultural complex involving mushroom ingestion developed (500 BC?)

Grade: C

Sources: *Amanita muscaria*—fly agaric, fly amanita (fungus)

Aguilar 2003, 80. The pharmacopeia of Maya shamans included the *Amanita muscaria* and various members of the *Psilocybe* genus. In India, the ‘Soma’ (the *Amanita muscaria* mushroom) was considered a sacred plant in the Rig Veda. Medieval Europeans were familiar with *Amanita muscaria* and considered it demoniac.

Wasson 1980. In his 1968 book on Soma (page 163) he noted the general similarity of northern Eurasian and Middle American mushroom usages and beliefs but could not bring himself to imagine any historical connection between the two. Now, in 1980, guided by Levi-Strauss, who supposed that a connection was likely, he considers the evidence to show the circumpolar extent (including Siberia and the Algonkian Indians) of at least fly agaric usage.

(Wasson 1980 cont’d.) The Quiché of Guatemala equate *Amanita muscaria* with the thunderbolt (“mushroom of the lightning-bolt”), although they do not eat it, preferring the *Psylocybe* species. The same belief in the connection of lightning to the *Amanita* was present in Eurasia (and among the Algonkian-speaking Ojibway). 185. *A. muscaria* was in use among Basques, in France, and among the Chinese. 189. The association of toad, mushroom, and female genitalia must be very ancient and probably crossed Bering Strait with early immigrants to the Americas. (That is, of course, purely speculative, in light of the restricted distribution of the plant and the cultural complex in the Americas.)

43. Parallels are cited between Santal (a language of India), which preserves a derivative of the Sanskrit, *putika*, the first surrogate for the sacred Soma of Vedic hymns, and Náhuatl (Mexico) as follows: 1) divinity glows in a mushroom giving it a soul; 2) the mushroom speaks, it is “the Word.”

(Wasson 1980 cont’d.) *Amanita muscaria* was the Soma plant of the Vedas. 57. Parallels between Mesoamerican and Siberian/Eurasian mushroom lore: 1) the mushroom evokes an imaginary world of Little People which are the spirits of the mushrooms; 2) it speaks through a shaman’s voice; 3) it is connected to lightning bolts. 228–99. *Amanita muscaria* is all around in the Chiapas highlands and highland Guatemala, but avoided by today’s dwellers. In Quiché, its name is *kakuljá*, “lightning bolt.” 185. “In Mesoamerica, *A. muscaria* must have been replaced by the superior *Psilocybe* series” of mushrooms.

Wasson and Wasson 1957, 317. Ancestors of the Zapotecs, Greeks, Semites, Polynesians and Chinese all had the notion of a connection of lightning to mushrooms. 318. There are “startlng parallels” between the use of fly amanita in Siberia and the divine mushrooms of Middle America: for example, the substance is said to “speak” to the eater.

González Calderón 1991, 44–5. (This source has text in English that sometimes is difficult to understand, and the author rarely cites references; we suppose, however, that a competent Sinicist could provide primary documentation, <u>if it exists</u>, for the following paraphrased assertions.) “When we checked the old Chinese texts, we found that the first historical narrations on the first sea travels of Chinese ships occurred during” the Han period. In the book *Shih-Chi* we can read that “there were miraculous drugs in the Peng-Lai Islands.” Speaking now of Quin-Shi-Wang-Di, the first unifier of China, after the “Chow [Chou] Dynasty:” He unified China into a single big nation. He heard of some remote, mysterious islands located in the East Sea, where there used to exist some wonderful herbs, which were able to produce the effect of eternal youth and immortality. The gods who watched over those islands, he was told, demanded a tribute of children. Constructing a fleet of ships, he placed aboard 3,000 girls and boys from good families, plus gifts, like seeds of the five types of grains. The fleet was under the leadership of Hsi-Fu. They set sail in the year 219 BC, according to the Shih-Chi book. The expedition failed. Hsi-Fu arrived in Ping-Yuang and Kuangtsu and stayed there, making himself king of the region, but never returned to China. In the year 104 BC, another trip into the ocean was begun, to search for the Islands of Fortune and the Sacred Mountains. The emperor was Wu, and the commander of the expedition was the magician Li-Sho-Shun. There is also another narration during the Han period that could involve a return trip. “The kings of the Barbarians from the East crossed the great ocean to offer tribute from their country to the emperor.”

See also Barthel 1985 for a possible transfer mechanism.

Amaranthus spp.

Sources: *Amaranthus* spp. information in general

K.T. Harper, personal communication, 2004. Amaranths and chenopods provide a “complete” diet of amino acids for humans without the addition of animal protein. People with a practical, traditional knowledge of the dietary value of amaranths might have considered those grains especially appealing to parties of migrants sailing to new and largely unknown environments.

Roys 1931, 232. Mayan *chac-tez* is *Amaranthus* sp. “See *x-tez*.” 242. Mayan *e-c* [pronounced *etzen*]. Quotes Motul, the oldest Mayan dictionary of Yucatan: “A species of *Amaranthus* of this land, resembling the Mercurialis of Spain.” [That statement deserves investigation in re origin and affiliation of '*mercuriali*" of Spain.] 285. *Amaranthus* sp., bledo (Motul dictionary). *Xx-tez*. *Tez* is a generic name for the species.

[A published source in some ways superior to Roys 1931 is Bradburn 1998, which came to our attention too late to incorporate below. It lists 50 species of flora from among those treated below, with over 75 Mayan terms for them as used in one Yucatan village.]

Bretschneider 1892, 411. Lists five species of *Amaranthus* having Chinese characters used in Japan (from Matsumura; the Chinese-character names may or may not be pre-European in usage): *A. caudatus* (an American grain), *A. mangostanus* [Asian native], *A. melancholicus* (var. tricolor) [Asian native], *A. spinosus* [see below], and *A. viridis* [Asian native].

Index Kewensis has the following synonymies: *A. caudatus,* syn. *paniculatus,* syn. *frumentaceus*(?). Also, *A. hypochondriacus,* syn. *leucocarpus*.

Balfour 1871–1873, I, 92–3. *A. caudatus,* English: 'Love Lies Bleeding.' Commonly cultivated for ornament. *A. cruentus*, in Persian, *batu zard*, a common food, used for bread, cakes, among peasants of the Himalayas. *A. frumentaceus* Buch. (syn. *A. caudatus* [American origin]). Panjab: *bathú*, which is ground into flour and is a principal article of diet for hill people. *A. spinosus,* Linn. Roxb., "thorny amaranth." A very troublesome weed all over southern India and Burma.

Brücher 1989, 54–5. Taxonomically, the genus is difficult. Aellen (1967) and J.Sauer (1967) tried to order its systematics. They recommended two sections: *Blitopsis* and *Amaranthotypus*. The former has "mainly" n=17 chromosomes, the latter n=16. Most are wild-growing cosmopolites. These potherbs originated in Asia and Africa. Citing Pal *et al*. 1982, the species *A. caudatus*, *A. cruentus,* and *A. hypochondriacus* are closer related among themselves than to any putative weedy progenitor (Kulakov *et al*. 1985). 56. *A. hypochondriacus,* syn. *leucocarpus,* hispanic names, *bledo, huautli*. *A. cruentus,* purple amaranth, of Central American origin (so also *leucocarpus*). [In America] *A. cruentus* is known earliest, 4,000 BP (citing MacNeish 1992). 57. *A. caudatus* is in northern Argentina, Bolivia, Peru. The early European herbals also depict this plant. In Argentina, it comes from 4–5,000-year-old sites.

Sauer 1950, 612. "The grain amaranths belong to several distinct but closely-related species, cultivated by a curiously diverse and scattered group of peoples since immemorially ancient times." 613. Four regions each have their own species cultivated: *A. leucocarpus* [syn. *hypochondriacus*] in Mexico, *A. cruentus* in Guatemala, *A. caudatus* in the Andes. On the whole, the ranges of the species in the New World are distinct [which means that when different species show up in Asia, quite certainly they came from different locations in the Americas]. "In Asia, there is a great, vaguely delimited grain amaranth region stretching all the way from Manchuria through interior China and the Himalaya to Afghanistan and Persia. *A. leucocarpus* and *A. caudatus* are both grown throughout this area. The poorly known grain crop of Africa is probably also *A. caudatus*." "In mode of cultivation and use, the Old and New World crops are strikingly similar. In both areas, the crop shows a special affinity for the highlands, so far as I know, its concentration at high elevations is not explainable by any natural barriers." "In both the Old and New World, the plants are usually grown on a small scale, mixed in the plantings of maize and other crops. The grain is ordinarily consumed by the growers and is prepared in similar ways almost everywhere. The seeds are first parched or popped; then they are either made into balls like popcorn, with a syrup binder, or they are ground to meal, which is stirred into a drink or baked into little cakes."

(J.Sauer cont'd.) Taxonomically, all of the grain amaranths cultivated in the Old World are indistinguishable from certain of those cultivated in the New World. Not only in terms of species, but also in terms of sub-specific entities, the available Old World specimens represent nothing but a small sample of the diversity present in the American grain amaranths. There are amaranths grown in Asia for potherbs or ornamentals, but never for seeds, which [the former] are obviously natives of Asia. This entire Asiatic potherb group is easily distinguishable from the grain group by important technical characters. The non-cultivated amaranths closely related to the grain species also show a striking concentration in the New World. No evidence was found of any non-cultivated entity closely related to the grain amaranths which are peculiar to the Old World. 614. "The conclusion appears inescapable that the grain amaranths are all of New World origin." "A well-developed grain amaranth produces such an enormous quantity of seed, though the seeds are individually minute, that the yield of the crop per unit area often exceeds that of maize." "Development of these stable entities so distinct from their wild relatives would be expected to require long selection. The antiquity of the crop is also indicated by other evidence." "The grain amaranths were one of the great food staples of Mexico at the time of the

Conquest, regarded by the people as among their most ancient crops, and fantastically important in legend and ritual."

(J.Sauer cont'd.) "The question as to whether the crop reached Asia before the European expansion cannot be answered with certainty. There is the 10th-century Chinese document [see below] that seems to refer to grain amaranths, but this is hardly absolute proof. If the crop was introduced into Asia after Columbus, it must be credited with a remarkable achievement in making itself very much at home among strangers within a few generations." "Strangely enough, plants resembling *A. leucocarpus* do not appear in the European herbals until about 1700, more than a century after *A. caudatus* had been brought to Europe as an ornamental."

(J.Sauer cont'd.) 588. "The crop is scattered so widely through Asia and is so firmly entrenched among remote peoples that it gives a powerful impression of great antiquity in the area. Many investigators, from De Candolle … to Merrill (1950, 16–17), have concluded that the crop has certainly been cultivated in southern Asia from time immemorial and probably originated there." "The best hope of finding early records would seem to be in India." 589. "It is startling to find that Bretschneider (1896, 405) presents what seems to be a clear reference to a grain amaranth in an ancient Chinese *Materia Medica*. This work, written about AD 950 for the Prince of Shu, modern Szechwan, lists six kinds of *hien*, a generic name for a group of related plants, mostly indigenous amaranths cultivated as potherbs. Among these were two whose seeds were used in medicine, one was called *jen* (meaning, man) *hien*, possibly because it grew tall and erect." "… A modern record of grain amaranths from the same area … gives the same name." *A.* was collected in the early 19th century in hills [in] south India where it was cultivated for seed which was ground for flour. 590. There are non-specific reports of cultivation of amaranths in Ceylon. Also, it was grown widely in northern India. They have been recorded repeatedly along the whole length of the Himalaya from Kashmir to Bhutan. 593. Also in Afghanistan and Persia, as well as in mountainous western China and Manchuria.

Anderson 1960, 70–1. Praises J. Sauer's thesis. He has "demonstrated beyond all reasonable doubt" that Asiatic and American amaranths "are identical." Even Merrill went out of his way to give it a clean bill of health.

Roys 1931, 285. Mayan "*X-tez*. *Amaranthus* sp. *bledo*. (Motul dictionary.)"

Bretschneider 1882, 32. Shen Nung, an emperor [purportedly, not actually] of the 28th century BC, authored a famous classic of *Materia Medica*. Mentions this plant in the document attributed to him. 49–53. From a treatise, *Kiu Huang Pen Ts'ao*, by Chou Ting Wang, an imperial prince under the first Ming Emperor (the prince died in 1425). He had seen this plant in Honan province.

Pal and Khoshoo 1974, 130. Description of uses in places where the seed is in the staple diet of the people. The most common use is in the form of sweetmeats. The popped grains are mixed with brown cane sugar and converted into balls or cakes. 132. Theories of origin: Citing Purseglove 1968 as evidence, they assert there is no valid evidence of the movement of crops by man between the Old and the New World in pre-Columbian times. Most of the grain amaranths reached Asia in the 18th century and early in the 19th century. The grain amaranths, although an accepted food of the Hindus and Buddhists on religious days, they say, do not have a Sanskrit name [this is contradicted now by Chopra, see above, and implicitly by archaeological sources, such as Saraswat *et al*.], but such names exist for vegetable amaranths indigenous to Southeast Asia and India. They set out to test the cross compatibility of species experimentally. Evidently the differentiation between the three groups of species is very great [contradicts J.Sauer on this point]. Contrary to general belief, a variety of isolating mechanisms prevents hybridization. All these facts indicate that the theories of introgression in the history of the grain amaranths put forward by J.Sauer are not substantiated. Three groups are differentiated by chromosome numbers (one type covers *A. caudatus* and *A. edulis* with weedy *A. quitensis.* Central and North American species divide on chromosome number with one type consisting of *A. hypochondriacus* and the wild *A. hybridus*, while cultivated *A. cruentus* and wild *A. powellii* form the third type.)

Amaranthus caudatus

Origin: Andean region

Summary: The Asian forms of the plant are clearly within the norms for *A. caudatus* in the Americas. The grain has been recovered at an archaeological site in India dated to before 800 BC.

Moreover, it bore a Sanskrit name. The food uses to which the grain is put are the same in the Himalayan area as in Middle America.

Transfer: South America to India

Time of transfer: while Sanskrit was still an active language (by AD 1000)

Grade: A

Sources: *Amaranthus caudatus*—amaranth, *bledo*, love-lies-bleeding

Chopra *et al*. 1956, 17. Sanskrit: *rajagiri*. Cultivated throughout India, chiefly in mountainous tracts, up to 9,000 ft. in the Himalayas.

Torkelson 1999, 1641. Sanskrit: *rajagiri*

Int. Lib. Assoc. 1996, 559. Sanskrit: *rajagiri*

Saraswat, Sharma, and Saini 1994, 282, 284, 331. *A. caudatus* excavated in India at the Narhan site (1000–800 BC).

Towle 1961, 37. Cook says that the seeds will pop like kernels of maize and taste is similar. No archaeological specimens have been recovered, but it is thought this plant was economically significant.

Watt 1888–1893, I, 211. Local people near Simla told him this plant was an introduced form of *bathú* (grain) which they consider indigenous to India.

Bretschneider 1892, 411. Lists five species of *Amaranthus* labeled with Chinese characters in Japan (after Matsumura, not necessarily classic Chinese): *A. caudatus*, *A. mangostanus*, *A. melancholicus*, (var. *tricolor*), *A. spinosus*, and *A. viridis*.

Sauer 1967, 127. It probably originated by domestication of *A. quitensis* as an ancient Andean grain crop. In South America, it is superficially similar to *Chenopodium lupinus.*

See also the material under *Amaranthus* spp. in general.

Amaranthus cruentus

Origin: Guatemala or thereabouts

Summary: It is so widespread throughout Asia that it must have been introduced there at a fairly remote historical period. The plant fits readily into the range of the American species. Uses are the same in both hemispheres.

Time of transfer: possibly three or more millennia BP

Re. plausibility of alternative explanations for its distribution: J. Sauer said, "If the crop was introduced into Asia after Columbus, it must be credited with a remarkable achievement in making itself very much at home among strangers within a few generations."

Grade: A

Sources: *Amaranthus cruentus* (syn. *paniculatus*)—amaranth, *huauhtli*, *alegría*

Pickersgill and Heiser 1978, 808. *A. cruentus* dates to 5500–4300 BP in Tehuacán Valley. [Compare divergent date by Sauer, below.]

Johannessen and Wang 1998, 29. In 1986, he and Anne Parker observed Buddhist priests in eastern Bhutan perform an annual eucharist-like service involving popped amaranth seed mixed with honey, an offering that the local population insisted had to be continued to ensure their well-being. The Aztecs had a similar rite.

Sauer 1967, 123. Evidently originated as a domesticated grain crop in southern Mexico or Guatemala. Progenitor is *A. hybridus*. 125. In the Old World tropics, the chronology and geography of the species' immigration are quite mysterious. Attributed to China and India in 18th-century literature. By 1850, it was common in south India. 126. Asiatic cultivation of *A. cruentus* is mostly outside the grain amaranth regions and extends through the tropical and warm temperate parts of India, Indo-China, China, Japan, Philippines, Indonesia, New Guinea, and Fiji. "In African botanical literature, *A. cruentus* usually masquerades as *A. caudatus*."

See also materials on *Amaranthus* spp. in general.

Amaranthus hypochondriacus

Origin: highland Mexico

Summary: This third grain amaranth shares with *A. caudatus* and *A. cruentus* an extended distribution in Asia. Again, food uses are similar. Sauer: “All specimens examined from Nepal appear to be identical to common Latin American forms.”

Time of transfer: probably three or more millennia BP

Grade: A

Sources: *Amaranthus hypochondriacus* (now the preferred taxon; syn. *leucocarpus*)—amaranth, *huauhtli*

Sauer 1950, 561–632. There were four species in the Americas cultivated for grain. *A. leucocarpus* in Mexico and the U.S. Southwest, *A. cruentus* in Guatemala, *A. caudatus* in the Andean region, and *A. edulis* in Argentina. The first and third are widely cultivated in Asia over a large area extending from Manchuria through interior China and the Himalayas to India, Afghanistan, and Iran. Carter cites him as showing that the Chinese character that today represents the word for grain amaranth was known as early as the 10th century in China. The Asian plants are not only nearly identical but also part of a complex of traits involving methods of cultivation, preparation, and use. (The most common method of utilization was popping the seeds and adding syrup as a binder to form cakes, in China, Mexico, Nepal, and Argentina.)

Sauer 1969, 80–1. Grown in the Tehuacán Valley, Mexico, Upper Palo Blanco phase, 200 BC–AD 700. Also in Arizona in the 14th century.

Sauer 1967, 127–8. “Post-Columbian introduction is hard to imagine.” “*A. caudatus* was taken to Europe in the 16th century and historically dispersed, yet “other races from the Andean complex are also in the Old World and are harder to explain; one was first found by European botanists in Kashmir and Ethiopia, where it is planted for grain.”

Sasuke and Sauer 1956, 141. There are two closely related species in Asia: *Amaranthus caudatus*, a native of the Andes, and *A. leucocarpus*, a native of the Mexican highlands. No information available indicates that these two species are distinguished by Nepalese, although they are planted separately. “All specimens examined from Nepal appear to be identical to common Latin American forms.” Local names reported are: *marcha* in northwest Nepal, *nana* in central Nepal in general, *pilim* among Sherpa of central Nepal, *latav* in Katmandu. No name is recorded among Tibetans in Nepal. Sometimes inter-planted with maize, maturing after harvest of the corn ears. Occasionally, some of the young plant leaves are boiled as potherbs, a common practice with various amaranth species in the plains of India and many other parts of the world. Amaranth grain is used exclusively for human food, not fed to livestock. In western and central Nepal the grain is ground into flour, then boiled into gruel. At Katmandu and Madwanpur on the pilgrim way to Katmandu, amaranth grain is popped and made into little cakes or balls held together with sugar syrup. These cakes are associated with a special winter festival during which they are offered to a particular god and eaten by the people.

(Sasuke and Sauer cont’d.) “In many respects—the species involved, the methods of planting, preparing for food, and ceremonial use—the grain amaranth pattern of Nepal is similar to that found over a tremendous area of the highlands of Asia and Latin America. The reason for the parallels between America and Asia is not understood, nor is it known how or when amaranths were introduced to Asia. The first botanists who recorded the crop in Asia believed it was an ancient native domesticate and this belief has persisted until quite recently. Since it has become clear that the wild relatives of the grain amaranth species are strictly American and that the crop is certainly ancient in America, the antiquity of the crop in Asia has naturally been called into question. It has been suggested recently that the plants were introduced from Brazil to India by early Portuguese traders (Merrill 1954, 301; no amaranth was cultivated in Brazil). This explanation is not completely satisfying because there is no evidence that amaranths were ever cultivated for grain in Brazil or any other Portuguese areas of the New World, nor is their distribution in Asia correlated with areas of Portuguese activity … ; grain amaranths are not the sort of crop that the early European voyagers would be expected to promote. The Spanish invaders of the grain amaranth regions of the New World generally regarded the crop with contempt or hostility because of its intimate association with what they regarded as the devilish ceremonials of the Indians. No European colonists are known to have adopted the crop. Could Europeans have introduced these as ornamentals? Reasons are given why this is unlikely. The possibility remains that at least one species, *A. leucocarpus*, was introduced to Asia as a crop in pre-Columbian times.”

Sauer 1967, 110–3. There are three domesticated species: *A. hypochondriacus* L.; evidently from *A. powellii* by selection as a grain crop in North America; syn. *A. frumentaceus*, syn. *A. hybridus*, syn. *A. leucocarpus*. Its "distribution as a grain crop in Asia, although perhaps old, is clearly secondary and its wide dispersal as an ornamental is recent." 113. In Mexico, at the Conquest, *A. hypochondriacus* was probably the main if not the only species cultivated for grain. 115. For at least a hundred years, the species has been a far more widespread and important crop in Asia than in its homeland. Early botanists generally took it for an indigenous domesticate because it was so well established in subsistence agriculture, more often than not in remote regions. (Other American Indian crops followed the same pattern: *A. caudatus*, and perhaps *Chenopodium quinoa* Willd., a tall chenopod of uncertain identity which strongly resembles the latter, has long been grown as a grain crop in the hills of northwest India, where it shares the name *bathú* with grain amaranths {citing Thompson 1852 and Singh 1961}). 120, 122. Some seen in Manchuria in 1945–1946.

See also the materials on *Amaranthus* spp. in general.

Amaranthus spinosus

Origin: tropical New World

Summary: A troublesome weed that grew also in pre-Columbian India. Multiple Sanskrit names attest its presence in India at least one and, more probably, two or more millennia ago; that agrees with its wide distribution "throughout southern India" and beyond. Since it is elsewhere apparent that the grain amaranths were transported by humans from the Americas to Asia, it is reasonable to suppose that *A. spinosus* seeds accidentally accompanied them.

Transfer: Americas to Asia (or the reverse if origin proves Asia)

Time of transfer: probably at least two millennia ago

Grade: A

Sources: *Amaranthus spinosus*—spiked amaranth (a weed)

Sauer 1967, 107. One of the commonest weedy amaranths of the New World tropical lowlands, where it presumably originated. By AD 1700, *A. spinosus* was spreading rapidly through the warmer parts of the world, both as a weed and as a sporadically planted potherb.

Miranda 1952–1953, I, 215. Grows in Chiapas.

Torkelson 1999, 1641. Sanskrit: *tanduliya*

Chopra *et al*. 1956, 15. Sanskrit: *tanduliya*, "a field weed"

Int. Lib. Assoc. 1996, 559. Sanskrit: *alpamarisha, tandula*

Pullaiah 2002, I, 48. Sanskrit: *tandaluya, kataib, chaulai*. Medicinal uses in India. "Prickly amaranth"

Bretschneider 1892, 411. Lists five species of *Amaranthus* labeled by Chinese characters used in Japan (from Matsumura; the Chinese-character names may or may not be pre-European in usage): Three Asian species plus *A. caudatus* (American) and *A. spinosus* (both hemispheres).

Balfour 1871–1873, I, 92–3. *A. spinosus* Linn. Roxb., "thorny amaranth." A very troublesome weed all over southern India and Burma.

See also material under *Amaranthus* spp. in general.

Anacardium occidentale

Origin: Brazil or Venezuela

Summary: A representation of the cashew fruit and nut were carved at Bharhut Stupa, India, adjacent to images of the annona, also an American fruit. The structure, and thus the plant, is dated to the 2nd century BC. At least two Sanskrit names for the cashew tend to confirm that date.

Time of transfer: before the 2nd century BC

Grade: A

Sources: *Anacardium occidentale*—cashew

Nadkarni 1914, 32. *A. occidentale*. Sanskrit: *shoephahara*. Eng.: cachew nut (*sic*). Established in the coast forests of India and all over South India.

Watson 1868, 251. *A. occidentale*. In the Hortus Malabaricus as *kapa-mava*, all vowels long.

Balfour 1871–1873, III, 409. Cashew-nut tree, called "Cashoo Apple" in English. Sanskrit: *beejara sula*. I, 107. Sanskrit: *bijara sala*.

Pullaiah 2002, I, 52. Sanskrit: *kajutaka*

Bretschneider 1882, 94. Condemns Balfour for accepting botanical names of plants in the ancient Sanskrit vocabulary; *Amara Cosha* [*ca*. AD 600], and other writings in the classical language of the Hindus, which was a dead language, not spoken even at the time of Buddha. "The author [Balfour] does not hesitate to admit the existence of Sanskrit names for such plants as … *Anacardium occidentale* … which, as is well known, have been introduced into Asia from the Americas, since the discovery of the New World."

Brücher 1989, 215–6. Portuguese navigators in the 16th century took seeds to India and Mozambique. The cashew is native to the semi-arid coasts of Venezuela and Brazil, where one still finds many biotypes wild.

Pandey 2000, 272. *A. occidentale*, a native of Brazil, is one species "naturalized in some parts of India."

Dressler 1953, 122. Appears that it may be native from Brazil to the Antilles, especially as a strand plant. Also occurs naturally in southern Yucatan and may possibly have been cultivated there.

Gupta 1996, 17. A native of Brazil, it was introduced into India in the 16th century AD by the Portuguese. The only depiction of the plant complete with flowers and fruits is at the Jambukeshvara temple, Tiruchirapalli in Tamil Nadu (see plate). The depiction of the fruit, the cashew nut, is slightly stylized. Whereas the sanctum sanctorum and the inner portions of the temple, according to tradition, legend, and the temple priests, was built 2,500 years ago, the outer pillared hall is much more recent. And the Archaeological Survey of India dates it to the 17th century AD, by which time the cashew nut plant had been introduced to India and was already a hundred years old. But the earliest sculpture of the cashew nut is from the Bharhut Stupa balustrade relief, dated *ca*. the 2nd century BC. The relief is a broken fragment depicting two fruits of the custard apple on the left and two cashew nuts on the right side of the panel. Yet, "… it is not offered in worship at temples. Since the plant has no religious associations, the pillar decoration showing the cashew nut plant motif is purely decorative."

Newcomb 1963, 41. The cashew is a New World species but today is most abundant in the Old World. Its major production is concentrated in South India.

Watt 1871–1873, I, 232. Originally introduced from South America. Indigenous to the West Indies. Now one of six species of the genus is naturalized in coastal forests in India. It bore a name in Sanskrit, *bijara sala* (Balfour 1871–1873, I, 107; III, 409).

J.Sauer 1993, 15. A native of Brazil, apparently. Natives made use of both nuts and wine made from the cashew apple. "The Portuguese introduced it to India in the 1560s, perhaps more as a source of wine and brandy than for the nuts."

Ananas comosus

Origin: Brazil, although long cultivated in Middle America

Summary: Found on Easter Island, the Marquesas, Tahiti, and Hawaii, providing good evidence for its pre-European presence. Gupta reports images sculpted on Indian temples, one dating to the 5th century AD. Pineapples are also shown in the art of Assyria, Egypt, Anatolia, and perhaps Israel.

Time of transfer: by the 8th century BC (Assyria) and by the 5th century AD (India, presumed to have been by way of the Middle East)

Grade: A

Sources: *A. comosus* (syn. *sativus*)—pineapple

England 1992, 160. A word for this plant existed in proto-Mayan, pre-1000 BC.

Langdon 1988, 329. Found by W. Knoche, one of first Chilean scientists to visit Easter Island in 1911. "Small, semi-wild," and "scrubby." Found by first missionary in the Marquesas (*ca*. 1800) with the same name as in Tahiti. Hawaiians claimed pineapple present there since pre-European times (citing Handy and Handy 1972).

Heyerdahl 1996, 149–57. In the Marquesas (Hivaoa), Von den Steinen, Linton, and Heyerdahl discovered and then rediscovered large, non-Polynesian stone carvings showing long-tailed quadrupeds that could represent only felids and whose nearest analogs were on the monuments of San Agustín, Colombia. He connects these (radiocarbon-dated by charcoal beneath the statues at *ca*. AD 1300) with several plant species of American origin that have been identified in remote locations in the Marquesas. They can only be accounted for by the arrival of voyagers. 218. The *faa-hoka* pineapple of the Marquesas was a South American plant. It could not have spread across an ocean without human aid. Brown (1935) reported that in addition to the large pineapple brought by missionaries from Hawaii in the 1800s, there were six local varieties that grew semi-wild, which Brown considered pre-European introductions from South America.

McBryde 1945, 141. Probably a native of Brazil but long cultivated in Mesoamerica. Aztec word is *matzalli*. He considers a possible Central American or Mexican origin for those in Mesoamerica.

Simmonds 1976, 16. Pineapple is old in the New World on distributional grounds but the only archaeological record for it consists of seeds and bracts found in coprolites from caves in Tehuacán Valley of Mexico dated to the period from about 100 BC to AD 700.

Heyerdahl 1964, 126. A semi-wild pineapple was found in deserted areas of Easter Island when the flora was first recorded by Europeans. Bertoni in 1919 suggested that the American pineapple seems to have spread into the Pacific in pre-Columbian times (Bertoni 1919). Macmillan Brown argued a very strong case for pre-European growth of *Ananas* in the Marquesas (Brown, 1931, 137). Degener stated that the Hawaiians had grown a poor variety of the plant in a semi-wild state long before the first recorded introduction by Europeans (Degener 1930, 88).

Collins, 1948, 376–7. He is puzzled over the following three references (note that this information is omitted in the largely identical article that he published in the *Southwestern Journal of Anthropology* in 1951). Layard (1849) and Rawlinson both describe stone carvings at Nineveh that show food served at a banquet, one of which both writers list as representing a pineapple. Rawlinson stated: "The representation is so exact that I can scarcely doubt the pineapple being intended." Layard also doubted that the Assyrians knew the fruit, but "the leaves sprouting from the top proved that it was not the cone of a pine tree or fir." A third reference is Wilkinson (1879, II, 213): "Among the numerous productions of India met with in Egypt which tend to prove an intercourse with that country may be mentioned the pineapple, models of which are found in the tombs, of glazed pottery. One was in the possession of Sir Richard Westmacott."

Krauss n.d. 188. "Extraordinarily, fossils of pineapple have been found in Switzerland, it has been reported."

Johannessen reports his personal experience seeing a representation of pineapple on a piece of jewelry in the museum at Ankara, and K. Harper (a professor of botany) has seen another pineapple on an object in the museum in Cairo.

Pickersgill 1976. Cites Merrill against Heyerdahl's claim for pineapple in the Marquesas. She resists claims of Assyrian, Egyptian, and Pompeiian representations of the pineapple, asserting magisterially that "the reproductions that have been published are not convincing." [Contrast Rawlinson above in Collins.]

Brown 1931, 137. *Ananas sativus* Schultes. Pineapple. Marquesan names are compounded from *ha'a hoka* or *fa'a hoka*. The fruit is small but extremely fragrant and superior in flavor. Six named and cultivated varieties are listed "all of which were an integral part of the ancient material culture, [and] were evidently originated by the Marquesans from the single Brazilian species. This fact seems fairly positive evidence that the early Polynesians, through contact with the Americas, obtained their original stock long before the discovery of the Marquesas by Europeans." 138. Anciently, the fruits were used more extensively for leis and for scenting coconut oil than for food. Planted usually in dry areas, in all inhabited valleys, where nothing else useful grew; plants flourished without human care.

Gupta 1996, 18. Clearly depicted on the vanamala of Vishnu in his *Varaha avatara* in the Udayagiri cave temples, Madhya Pradesh, dated *ca*. 5th century AD (plate 10). This depiction shows that the plant must have been growing in India at that early date. For "there is no evidence of artisans having come from Brazil at any point in Indian history and the local artisans could not have sculpted it without being familiar with it." The only other temple where there is a depiction of the pineapple fruit is at Moti-Shah-Ka-Tuk, Shatrunjaya hill complex, Palitana, Gujarat. The small shrine where it is sculpted is white washed and difficult to date. The Shatrunjaya hill Jain temple complex consists of nearly 863 Jain temples and is believed to be more than 1,000 years old.

Pullaiah 2002, I, 53. Sanskrit: *anamnasam*, *bahunetraphalam*. Medicinal uses in India.

Bertoni 1919, 280*ff*. He believed Polynesians carried pineapples from the Americas.

Watt 1888–1893, I, 236. The genus has five or six species, inhabitants of tropical America. “From the vernacular names one would suppose it came to India via Persia.” It was not found in Europe, Asia, or Africa before Columbus (*sic*). Its introduction is “expressly mentioned by Indian authors.” “The rapidity with which it spread through Europe, Asia, and Africa is unparalleled in the history of any other fruit.” [Unless, of course, it had spread in pre-Columbian times, as is now certain.]

Zena Halpern of Syosset, NY, (personal communication 2003) has furnished us with a photograph of a carved stone in a museum in Haifa, Israel, that displays a pineapple on it, although a part of the fruit representation is broken off, rendering the identification less than final. The carving is probably from the Iron Age.

Addenda: Too late to enter in detail: Casella 2002a; Casella 2002b; Casella 2002c; Ciferri 2002; Jett 2002c; Merrill 2002.

Annona spp. in general

Sources: *Annona* spp. in general

Roys, 1931, 271. Mayan language: “Op. *Annona reticulata*. L. Custard-apple, *Anona colorada*.”

Schoenhals 1988. *A. cherimola*, custard apple, cherimola. *A. glabra*, pond apple, alligator apple. *A. muricata*, guanábana, soursop. *A. purpurea*, custard apple. *A. reticulata*, custard apple.

Steentoft 1988, 72. *Annonaceae*—soursop family. “A pantropical but especially Old World family of woody plants.” 74. [Yet] *Annona* (West Indian name) is largely an American genus, with only three species in West Africa (*i.e.*, *A. senegalensis*, *A. glabra*, and *A. glauca*, which replaces *A. glabra* in Ghana).

Balfour 1871–1873, I, 125. *Annonaceae*. A tropical order of plants, chiefly inhabiting the Americas and the East Indies. The order includes about 15 genera and 250 species, more than half of which occur in India.

Brücher 1989, 218. In the Americas more than 70 Annona species exist, of which at least a dozen have been domesticated for their aromatic fruits.

Addenda: Too late to enter in detail: Casella 2002a; Casella 2002b; Ciferri 2002; Casella 2002c; Jett 2002c.

Annona cherimolia

Origin: Americas

Summary: Especially characteristic of the highlands of Colombia, Ecuador [and] Peru, [but also occurs in] Mesoamerica.

The fruit of *A. cherimolia* is shown held by a sculpted goddess figure on a wall of a Hoysala Dynasty temple, Karnataka State, India, dated to the 13th century.

Transfer: Americas to India

Time of transfer: by 13th century AD

Grade: B

Sources: *Annona cherimolia*—large annona, custard apple

Shady 1997, 18. *A. cherimolia* remains have been found at the Los Gavilanes site in the Huarmey valley, Peru, dating to the Late Archaic (3000–1500 BC).

Towle 1961, 38–9. A small tree bearing edible, heart-shaped fruits. Remains have also come from graves at Ancón (dated in BC times). Also one prehistoric funeral vase depicts a fruit.

Johannessen and Wang 1998, 16–7. Held in the hands of sculpted figures on temples in India, as in the hand of a goddess statue on an AD 1268 Hoysala Dynasty temple at Somnathpur, Karnataka State (illustrated). [Johannessen comments: the image of the fruit shown at Somnathpur is a general, but not a perfect, match with *A. cherimolia*.]

Roys 1931, 279. Mayan. “Pox. *Annona cherimola*, Mill. Cherimoya.” Often called the custard apple in English.

Balfour 1871–1873, I, 125. *A. cherimolia*. A tree of Peru, introduced into India in 1820.

Bailey 1935, I, 294. From the Andes of Peru and adjacent regions but naturalized at a very early date in Mexico and Central America.

Dressler 1953, 123. Wild cherimoyas in Ecuador. There is archaeological evidence for the early occurrence of *A. cherimolia* in Peru, yet Cobo wrote of introducing it from Guatemala about 1630 and implies that it was previously unknown [another ‘historical’ fable).

Brücher 1989, 219. He considers *A. cherimolia* “the most attractive fruit of America.” Characteristic of the tropical mountains (800–2000 m.) of Colombia, Ecuador, and Peru.

Annona glabra

Origin: West Indies, South America

Summary: Reports differ as to value as an edible fruit, yet it was used in some areas and apparently occasionally cultivated. It grew wild on shorelands of the West Indies and South America. It had a name in the Yucatec Mayan language. Also found in West Africa and in Kerala, the southwest coast of India, and (recently) islands in the Indian Ocean.

Since other species of *Annona* reached South and Southeast Asia as early as the 3rd millennium BC, it is not unreasonable to suppose that *A. glabra* shared in the same transfer process as those earlier manifested, even if it was an inferior fruit. Oceanic drift over such a vast distance (and from the Atlantic side of the Americas) to South Asia is out of the question (the tree is also entirely missing in the Pacific Ocean area).

Transfer: Americas to South Asia.
Time of transfer: pre-Columbian (?)
Grade: incomplete

Sources: *Annona glabra*—pond apple

Bailey 1935, I, 293. Pond-Apple. Alligator-Apple. Monkey-Apple. Mangrove-annona. Mamin, etc. Fruit considered not edible except by animals. Found in Florida, and also along tropical shores of the Americas, West Indies, the west coast of Africa, and the Galapagos Islands.

Dressler 1953, 123. Reports as to quality and cultivation of this species do not agree. Appears to have a very wide natural distribution as a strand plant.

Roys 1931, 263. Mayan. “H-maak. *Annona glabra*, L.”

Brücher 1989, 218. *A. glabra* L. grows wild (he has seen it in Panama) but fruit is often collected. It cannot be excluded that this is an ancestral form of some of the domesticates.

Sreekumar *et al*. 1996. *A. glabra,* previously known in India only from the west coast of Kerala, is recorded (wild) for the first time from the Andaman and Nicobar Islands. It has potential value as an edible fruit.

Annona reticulata

Origin: tropical America

Summary: It was known by at least five Sanskrit names, besides being shown on sculpture at the Bharhut Stupa of the second century BC. Its name on the Malabar coast incorporates Rama’s name and thus seems to have a connection to the ancient legends. Moreover, common names of the fruit can be construed as related between Mexico and Asia.

Transfer: Americas to India
Time of transfer: by the 2nd century BC
Grade: A

Sources: *Annona reticulata*—custard apple

Roys, 1931. 271. Mayan. “Op. *Annona reticulata* L. Custard-apple, *Anona colorada*.”

Balfour 1871–1873, I, 125. English name: Bullock Heart**.** Sanskrit: *Rama sita.*

Pullaiah 2002, I, 60. Sanskrit: *ramphal*. Medicinal uses in India.

Watson (1868) reports an additional Sanskrit name, *luvunee,* (citing Roxburgh 1814 and other early botanical researchers in India).

Torkelson 1999, 1646. Sanskrit: *ramphala.*

Chopra *et a*l. 1956, 19–20. Sanskrit: *ramphala*. Cultivated in India, naturalized in Bengal and South India.

Int. Lib. Assoc. 1996, 559. Sanskrit:, *krishnabeejam, ramphal*.

Watt 1888–1893, I, 256. Naturalized in India, supposed imported from the Americas. But considered by some authors a native of Asia.

Bishagratna 1907, 72. Reads *A. reticulata* in a text assigned to the 6th century BC.

Bailey 1935, I, 294. Common Custard Apple, Bullock’s-Heart. At home in tropical America, now widely spread throughout the tropics of both hemispheres. A robust tree which has spread spontaneously in the forests of the Philippines, the island of Guam, and the East Indies, while its congeners, *A. muricata* and *A. squamosa*, occur usually only where planted. It is essentially tropical while the *cherimoya*, with the smooth-fruited forms with which it has often been confused, is subtropical. Fruit of *reticulata* is inferior in flavor to both *cherimoya* and *squamosa*. 295. Produces fruit only once per year while *squamosa* has multiple fruitings

Nicolson *et al*. 1988, 50. In Hortus Malabaricus (1682) this appears as *anona-maram*. “Today the tree is called Ramachakkamaram (tree, *maram*, with the fruit, *chakka*, of Lord Rama).” It bears the same name as *A. squamosa*. Cultivated throughout Kerala.

Pokharia and Saraswat 1999, 97. “The fruit is called *ata* in Malabar, *ahata* or *ate* in Mexico, and *ate* or *atte* in the Philippines. But *Annona reticulata* (bullock’s heart) was called *parangi* (‘foreigner’) or Portuguese Jack fruit. These facts seem to suggest that the name *ata* came to India from Hispaniola via the Cape” [*sic*—of Good Hope?] (endnote 129). They take these data to indicate a Portuguese introduction. Yet Sitholey’s drawings of sculpted plants at Bharhut show that the “dazzling presence of custard-apple has been confirmed, as claimed by Cunningham in 1879.” (Custard-apple argument is continued on p. 99.)

Miranda 1952–1953, I, 193. Cultivated in Chiapas for fruit. Very resistant to unfavorable conditions.

Panagiotakopulu 2000, 35. Different substances used as insecticides in storerooms against insects and other pests (in Eurasia). Include *Annona reticulata*.

Annona squamosa

Origin: tropical America

Summary: At least four Sanskrit names were used for the tree, and its fruit is associated with the sacred figure, the wife of Lord Rama, in the Ramayana record. It is mentioned in another literary source dated near the beginning of our era. The fruit is sculpted at Bhárhut Stupa, 2nd century BC, and at Ajanta Cave, and in other sacred art since then. Seeds have been excavated from a cave site in the island of Timor dated to the middle of the 3rd millennium BC (together with two other plants of American origin) and excavated also in India from 700 BC.

Transfer: Americas to South Asia

Time of the transfer: by the middle of the 3rd millennium BC

Grade: A

Sources: *Annona squamosa*—sweetsop, sugar-apple, annona

Nadkarni 1914, 38. *Annona squamosa*. Sanskrit: *shubhâ, suda*. Eng.: custard apple. Hindi: *sharifah*. Bengali, Gujerati, others: *sitâphal*. Cultivated in gardens all over India for its fruit.

Torkelson 1999, 1646–7. Sanskrit: *sitaphalam.*

Chopra *et al*. 1956, 19–20. Sanskrit: *gandagatra, sitaphala.*

Pullaiah 2002, I, 60. Sanskrit: *sitaphalam, gandhagathra, shubha*.

Bretschneider 1892, 412. Japanese source gives (Chinese) characters for the name *of Annona squamosa* (may not be from classic Chinese sources, however).

Brücher 1989, 220. A native of Central America and the Antilles. The species is now dispersed in all tropical countries, especially in India, which is erroneously considered as their homeland.

Nicolson *et al*. 1988, 50. “In the market, the fruit is called *seethachakka*, the fruit of Seetha (wife of Lord Rama).” Cultivated mostly in drier areas.

Pandey 2000, 271. *A. squamosa*, from tropical America and West Indies, is a species “naturalized in some parts of India”.

Johannessen and Wang 1998, 16–17. Held in the hands of sculpted figures on temples in India, as in the hand of a goddess statue in the 10th-century Durga temple at Aihole, Karnataka State (illustrated).

Gupta 1996, 19. Thrives in Karnataka and Maharashtra. Grows in the wild in Madhya Pradesh. The tree is called *Sitaphala* because of a popular belief that Sita, wife of Ramachandra of the epic *Ramayana*, when in exile with her husband, used to eat fruits of this tree. Yet there is no religious significance attached to the plant. But it could symbolize fertility, as from one composite fruit a large number of seeds are produced, at least in some fruits.

(Gupta cont'd.) Sculpted on both Hindu and Buddhist temples in Madhya Pradesh, Karnataka, Bengal, and Andhra Pradesh. Held in the hands of Vishnu in Bengal (plate 11); Murugan (plate 12); Kubera from Karnataka Hoysaleshvara temple, 12th century AD. He sits on a pedestal under a canopy from which bunches of mangoes are hanging, and is holding a custard apple in his left hand and an akshamala in his right hand. As well as in the lower left hand of Shiva on a lintel sculpture showing the Trinity, Kakatiya, 12th century AD, Warangal, Andhra Pradesh, and in the hands of various other deities. The best depiction of the Sitaphala is from Bhárhut in Madhya Pradesh (plate 13), on the Kalpalata, the wish-fulfilling creeper, where not only the fruit, but also the leaves are sculpted. According to Randhawa, the custard apple was introduced into India by the Portuguese in the 16th century. But the tree must have been growing in India from very early times considering that it is mentioned in the Ramayana, *ca*. 2000–1000 BC up to AD 200 [misprinted in the text as AD 2000], and sculpted at Bhárhut, *ca*. the 2nd century BC.

Bussagli and Sivartamamurti 1978, 189, Fig. 216. Varuna, lord of the waters, with his consort, mounted on a makara monster, is shown holding an annona in his hand. From Gurjara Pratihara, 8th century AD.

Towle 1961, 39. In Peruvian archaeological materials, the fruit is said to be modeled in pottery jars.

Roys 1931, 271. Mayan: 312. "Zuli-pox. *Annona reticulata*, L. *Anona colorada*." 313. "Calmuy (C = plosive *tz*). *Annona squamosa*, L. Saramuyo."

Watt 1888–1893, I, 259–60. Custard Apple of Europeans in India; Sweet-sop or Sugar Apple of the West Indies and the Americas. Gives vernacular names. Common in areas of India indicated here and in Burma. Custard apples have been identified among the sculptures of the Ajanta caves as well as of the Bhárhut Stupa. This opposes theory of late introduction. General Cunningham remarks: "My identification of this fruit amongst the Máthura sculptures has been contested on the ground that the tree was introduced into India by the Portuguese. I do not dispute the fact that the Portuguese brought the custard apple into India, as I am aware that the East India Company imported hundreds of grindstones into the fort of Chunár, as if to illustrate the proverb about carrying coals to Newcastle. I have now travelled over a great part of India, and I have found such extensive and such widely distant tracts covered with the wild custard apple, that I can not help suspecting the tree to be indigenous. I can now appeal to one of the Bhárhut sculptures for a very exact representation of the fruit and leaves of the custard apple." Further, he said, "The names of the two varieties of custard apple, Rámphal and Sítaphal, are in themselves almost enough to show that from very early times the trees have been grown and honoured by the Hindus." Watt notes: "… Although there seems hardly any doubt as to *Anona squamosa* being an introduced plant, the date of its introduction is, however, very obscure."

Glover 1977, 43. Annona remains were excavated from a cave on the island of Timor that dated soon after 3000 BC.

Bussagli and Sivartamamurti 1978, 189. Fig. 216 depicts an 8th century (AD) sculpture of Varuna, lord of the waters, seated with his consort on a makara monster and holding in his hand an annona fruit.

Watson 1868, 181, 527. It also has a second Sanskrit name, *gunda-gutra* or *gunda-gatra*. Meanwhile, in the Malayalam language, the annona fruit is called *Seethachakka*, the fruit of Seetha (Nicolson *et al.* 1988, 50). Its mention in the *Ramayana* epic could mean that the species was present in BC times, simultaneously with or earlier than the artwork at Bhárhut Stupa.

Nadkarni (1914, 38) notes two other Sanskrit names: *shubhâ* and *suda*.

Bretschneider 1892, 413, deserves further study, since the antiquity of Chinese knowledge of the fruit is hinted at by the early presence of the annona representations in India. The species was recognized early in Bhárhut and Sanchi sculptures in Madhya Pradesh and carvings dug up at Mathura (2nd–1st century BC) by Gen. Cunningham (1879).

Pokharia and Saraswat 1999, 101. A series of caves in Timor, Indonesia, have yielded a continuous sequence of occupation from 12,000 BC to the time of Christ [*sic*; the cited source, Glover 1977, says, rather, that the terminal date is no later than the middle of the 3rd millennium.] Interestingly, in the top layers several introduced New World crops occur, such as peanuts (*Arachis*), custard-apple/sweetsop (*Annona*), and maize (*Zea mays*) together with Southeast Asian or generally Asian natives, including coconut, mangosteen, and almond (endnote 176). Seeds of *Annona* have also been found in a stratigraphic sequence of an iron-using culture at Raja Nal-Ka-Tila, Sonbhadra Dist., U.P., India, radiocarbon-dated to about 700 BC.

Arachis hypogaea

Origin: South America

Summary: Archaeological finds place it in use in Peru by earlier than 700 BC. Archaeology shows the peanut by 2800 BC (uncalibrated radiocarbon dates) in China and by the mid-3rd millennium BC on the island of Timor. There is strong evidence for a link between names of the nut in lowland South America and India. There are also several names in Sanskrit (probably dated in BC times). In morphology, there are very detailed similarities, if not identities, between Asian and South American peanuts.

Transfer: Americas to Southeast Asia

Time of transfer: no later than *ca*. 2900 BC

Grade: A

Sources: *Arachis hypogaea*—peanut, ground nut

Shady 1997, 18. Peanuts have been found in three sites of the Late Archaic (3000–1500 BC) on the coast of Peru.

Sauer 1993, 800–83. Was being grown in Peru before 2000 BC. 881. The name *mandubi* (see Krapovickas, *et al*. below) was reported from the coast of Brazil about 1550. 882. The "Peruvian" variety of peanut (*Arachis asiatica*) was taken to the Philippines by Spanish galleons and from there to southeastern China before 1600.

Nadkarni 1914, 39. *Arachis hypogea.* Sanskrit: *buchanaka*.

Torkelson 1999, 1646. Sanskrit: *buchanaka.*

Chopra *et a*l. 1956, 22. Sanskrit: *buchanaka.*

Pullaiah 2002, I, 65. Sanskrit: *bhueanakah, mandapi*. Medicinal uses.

Pokharia and Saraswat 1999, 101. Caves in Timor, Indonesia, show a continuous sequence of occupation from 12,000 BC to the time of Christ [*sic*. See, rather, Glover, 1977, whom they cite; the latter says the occupation referred to by Pokharia and Saraswat belongs to the 3rd millennium BC.] (endnote 175). In the top layers, a culture introduced from the northwest (Indonesia) is manifested which includes introduced New World crops, the peanut (*Arachis*), custard-apple/soursop (*Annona*) and maize (*Zea mays*), together with Southeast Asian or generally Asian natives, including coconut, mangosteen, and almond (endnote 176).

Zeven and de Wet 1982, 172–3. *Arachis hypogaea.* Primary gene center is in Argentina and Bolivia. (Subspecies *hypogaea* var. *hirsute* Kohler is synonymous with *A. asiatica* Lour., reportedly introduced by the Spaniards to the Philippines.)

Watson 1969, 400. "At the site of Chien Shan Yang in Chekiang, in addition to rice, the followng [was] identified": *Arachis hypogaea*. (Also *Trapa natans*). (Citing, in endnote 17, Chekiang Province Cultural Properties Control 1960.)

Pickersgill and Heiser 1978. 813. In Tehuacán, Mexico, from Palo Blanco phase (2200–1250 BP) and later. It is much older in Peru.

Carter 1974, 213–4. Cites a report of archaeological specimens, Chang 1963. At a named site in Chekiang excavated in 1956 and 1958, two carbonized peanuts were found in a Lungshanoid association (*i.e*., from *ca*. 2000 BC to perhaps 1500 BC). They were identified by the Laboratory of Plant Seeds of the College of Agriculture of Chekiang as *Arachis hypogea*. The second site was near the village of Shan-pei, northwest Kiangsi, and the archaeological association was again Lungshanoid. Chinese documentary sources attribute the origin of the peanut to the south, from overseas. Chekiang is said to have obtained peanuts from Fukhien, its southern neighbor, toward the end of the 16th century. (This is only the date for local borrowing, not necessarily for the arrival in China initially.) Bretschneider (in Burkhill 1935) quoted a Chinese source that attributed the introduction of the peanut to the Sung (960–1280) or Yuan (1260–1368) Dynasty. Bretschneider rejected the date, probably because he did not believe an American plant could be in China then.

Chang Kwang-Chih 1970, 179. The groundnut (peanut), generally thought to be native to South America, came from a Lungshanoid site in North China.

Chang Kwang-Chih 1986, 491, 421. The peanut quite surely was known in Lungshanoid pottery times [*i.e*., pre-Shang], regardless of claims of critics that the stratigraphy of the specimens had been confused. For the criticisms, see Harlan and de Wet (1973, 51–62) and Bayard, (1975, 167–70).

Jeffreys 1976, 9–28. Among crops he believed to be present in Africa before the Portuguese could have brought them, he included the groundnut.

Laufer 1907. He claimed the peanut reached China from the Malay Archipelago or Philippines via Chinese sailors or the traders of Fukien. The earliest date is AD 1573 he concluded.

Patiño 1964, II. Shows on map on p. 163, distribution of plantings of this at the time of the Conquest. Oviedo stigmatized the plant: "The Indians in this island of Hispaniola, have a fruit that they call *mani* [and] that they sow and reap, and it is a very ordinary plant …. Christians [Europeans] use it very little and then only some low fellows and children and slaves …. It is of mediocre aroma and little substance, but a very common vegetable to the Indians …." (Oviedo 1851, I, 274; II, 165). Patiño observed, "We don't know if the majority of Spaniards had the same taste as Oviedo and disdained the peanut in early times. Food habits are difficult to change." [Sounds like the kind of plant no Spaniard would have bothered to carry to Goa or the Philippines.]

Towle 1961, 42–3. Remains of the pod are among the most commonly encountered plant remains in Peru, and in addition, we find pottery vessels decorated with representations of the pods, and there are textile designs depicting parts of the peanut plant. A larger variety of nut in coastal sites is similar to one grown in the Orient today (Ames 1939, 46–8). A smaller variety is also found, as from a site at Supe, belonging to the Early Ancón Period (*ca*. 700 BC). Also from the Cupisnique levels at Huaca Priéta. Well-preserved peanuts were found in a mummy bundle from Paracas Necropolis. Plant and pods were depicted on Early Nazca textiles.

Steward 1949, 742–3. Considers that the quality of evidence for diffusion is maximal in "actual American domesticated plants, whose identity and genetic connection with Old World species can be established beyond reasonable doubt." These include "perhaps peanuts."

Pickersgill and Heiser 1978, 813. In Tehuacán, Mexico, from Palo Blanco phase (2200–1250 BP) and later. It is much older in Peru.

Anderson 1952, 167. Primitive forms of the peanut have come from ancient Peruvian tombs. "Yet up until the Peruvian excavations the experts were certain that it came from the Old World, so widely is it disseminated there, with every appearance of having been grown for a very long time in Asia and Africa. In fact, the old argument used to be whether it came from Africa or from Asia." "The most primitive type of peanut, the same narrow little shoestrings which are found in the Peruvian tombs, are commonly grown today, not in Peru, but in South China. How did they get there?"

Skvortzov 1920, 142–5. Considered the peanut present in Asia before European influence.

Krapovickas 1968, 527. Despite diffusionists' claims for the peanut in China before European discovery, Merrill's anti-diffusionist interpretation has been generally accepted. Krapovickas compiled names for the nut from Native American groups in the Amazon Basin, the area where botanists think the plant was first domesticated. There it bears such names as: Tupí, *mandobi*, *manobi*, *mandowi, mundubi*, and *munui*; Pilaá, *mandovi;* Chiriguano, *manduvi;* and Guaraní, *manubi*. Black (1988) compared these with names for the peanut in India (from Kirtikar *et al*. 1953, 754–65), Sanskrit, *andapi*, Hindi, *munghali*, and Gujarati, *mandavi*.

Ping-ti Ho 1955, 191–201. No earlier (pre-European) diffusion of such crops, including the peanut, is justified by the evidence from China.

Johannessen and Wang Siming 1998, 18. Some government archaeologists in Beijing accept a date for peanuts of *ca*. AD 300 as well as two finds of Neolithic age peanuts. 22–4. Johannessen has examined the two excavated specimens of early peanuts and describes them. One was from Jiangxi province, found in a Neolithic house site between two pots (Chinese source citations) and dated *ca*. 4400 BP. It is virtually impossible that these specimens were modern and "accidentally" came to rest in this position by falling down a rodent hole or that they were introduced by plowing of the surface, as suggested by at least one botanist. A second peanut is also Neolithic in age, from Zhejiang province. Although K.C. Chang several times referred to these two Neolithic specimens, he also, paradoxically, asserted at one point a "post-European" date for them. A written record of the peanut is found in a 300-

AD volume on the flora of South China and North Vietnam, although there are some problems with the description. Also, some Chinese scientists acknowledge (personal communications) that the peanut is old, but insist it was domesticated in China (all wild relatives of the peanut are from South America). 25. Safford (1917) found peanuts of the same type as those from Ancón, Peru, to be present in modern China. Johannessen found that the same Ancón varieties still are found in farmers' markets in China.

Chen Wenhua 1994, 59. Reports not only basic facts regarding the two Neolithic discoveries from the 1960s but also that subsequently 10 or more peanuts came from the tomb of a Western Han emperor (before 200 AD).

Safford 1917, 17. The species of peanut found in graves at Ancón, Peru, resembles specimens collected in southern Mexico by Collins. The same form is cultivated in China, Formosa, and India, "where it was probably introduced at a very early date."

Bretschneider 1882, 64. In the midst of a discussion of how Chinese characters expressing a plant name often relate to the appearance of the plant, etc., he cites "*Arachis hypogaea*, the ground-nut, is called [3 Chinese characters] *lo hua sheng* ('the flowers fall down and grow'), the same concept as its Greek name also denotes; the fruit growing (seemingly) in the ground."

Bretschneider (1892, 167) gives a Chinese name for *A. hypogaea* from a Japanese source (Matsumura) which may or may not reflect usage in classical Chinese sources.

Balfour 1871–1873, I, 153–4. *Arachis hypogea*, Linn. syn. *A. Africana* Loureir and *A. Asiatica* Loureir. English: American earth-nut, groundnut, earthnut, manilla-nut, pea-nut. Sanskrit: *buchanaka*. Indigenous to South America; extensively cultivated in India for oil.

Argemone mexicana

Origin: Mexico

Summary: At least six Sanskrit names for the plant are known, and Chinese names may also have been identified. The plant is mentioned in an Indian medical treatise dated to the 1st or 2nd century AD. Seeds have been recovered by archaeologists in sites in India dated 1100 BC, before 800 BC, and 100-300 AD. Overlapping medical uses are documented for Mexico and India.

Transfer: Asia from Mexico

Time of transfer: before 1100 BC

Grade: A

Sources: *Argemone mexicana*—Mexican poppy, prickle poppy

Nadkarni 1914, 41. *Argemone mexicana*. Sanskrit: *brahmadandi*. Eng.: yellow thistle; prickly or Mexican poppy. Common everywhere in India on roadsides and waste places. Much medical use is discussed.

Watt 1888–1893, I, 305–6. Reports Sanskrit names (*srigála kantá* and *brahmadandi*). The second is confirmed by Nadkarni {1914, 910}, and *cf*. "*bramadundie*" and "*bramhadundie*" in Watson 1868, 78, as well as "*bramhie*" or "*bramh*" in Balfour 1871–1873, I, 177.

Chopra *et al*. 1956, 23. Sanskrit: *srigala-kantaka*. Naturalized throughout India up to 5,000 ft.

Torkelson 1999, 1646. Sanskrit: *satyanasi*, *srigala-kantaka*.

Int. Lib. Assoc. 1996, 559. Sanskrit: *bhramhadandi*, *swarnaksiri*.

Pullaiah 2002, I, 66. Sanskrit: *swarnakshiri*, *bhramadendi*. Medicinal uses.

Saraswat, Sharma, and Saini (1994, 262, 333, 334) report mention of this plant in the medical treatise Bhava Prakasha in the *Sushruta Samhita* (1st/2nd century AD) where two Sanskrit names of the plant are given as *swarnakshiri* and *kauparni*.

Saraswat *et al*. (1994) also report archaeological finds of *A. mexicana* seeds at the Narhan site in Uttar Pradesh belonging to the Black-and-Red-Ware phase (*ca*. 1300–800 BC) and also the Black-Slipped-Ware phase (*ca*. 800–600 BC). Moreover, Saraswat *et al*. (1981, 284) found charred seeds of the plant at a site in the Punjab that yielded radiocarbon dates of 1100 BC and 1060 BC (Pokharia and Saraswat 1998–1999, 90, 100).

Pandey 2000, 271. "The Mexican prickle poppy, is naturalized throughout India."

Balfour explained its presence as due to introduction from Mexico in modern ship ballast (1871–1873, I, 177). However, Watt (1888–1893, I, 305–6) was puzzled by the supposition that it was only recently acquired, noting, "But for its known history [*sic*], no one could hesitate in pronouncing it wild and indigenous …. It has even received by adaptation vernacular names known to oriental literature before the introduction of the plant," that is, before the era of European discovery.

Aristida subspicata

Origin: South America
Summary: Found dominant in areas near Nukuhiva, the Marquesas Islands, where it was credited by Brown with having been inadvertently imported by pre-European Polynesians. Embeddedness of the plant in local custom confirms his judgment.
Transfer: Americas to the Marquesas Islands
Time of transfer: before European discovery in the 18th century
Grade: B

Source:*Aristida subspicata*
Brown 1931, 79. "The presence of this American grass [*Aristida subspicata*] as a dominant element in the prairie of Nukuhiva [the Marquesas] is of interest. It is not unlikely that it was unintentionally brought in by the early inhabitants, possibly at the same time that the wild pineapple was introduced" (*i.e*., before European discovery).

Artemisia vulgaris

Origin: temperate Eurasia
Summary: Widely distributed in Eurasia as well as in Mesoamerica and Peru. Closely associated with the Greek goddess Artemis, with detailed similarities in customs involving the medical treatment of women and children and the process of childbirth. Also, the plant served for magical protection of travelers on the water.
Transfer: to nuclear America
Time of transfer: pre-Columbian
Grade: B plus

Sources: *Artemisia vulgaris* (syn. *mexicana*)—mugwort, wormwood
Roys 1931, 310. Mayan: "*zizim*. *Artemisia mexicana*, Willd. Agenjo del país. *A. vulgaris*, L." [Apparently considered equivalent.] The Motul dictionary says: "There are wormwood plants much fresher and more fragrant than these here (in Spain). Their little leaves are longer and more slender. The Indians grow them for their fragrance and to please" (from Landa, Tozzer 1941, 194, which depends on Lundell's botanical judgment: "This is probably *Artemisia vulgaris* L. *zizim*").
Hernandez 1942 [before 1580], I, 291. In his *Anonima mechoacanense*, his modern botanical editors identify "*Artemisia mexicana*?," "Iztauhyatl."
Zeven and de Wet 1982, 150. Center of maximum diversity, "temperate N. Hemisphere."
Dastur n.d., 41. Distribution: Western Himalayas to Sikkim, Assam, the hills of western and southern India.
Pullaiah 2002, I, 73. (syn. *nilagirica*). Sanskrit: *barha grnthika* (*sic*), *vishirnakhya*. Medicinal uses.
Bretschneider 1892, 247. A name that occurs in the *Shi king* (document) has been correctly identified by Legge with the mugwort, *Artemisia vulgaris*, L. It is one of the plants that the Chinese employ for their moxa.
Mackenzie 1924, 201–4. The plant representing, and even being, the goddess Artemis among the Greeks was mugwort or wormwood. Her Mexican equivalent was Chalchiuhtlicue. Her mountain near Mexico City was called Yauhqueme, which signifies "covered with mugwort." She dwelt on that mountain. In like manner Artemis dwelt on Mount Taygetus and her herb Artemisia grew there. One of the Greek names for the plant is *taygetes*. (Citing Rendel Harris, *The Ascent of Olympus*, 75.) She was a furnisher of medicinal herbs, she assisted at childbirth, and the herb was a child's medicine as well as a woman's medicine. The herb was also supposed to protect, especially mariners, against tempests. Chalchiuhtlicue did the same and had the same water/marsh associations, herbal connections, and childbirth links. Artemisia was also in use in China as a medicinal herb "from time immemorial." The mugwort cure and associated goddess also reached Kamchatka. The lotus in Asia and the white waterlily in the Americas were cult symbols associated with (Aztec) Chalchiuhtlicue.

Yacovleff and Herrera 1934–1935, 280. Artemisia (*Franseria artemisioides* Willd.) A four-foot-high bush in Peru. The whole plant exhales a soft perfume. Mixed with alcohol, the leaves are used as an anti-rheumatic, or in hot baths for the feet. Also used anciently in preparation of textile dye.

According to K.T. Harper (personal communication 2004), Chinese scientists have recently extracted a useful anti-malarial chemical from a green, herbaceous mugwort very similar to *vulgaris*.

Panagiotakopulu 2000, 35. Substances used as insecticides in storerooms against insects and other pests (in Eurasia) include *Artemisia* spp.

Asclepias curassavica

Origin: Americas

Summary: A Sanskrit name in India, where the plant is now naturalized, puts it there one or two millennia ago. It was also considered to be pre-European in Hawaii and the Marquesas, which would probably mean transfer from the Americas (although one desires further confirmatory evidence to increase confidence).

Case 1: **Transfer**: to India
Time of transfer: before AD 1000
Grade: C

Case 2: Transfer: to eastern Polynesia
Time of transfer: pre-European discovery
Grade: B plus

Sources: *Asclepias curassavica*—milkweed, blood flower

Langdon 1982. Marquesans on Fatuhiva used the word for cotton (*vevai*) to refer also to this shrub, which is of American origin and “probably of aboriginal introduction in the Marquesas” (citing Brown 1935). On the nearby island of Hivaoa another term for cotton, *uruuru*, was involved in the native name there for this same shrub.

Safford, 1905, 191. Of American origin but has found its way to almost all tropical countries. Its root possesses emetic properties and leaf juice is a remedy for intestinal worms.

Roys 1931, 215, 318. “Mayan: *Anal, Anal-kak, Anal-xiu*. *Asclepias curassavica*, L. Span. Cancerillo. Milkweed. Prescribed for an abscess of the breast.” 223. May also be named *x-canzel-ak*. 228. *Chac-anal-kak* is same. 229. “*Chac-hulubte-kak*. *Asclepias curassavica*, a synonym for Anal.” 257. “*Kokob-xiu*. *Asclepias curassavica*, L. (?)” 277. “*Pol-kuch*, or *X-pol-cuchil*. *Asclepias curassavica*, L.”

Brown 1935, 237. Part of a large genus centering in the Americas. *A. curassavica* is a pantropic weed of American origin; probably of aboriginal introduction in the Marquesas. The native name is *vevai*, or *pua kirata*, or *uruuru vai kirata*.

Hillebrand 1888, 300. Called wild ipecac. A native of Mexico and the West Indies. A native Hawaiian name may indicate pre-European presence.

Watt 1888–1893, I, 343. According to some authors, the soma plant of Sanskrit authors is *A. curassavica*—indigenous in the West Indies, but quite naturalized in India. Found as a weed in various parts of India.

Int. Lib. Assoc. 1996, 560. Sanskrit: *kakatundi.*

Pullaiah 2002, I, 75–6. Sanskrit: *kakatundi*. Vernacular: blood flower, false ipecac.

Chopra *et al*. 1956, 28. Naturalized in many parts of India.

Aster divaricates

Origin: Americas

Summary: This is one of the species imported to Hawaii in pre-European (aboriginal) days that Hillebrand identified.

Transfer: to Hawaii
Time of transfer: before European discovery of Hawaii
Grade: B

Source: *Aster divaricates*

Hillebrand 1888, XCIII. The editor, W.F. Hillebrand, notes that his father changed his mind about some plants that he had assumed to be introduced after Cook but finally concluded they "may in reality have been of earlier introduction." But he failed to go back and change the symbols in the manuscript indicating the fact. Here young Hillebrand says "Of 9 non-endemic species which existed before the discovery … one" was *Aster divaricatus* (*sic*). "Not common; collected first by Chamisso. The species to which Gray (*cit.*) refers our plant is found in many of the warmer portions of the American Continent, both east and west."

Bixa orellana

Origin: Brazil

Summary: Distributed in Peruvian archaeological sites before our era and in Mesoamerica at the Conquest. In Pacific islands, Southeast Asia, India, and Africa. At first assumed by Indian botanists to be native to India because it was so thoroughly naturalized. Used as a colorant and as medicine. It has two Sanskrit names, implying considerable age in India.

Transfer: assumed to have reached the Pacific islands, Southeast Asia, and then India as a progressive series of movements, and then on to East Africa from India.

Time of transfer: reaching India in time to enter the Sanskrit lexicon, no later than 1000 AD.

Grade: A minus

Sources: *Bixa orellana*—achiote, arnatto, annatto

McBryde 1945, 148. Widely used in Guatemala for food coloring.

Towle 1961, 67. Found in Peru in a burial at Ancón and elsewhere. Not native to Peru.

Donkin 1974, 33–56. He assumes post-Columbian distribution to Africa, India, Southeast Asia, and the Pacific islands. In 1832, Roxburgh thought the plant indigenous to India.

Newcomb 1963, 41. A monotypic genus of Brazil, used as a coloring agent and flavorer. Occurs in the Pacific Islands and Southeast Asia also.

Roys 1931. Mayan: *kuxub*. Achiote, arnatto.

Balfour 1871–1873, I, 177. Sanskrit: *brahmi.* Grows luxuriantly in many parts of India, wild. Seeds and milk-like sap are used in native medicine. "The plant was introduced from Mexico in (ships') ballast." [Johannessen notes: This plant is commonly reproduced by inserting a branch in soil where it grows without further care.]

Pullaiah 2002, I, 97. Sanskrit: *sinduri*. Medicinal uses. Vernacular name: anotto.

Shady *et al*. 2003. Achiote was among the species of domesticated plants excavated at the ancient site of Caral in coastal Peru, which is radiocarbon-dated between *ca*. 2700 and 2000 BC.

Cajanus cajan

Origin: India

Summary: Despite its Old World origin, the plant is widely distributed in native agriculture in the tropical New World, and C. Sauer suspected its pre-Columbian presence. Further information is required.

Transfer: Americas from Old World

Time of transfer: uncertain

Grade: incomplete

Sources; *Cajanus cajan* (syn. *C. indicus*; syn. *Cytisus cajan*)—pigeon pea

Newcomb 1963, 40. Originally of the Old World, yet in the New World tropics it is a widely spread shrub. Grows in native gardens in the West Indies, the Amazon, and tropical South America in general. Maybe it was introduced (to the Americas) by Europeans, but, if that explanation is adopted, the plant's present wide dissemination in the hemisphere is strange.

Watt 1888–1893, VI, Part I, 364. *Cajanus indicus*. Pigeon-pea. Apparently a native of equatorial Africa. Cultivated in most areas of India.

Zeven and de Wet 1982, 76. Center of maximum gene diversity: India.

Pullaiah 2002, I, 108. Sanskrit: *adhaki*, *tuvari*.

Canavalia sp.

Origin: New World (Old World)

Summary: There are two species, *C. ensiformis* and *C. obtusifolia*, that are domesticated, but since reports sometimes are by non-biologists, they do not give us much confidence in the accuracy of their distinction, so we refer only to *Canavalia* sp. The two species are said to be from the Old World according to some and the New World according to others, with the American evidence somewhat stronger. Vavilov assigned it to his Mexican/Central American center of origin, and there are twice as many American species of *Canavalia* as in the Old World. On the other hand, there is a Sanskrit name for *Canavalia ensiformis* in India, and the genus is found by botanists distributed throughout the eastern part of India from the Himalaya to Ceylon and Siam.

At pre-ceramic Huaca Priéta, Peru (2500 BC), there may have been two species of *Canavalia* found, together with *Phaseolus lunatus*. Abundant seeds assigned to *Canavalia* sp. were also recovered from the cemetery at Paracas, Peru (late BC times). However, one botanist in the late 19th century dismissed the possibility of these being jackbeans because of color differences in the seeds. In absence of comparative plant material from Peru (in that day), he noted a similarity in color between his specimens and the seeds of *C. obtusifolia*, a species he considered "native to Asia." [Note that the actual radiocarbon date at Huaca Priéta for the plant layer is 2578 to 2470 BC, according to Yen (1963), which calibrates to 3200–3070 BC.]

It has been claimed that a wild strand species, *C. maritima*, is spread easily by sea and thus could have reached the opposite hemisphere by natural means. The supposition is that *C. maritima* was ancestral to domesticated *Canavalia*. But even if dispersion of *C. maritima* by sea were a fact, accounting for the same domesticated species in both Old and New Worlds would require two separate domestication events in which the strand plant was carried by sea to shore, then picked up by humans and taken to the inland habitat preferred by the domesticates, where evolutionary processes (including selection by cultivators) continued in exact parallel to produce identical outcomes. Those seem highly unlikely assumptions. On the other hand, we already know (see below) that *Phaseolus lunatus,* which was associated with *Canavalia* spp. in early Peru, was also present with *Canavalia* seeds in an archaeological site in India dated to 1600 BC (which accounts for a Sanskrit name). It is a far more economical explanation to suppose that the voyagers who carried the lima bean from Peru to India, also carried *Canavalia ensiformis* (or *C. obtusifolia*).

Transfer: Americas to South Asia (or possibly vice versa)

Time of transfer: before 1600 BC

Grade: A minus

Sources: *Canavalia* sp.—swordbean, jackbean

Bretschneider 1892, 164. Among pulses illustrated, especially in a Japanese compilation (that may be following classic Chinese precedent) was *C. ensiformis*.

Dressler 1953, 126. Piper considers it "practically certain that the plant is native to the Americas." Its nearest relatives appear to be Mexican, Central American, and West Indian in distribution. Vavilov assigns it to the Mexican/Central American center of origin (on the basis of diversity) with a query.

McBryde 1945, 147–8. Its origin has been subject to much disagreement. Some say Old World. McBryde has seen archaeological evidence in Peru that seems to indicate that this was the commonest bean of that region in pre-Columbian times, dating from pre-ceramic cultures and probably antedating the lima bean. According to Bukasov (1930) 24 of the species of *Canavalia* are American and only 13 from the Old World.

Martínez M. 1978, 110–11. Miranda (1976, II, 19) reports only one wild species of *Canavalia* from Chiapas in his collections, *C. villosa*, a wild species. Yet *C. ensiformis* is one of the most abundant plants found in Martínez' archaeological remains. It was usually mixed with the regular bean, *Phaseolus* (*vulgaris*) which it resembles.

C. Sauer 1950, VI, 499. The problem (of pre-Columbian distribution in Asia) is raised by the jackbean, or swordbean, widely cultivated throughout the Pacific and "always considered to be of Old World origin." It "is now known from prehistoric sites along the coasts of both South America and Mexico." He now considers the jackbean a New World domesticate.

Schwerin 1970. Proposes that African farmer/fishermen blown across the Atlantic introduced cotton, bottle gourds, and jackbeans between 8000–5700 BC.

Shady 1997, 18. The jackbean (*Canavalia* sp.) has been excavated at nine different Late Archaic (3000–1500 BC) sites in Peru.

Towle 1961, 45. L. Kaplan reported that *Canavalia* sp. was present with *Phaseolus lunatus* from the early pre-ceramic levels through those of the ceramic-bearing Cupisnique Period at Huaca Priéta. Three species of *Canavalia* were found at Huaca Priéta, Peru. Seeds of this species were also recovered from Paracas and another site; however, Harms (1922) dismissed the possibility of some of these being jackbean because of color differences. "In lieu of comparative plant material from Peru, he notes a similarity in color between his specimens and the seeds of *Canavalia obtusifolia*, a species native to Asia.

Newcomb 1963, 35. J. Sauer worked on this genus, which produces a large pod in the wild plant (*C. maritima*?). Sauer believes this to be pan-tropic, and it is a strand plant. There is evidence for separate domestications in New and Old Worlds. Lends itself to natural dispersal by reason of its growth habitat. 61–62. J. Sauer has studied this genus. Both New and Old World cultivated types derive from a strand plant, *C. maritima*, which has large edible beans. In both hemispheres "somebody got interested in this plant" and carried it inland from its native habitat. But strand plants are different because they are pan-tropic. Other plants with similar species or the same species occuring in both Old and New Worlds are more difficult to explain. Genera that occur in both hemispheres are much easier to account for than species. [Note that the actual radiocarabon date at Huaca Priéta for the plant layer 2578–2470 BC, according to Yen (1963), which calibrates to 3420–3070 BC.]

Watt 1888–1893, II, 197. Sword bean. Sanskrit: *shimbí*. Found in the eastern part of India from the Himalayas to Ceylon and Siam, wild or cultivated. Both green pods and beans are eaten.

Canna edulis

Origin: South America

Summary: This species is cultivated for its edible starchy rootstock. The stock is pictured in ceramic effigies and also drawn on pots in coastal Peru. Macrofossil remains have been excavated from as early as 4300 BP. *C. edulis* has a pre-Columbian name in Mayan and grows wild in Yucatan, where it may have been cultivated. It may also have grown on Easter Island before discovery.

It was reported in China in AD 300, and in India early enough to bear two Sanskrit names. In India and Bhutan the tuber is eaten, and it also has medicinal uses. It grew in Polynesia and as far west as Fiji. In Burma, its hard seeds were used as sacred beads; in Mexico in colonial times as rosary beads. In Mexico, Hernandez (pre-1580) pictured a plant with a Náhuatl (Mexican) name that appears to be the same as *C. indica*.

Case 1: Transfer: to Eastern and Central Pacific islands
Time of transfer: pre-Columbian
Grade: C

Case 2: Transfer: Americas to East and South Asia
Time of transfer: before AD 300
Grade: A minus

Sources: *Canna edulis* (syn. *indica*, syn. *patens*, syn. *orientalis*)—achira, platonillo, Indian shot

Towle 1961, 132. Used in the Nazca era (*ca*. 1st–9th century AD). 33. Both this *C. edulis* and *C. indica* go under the name achira. (Today both are considered synonymous.) Cultivated for edible tubers. Vases of unspecified date representing the rootstocks have been found in archaeological sites on the coast.

Shady 1997, 18. Excavated at seven different sites of the Late Archaic (3000–1500 BC) in Peru. [Note that the actual radiocarbon date at Huaca Priéta for the plant layer is 2578–2470 BC, according to Yen (1963), which calibrates to 3200–3070 BC.]

Bronson 1966, 256. *Canna edulis* grows wild in the Mexican Peten, and he thinks it possible that the root was cultivated or utilized by early Maya.

Roys 1931, 233. "Chankalá. *Canna edulis*, Ker-Gawl. Lengua de dragón."

Brücher 1989, 40–1. There are no Mesoamerican archaeological finds, but remains have been found in Peru (citing Ugent and Pozorski) at 4300 BP.

Zeven and de Wet 1982, 168. Center of diversity was probably northwestern South America.

Nadkarni 1914, 77. *Canna indica*. Sanskrit: *sarvajaya*. Eng.: Indian shot. Common all over India in gardens.

Pullaiah 2002, I, 116. *Canna indica*. Sanskrit:*devakuli*.

Balfour 1871–1873, I, 43. Sanskrit: *silarumba*. Much cultivated by the Burmese for the seeds, which they use for sacred beads.

Yacovleff and Herrera, 311–12. Achira, *Canna indica*. Shown in Nazca and Chimú art.

Brown 1931, 169–170. Throughout Polynesia to Fiji. "Native of tropical America; pantropic; of rather late introduction in the Marquesas, where it occurs both naturalized and cultivated in nearly every inhabited valley." [Unclear what he intends by "rather late."]

Watt 1888–1893, II, 102. Sanskrit: *Sarvajayá, silarumba*. Related to chiefly Hindi names. Several varieties are common all over India and Ceylon, mainly in gardens. Medicinal uses. Rootstock is edible in almost all the species. "From the root of one kind, *C. edulis*, a nutritious aliment is prepared," according to Drury.

Bretschneider (1882, 38) lists plants in the document *Nan fang Ts'ao Mu Chang*. The author was Ki Han, a Minister of State in the Tsin (Jin) Dynasty, AD 290–307, who had previously been Governor of Canton. The 80-species list includes: banana, *Canna indica*, and "sweet-potato (batatas)."

Hernandez 1942–1946, III, 735–7. His *tozcuitlapilxochitl*, which others call *cocoyotzin*, is an herb that was taken some time ago to Spain. It is called there *litospermo arundináceo* because it has leaves and fruit that are white at first and then (turn) black. The *lithospermum arundinaceum* of the 16th century is *Coix lacryma-jobi* L., it seems, from the East Indies, and notable for its hard, spherical fruits. (*Coix lacryma-jobi* is a medicinal plant cultivated in South Asia under the Sanskrit name *jargadi*—see Int. Lib. Assoc. 1996, 563). "It is extraordinary, if the plant was introduced by the Spaniards, that already by the time of Hernandez' visit to Mexico it had common Mexican (Náhuatl) names." Actually, of the two figures shown by Hernandez under this name, one is, it appears [according to the modern botanists who edited this edition of Hernandez], a species of *Canna* ("*C. indica* L?"). Both genera, *Coix* and *Canna*, were anciently cultivated in Spain. [Johannessen observes: *Coix* is a grass and, in the hand, would not have had its leaves confused with *canna*.]

Mellén B. 1986, 133. "Achira" was found by Spanish visitors from South America as being present on Easter Island.

Cannabis sativa

Origin: Central Asia

Summary: Long used as a psychoactive drug in Asia, a signature chemical from the metabolic breakdown of this plant in the human body has been identified in Peruvian mummies dated from AD 100 to 1500.

Transfer: either India (via the Pacific?) or the Middle East (via the Atlantic?) to the Americas

Time of transfer: no later than AD 100

Grade: A

Sources: *Cannabis sativa*—hashish, marijuana, Indian hemp

Int. Lib. Assoc. 1996, 561. Sanskrit: *bhanga, vijaya*

Chopra *et al*. 1956, 48. Sanskrit: *ganjika, bhanga*

Nadkarni 1914, 77. *Cannabis sativa*. Sanskrit: *vijayâ, siddhapatri.* Hindi: *ganja*. Arabic: *kinnab*. Native of western and central Asia. Now cultivated all over India and wild in the western Himalayas and Kashmir. The plant is sacred to the Hindus.

Zeven and de Wet 1982, 71. Center of maximum diversity in Central Asia. 149. There is a wild form in Central Asia.

Jett (2004) reprises the literature on evidence for the mortuary use of hashish in the New World: "Hashish or Indian hemp (*Cannabis sativa*), a native of western Asia, carried the alkaloid delta-9-tetrahydrocannibinol (THC). The plant (commonly called "marijuana"), which has long been popular in the Middle East for its psychoactive effects, is generally assumed to have been a post-Columbian introduction to the warmer parts of the New World. However, Parsche, Balabanova, and Pirsig (1992b) found THC (along with cocaine and nicotine) in the tissues, teeth, and hair of ancient naturally mummified bodies from both the North Coast and the South Coast of Peru—in 39 of the 60 cadavers tested and in a corporal distribution indicating ante-mortem use. These mummies ranged in date from about AD 115 to AD 1500."

Balabanova, Parsche, and Pirsig 1992b. Residues from hashish and cannabis were identified chemically in cranial hair of pre-Columbian Peruvian mummies.

Parsche, Balabanova, and Pirsig 1993, 503. They analyzed hair, skin, muscle, brain, teeth, and bones from 72 Peruvian (as well as11 Egyptian) mummies and found chemical residues of cocaine, nicotine, and hashish and their metabolites in both sets of mummies (16 of the Peruvian corpses revealed cocaine; 26 had tobacco traces; and 20 showed hashish).

Díaz 2003, 80. Marijuana (*cannabis*) may have been introduced to Mexico during the colonial period as a source of fiber. Shortly afterward, the plant was used for ritual purposes by indigenous groups. Famous Mexican scientist Alzate described its ritual use with a beautiful Náhuatl name, *pipiltzintzintli* [which actually implies a pre-Columbian use, although it does not guarantee it].

Addendum: Too late to enter in detail: Jett 2002.

Capsicum spp. in general

Sources: *Capsicum* spp. in general

Nicolson *et al*. 1988, 246. They believe that "the taxonomy of *Capsicum* is still far from resolution." The *Hortus Malabaricus* name for *C. annuum*, *capo-molago*, occurs in Kerala today as *kappamulaku* (*kappa* meaning 'ship,' *i.e*., introduced by Europeans, and *mulaku*, a general term for 'hot chilies.'

Brücher 1989, 166. A *capsicum*, flowers and fruits, appears on a stela from Chavin, Peru, 1st millennium BC. 168. The genus *Capsicum* includes 30 wild-growing species, five of which were domesticated by distinct Indian tribes. Soviets claim a Central American gene center for *Capsicum*. Others suppose concentration in the low mountain region of South Brazil, where a dozen species grow, 8 more from Bolivia/NW Argentina, 7 from Peru/Ecuador, 4 more from Mexico. Phylogeny is complicated.

Bailey 1935, I, s. v. *Capsicum* (page not noted). Originally from tropical America, but escaped from cultivation in the Old World tropics where it was once supposed to be indigenous [a sign that it was thoroughly naturalized and thus old].

Yarnell 1970, 225. Earliest archaeological remains: Peru, 4000 BP; Southern Mexico, 8000; Northern Mexico, 9000.

Shady 1997, 18. *Capsicum* sp. has been excavated at nine different sites of the Late Archaic (3000–1500 BC) in Peru.

Bronson, 1966, 262. McQuown and Kaufmann have reconstructed ten plant names in proto-Mayan, perhaps at about 2600 BC [more likely somewhat later]. Among them is 'chili'.

Langdon 1988, 334. *Capsicum* was reported in Tahiti as far back as 1768 by Bougainville, who reached that island only eight months after its European discoverer, Wallis.

Heyerdahl 1963, 31. The chili plant was listed by Knoche (1919, 169) as one of the aboriginal cultigens on Easter Island, known as *poro-poro*.

Newcomb 1963, 41. In the Solomon Islands, chilies are used, and there is grown a curious form of a very primitive botanical kind. 'Turkish' area usage is also very strong. This includes paprika, which does not have a known equivalent in the New World. Names are very confused. Spaniards did not consume much chili and the Portuguese even less. So how did the chili get into SE Europe and the adjacent Near East, India, and southwestern China? Note the difficult question of some of the peppers of the Guinea Coast, *e.g. malagueta* or 'grains of paradise.' The term *pimienta* is used in South America for black pepper. This probably has Brazil ties. Note the wide usage of *Capsicum* in Korea; also old in parts of East Asia such as West China, which is remote and inaccessible. Yet, chilies are not used in coastal China, which was more accessible to the New World. This is a curious pattern if one assumes Iberian introducation to the Far East.

Johannessen and Wang Siming 1998, 27. A Chinese written character of pre-European occurrence designates "chili pepper." The plant is feral. One form in south Yunnan develops into a moderate-sized tree (citing personal communication from a biologist at Yunnan University, 1996). [*Cf*. the sculpture shown by S. Gupta of a tree-sized *capsicum* plant in India.] Furthermore, the chili pepper plant is shown in Java on ancient panels on a temple wall constructed before the 10th century AD at the Prambanan Temple complex, east of Yogyakarta (see Johannessen and Wang Siming, Fig. 11). Besides, a considerable age for this plant in Asia is implied to account for its use in the daily cuisine of almost the entire Chinese population, especially in the south. The use of the same condiment in the diet of South India implies similar antiquity there.

For additional references to *Capsicum* species in the medieval literature of India and Egypt, see Johannessen and Parker 1989b, 16.

Capsicum annuum

Origin: Americas

Summary: Three Sanskrit names were used for one or another *Capsicum*, and *C. annuum* was mentioned in a Hindu text (in a medicinal context) dating no later than the 8th century AD. It is mentioned in the *Siva* and *Vamana Puranas*, dated *ca*. the 6th–8th century AD. The plant and fruit are shown in sculpted art of Java and India in medieval times. The species was also found growing in Tahiti and Easter Island at a time indicating aboriginal cultivation of the crop. Both *C. annuum* and *C. frutescens* are cultivated very widely and play key roles in the cuisines of East, South, and Southeast Asia.

Case 1: Transfer: to South and Southeast Asia

Time of transfer: no later than the 8th century

Grade: A

Case 2: Transfer: to eastern Polynesia

Time of transfer: pre-Columbian

Grade: B plus

Sources: *Capsicum annuum*—chili pepper

García-Bárcena 2000, 14. *C. annuum* was found domesticated in the Tehuacán Valley of Mexico from 4100 BC, although it was being collected in the wild long before that.

Gupta, 1996. 49–50. Quotes Heiser *re*. arrival of *Capsicum* in tropical Asia from the Americas after Columbus. Regarding the 16th-century AD introduction of chilies by the Portuguese, "this obviously is not true. Chilies have been grown and used in India much earlier, as chilies are mentioned in *Siva* and *Vamana Puranas*, which are dated *ca*. 6th–8th century AD." Mention is made in *Siva Purana* that chilies (C*apsicum*) are an ingredient in a remedy for consumption. In spite of the importance of this plant in the diet, the author has seen them depicted only at Jambukeshvara Shiva temple at Tiruchirapalli, Karnatiaka. In all panels showing *Capsicum*, the flowers and leaves are true to nature (plates 55, 56) and not only showing fully developed fruits but also the different stages in their development are sculpted. In plate 55, the only discrepancy is regarding the large size of the plant motif showing a *rishi* [figure] sitting under it. The *Capsicum* plant is usually not more than 70–80 cms. in height." [Note above, Johannessen's mention of a Yunnan *Capsicum* growing as large as a "moderate-sized tree."]

Towle 1961, 132. Used in Nazca era (1st–9th centuries AD).

Roys 1931, 229. *Chac-ic* in Mayan. 247. "*Ic*. *Capsicum annuum*, L. Chile."

Watt 1888–1893, II, 134–9. "The greatest confusion exists in Indian literature as to the cultivated species of *Capsicum*." "Much remains still to be done in order to clear up the ambiguities which exist in the literature of the Indian *Capsicum*s." Sanskrit: *marich-phalam*. Arabic and Persian terms are related: *filfile* and *filfile-surkh*, *pilpile-surkh*. This annual is cultivated throughout India. Supposed to have been recently, comparatively speaking, introduced from South America. According to the best authorities, this and the other species of *Capsicum*, now cultivated in India, have no Sanskrit names (*sic*). "Although not natives of India, the cultivated forms, at the present date, are everywhere met with and constitute an indispensable ingredient in native curry."

Nadkarni 1914, 86. *Capsicum annuum* and *C. frutescens*. Sanskrit: *marichiphalam*. Eng.: Spanish pepper, red pepper, cayenne pepper. Very largely cultivated throughout the plains of India and in the hills in some districts.

Torkelson 1999, 1675. Sanskrit: *katuvira*, *marichi-phalam*

Pullaiah 2002, I, 121. Sanskrit: *katuirah*, *rakta maricha*. Used medicinally.

For references to *Capsicum* in additional historical sources from India and Egypt, see Johannessen and Parker 1989b, 16.

See also material under *Capsicum* sp. in general.

Capsicum frutescens

Origin: Mesoamerica

Summary: Art in India display and ethnographic reports in China document *Capsicum*s so tall they can only be perennials, and *C. frutescens* is perennial. A Sanskrit name is recorded. The plant is widely cultivated in Asia today.

Transfer: Asia from the Americas

Time of transfer: by medieval times

Grade: A

Sources: *Capsicum frutescens* (syn. *C. minimum*)—chili pepper

Pickersgill and Heiser 1977, 823. Unequivocally a domesticated plant in the Tehuacán Valley, Mexico, from the Santa Maria period, 2900–2200 BP.

Martínez M. 1978, 122. Miranda's survey of flora of Chiapas found this species. *Capsicum* spp. were found lightly in Martinez' archaeological remains of 1st century date.

Roys 1931, 264. Mayan. "*Max, Max-ic*, or *Putun-ic*. *Capsicum frutescens*, L. Chile del monte."

Brücher 1989, 46. *C. frutescens* is widespread, from the southeasterm U.S. to Argentina. It has a wide distribution as a wild or semi-domesticated plant in lowland tropical America and, secondarily, in southeastern Asia. It is also grown in India and throughout the islands of Polynesia. 170. Probably domesticated in Costa Rica and Nicaragua.

Nicolson *et al*. 1988, 246. The Kerala name for this particular species is *valiyakappamulaku*, or more commonly, *valiyamulaku*. (*Kappa* in the former means 'ship,' *i.e*., 'foreign.')

Pullaiah 2002, I, 122–3. Sanskrit: *katuvirah* (this name is one consonant different from the name for *Capsicum annuum).*

In general, it may be noted that when sources refer to large or tree-sized *Capsicum*s, as they occasionally do in Asia, they probably are speaking of *C. frutescens*, because only a perennial would reach such a size, and the perennial species is *frutescens*.

See also material under *C. annuum*.

Carica papaya

Origin: Central America

Summary: Found in the Marquesas Islands, and evidence indicates its cultivation/use was aboriginal. Presence of (multiple) Sanskrit, Hindi, Arabic, and Persian names for the papaya, plus the plant's widespread naturalization in South Asia, strongly indicates that it had also spread to Asia long before 16th-century European commerce commenced.

Case 1: **Transfer:** Americas to Polynesia

Time of transfer: pre-Columbian

Grade: B plus

Case 2: Transfer: to South Asia, uncertain

Time of transfer: uncertain

Grade: incomplete

Sources: *Carica papaya*—papaya, pawpaw

Zeven and de Wet 1982, 188. Lowlands of Central America somewhere between southern Mexico and Nicaragua. Not known wild. [However, Johannessen comments that wild—feral?—papaya does occur and is used commercially as a meat tenderizer in Central America.]

Nadkarni 1914, 87. *Carica papaya*. Eng.: papaw tree. Hindi: *popaiyah*. Pers. and Arab: *amba-hindi*.

Pullaiah 2002, I, 125–6. *Brahmairandah, eranda, karkati*. medicinal uses.

Heyerdahl 1964, 127. A native of the New World. A large form grew from Mexico to Peru. A smaller, poorly known lot of indigenous South American species were cultivated through the Andean area to northern Chile.

Brown 1935, 190. *Carica papaya*. At least two varieties are present in the Marquesas. *Vi inana* (or *inata*, "papaya of the people") is recognized by Marquesans as an ancient food plant, doubtless of aboriginal introduction. Its fruit is smaller and less palatable than the *vi oahu* which is claimed by the natives to have been introduced from Hawaii by early missionaries. Sap of the papaya is used as a poultice. "A native of tropical America; of aboriginal introduction in Polynesia."

Tozzer 1941, 199. The papaya tree and fruit are described as in common use among the Maya, and Footnote 1085 identifies it as *C. Papaya* L.

Lundell 1938, 43. "It must have been known to the ancient Maya."

Safford 1905, 215–6. A native of tropical America, but it has become established throughout the entire tropical world.

Roys 1931, 236. *Chich-put* (the *h*'s in *chich* indicate 'ch explosive'). *C. papaya*. This is the wild form. Fruit said to be inedible. 280. "*Put*. *Carica papaya*, L. Papayo."

Pandey 2000, 280. *C. papaya*, from Central America, is one species "naturalized throughout India."

Bretschneider 1892, 300. Legge takes the *mu kua* to be the papaya, but he is mistaken. The *mu kua* of the (Chinese) classics is undoubtedly the quince.

Heyerdahl 1996, 149–57. In the Marquesas (Hivaoa), Von den Steinen discovered and then Linton and Heyerdahl both re-discovered, large, non-Polynesian stone carvings (radiocarbon-dated by charcoal beneath the statues at *ca*. AD 1300 showing long-tailed quadrupeds that could represent only felids and whose nearest analogs were on the monuments of San Agustín, Colombia. He connects these with several plant species of American origin that have been identified in remote locations in the Marquesas. They can only be accounted for by the arrival of voyagers. 219. Among these plants was the papaya (*cf*. Brown {1935} above).

Cassia fistula

Origin: Old World

Summary: This well-known medicinal plant (laxative) was used throughout Eurasia. Yet it also grew in North, South, and Middle America, as well as in Africa. Details of chronology and distribution in the Americas deserve further investigation.

Grade: incomplete

Sources: *Cassia fistula*—purging cassia

MOBOT 2003. Distribution: North, South, and Middle America, and Africa.

Gupta 1996, 51. Represented in art as early as the Bhárhut Stupa, 2nd century BC.

Pullaiah 2002, I, 133. Sanskrit: *aragvadha, suvarnaka*. Medicinal uses.

Ceiba pentandra

Origin: Americas

Summary: It grew and was utilized in Java and South China by the 10th century. Its growth was also intentional and its utilization was widespread in Malabar, India, where two names in Sanskrit were used for the tree. It was also grown in the Marquesas Islands before Europeans arrived there.

Case 1: Transfer: Americas to Southeast Asia

Time of transfer: by the 10th century

Grade: A

Case 2: Transfer: Americas to the Marquesas

Time of transfer: pre-Columbian

Grade: C

Sources: *Ceiba pentandra*, (syn. *Eriodendron anfructuosum*, syn. *Bombax malabaricum, B. ceiba*)—kapok, silk cotton tree, white silk cotton tree

Miranda 1952–1953, I, 268. The kapok of Java is *Ceiba pentandra*.

Aiyer 1956, 31. Listed as *Bombax malabaricum*. Mentioned in the *Charaka Samhita* as the silk cotton tree, no later than the 4th century AD (and possibly as early as 900 BC).

Zeven and de Wet 1982, 187. Toxopeus (1948) believed that this tree originated in an area later divided by the Atlantic, so it is native both to the Americas and Africa. However, Bakhuizen van den Brink (1933) and Chevalier (1949) thought that seeds may have come from America in prehistoric times. Its chromosome number (2n=72) suggest a polyploid origin, and, if this is correct, the kapok tree can only have arisen in the area where its parents occur. As all other *Ceiba* species are restricted to the Americas, this would indicate an American origin.

Nicolson *et al*. 1988, 74. *Bombax ceiba* is called *mulelavu* still today. *Mul* means 'spines' or 'thorns' and *elavu* means 'silk cotton tree,' *i.e*., spiny *elavu*. Known wild in Kerala. *C. pentandra* is discussed also, with equivalents *B. pentandrum* and *Eriodendron anfratuosum* (*anfructuosum?*). *Panjimaram* is still used as a name. *Panji* (the *nj* is pronounced as nasalized 'y') refers to cotton, and *maram* means 'tree.' Tree is only known in cultivation in Kerala.

Carter 1974, 212. This tree is portrayed in a Javanese sculpture at about AD 977.

Dastur n.d., 78. Most parts of the tree are used medicinally.

Schafer 1970, 64. In the Tang era (AD 600–900), the people of Hainan Island spun and wove kapok. It was called 'tree floss,' or 'silk cotton,' and was frequently mentioned in the historical sources as woven into blue and red fabrics by women of the Li people. It seems to have been 'simal' rather than a perennial cotton, "and indeed, this fiber, so difficult to weave and usually considered suitable only for stuffing quilts and pillows, is still spun and woven by the Li tribeswomen."

Towle 1961, 65–6. "Much confusion has arisen as to the identity of the several genera involved." Both Saffray (1876) and Rochebrune (1879, 345, 355) identify the fibers used for stuffing dolls and for wrapping small objects as the floss of *Bombax ceiba*. This species was earlier attributed to the tropical regions of Asia, but recently has been described as native to the Americas. However, the plant is not reported from Peru [?]. Harms (1922, 181), considering *Bombax ceiba* as a native of Asia, suggested that the fibers examined by Saffray and Rochebrune were those of *Ceiba pentandra*, a species of a related genus [now synonymous] and the source of the kapok of commerce. Again, this species, although a native of the Americas, like *B. ceiba*, is not found in Peru. However, two other bombacaceous species, *B. ruizii* and *Chorisia insignis*, are found in northern Peru and the valleys of the central Andes. Both of these produce floss, that of the latter closely resembling the fibers of *Ceiba pentandra*. It is quite probable [*sic*; this suggestion is not defended by Towle] that the fibers examined by Saffray and Rochebrune were from one of the other of these two plants.

De Prez 1935, 60. Kapok trees are represented on four Javanese monuments dating to different periods of time. Particularly, two reliefs from the pool of Djalatounda, situated at the residence of Sourabaya, are dated to about AD 977 (see one illustrated as his Fig. 19). Those trees bear undeniable resemblance to the Javanese kapok tree, *Ceiba pentandra* (L) Gaertn. var. *indica.* Also known under the name *Eriodendron anfractuosum*, D.D. The resemblance is very striking as seen also in the sketch of that tree according to the *Historia plantarum of Bontius* (1658) (reproduced as De Prez' Figure 23). These bas-reliefs from Djalatounda offer very probably the most ancient representation of the ("Indo-American") kapok tree known in Java and perhaps in Asia. 61. This representation confirms the opinion of Bakhuizen van den Brink in his study on the flora of the Indies and on the elements of American origin where he mentions among others the intrusion of the *Ceiba pentandra*. This shows that the kapok tree was present in Asia and in the Malay Archipelago before the discovery of the New World.

Bronson 1966, 262*ff*. McQuown and Kaufmann have reconstructed ten plant names apparently present in proto-Mayan, perhaps at about 2600 BC. [More likely somewhat later]. Among them is *ceiba*.

Yacovleff and Herrera 1934–1935, 283. Common in Peru. (Species not mentioned, but their description of the tree-cotton fits.)

Safford 1905, 221. There is some difference between trees growing in the East Indies and in the West Indies, and some botanists have regarded them as distinct species. "No difference, however, can be discovered in herbarium specimens great enough to warrant their being separated."

Newcomb 1963, 41. Herbert Baker has been collecting them and is doing genetic work on them. This genus was not disseminated by ocean currents. *C. pentandra* is from the Guinea Coast (of Africa) (*sic*). The *ceiba* of Sinaloa is a "shadow stealer" in local lore of the New World, but it occupies a similar spot in African lore. *Ceiba* sp. in Nigeria is a holy tree cared for by man. The Southeast Asian kapok is not a simple *C. pentandra*, but is a subspecies of the African temple *Ceiba*. Baker sees a dispersal route of tropical America to Guinea Coast to Southeast Asia. What is the story in tropical East Africa, C. Sauer asks?

Miranda 1952–1953, 268. Nearly all commercial kapok today comes from the East Indies, especially Java. "There are several trees of the *Bombacaceae* that produce it; the so-called kapok of Java derives from the same *Ceiba pentrandra*."

Brown 1935, 179. The native names are *uru uru* and *urupuato* in the Marquesas. Of "recent introduction" in the Marquesas.

Watt (1888–1893, III, 258–60) lists *Eriodendron anfractuosum* as The White Cotton Tree; Kapok floss. Synonym *Bombax pentandrum*, Linn.; and *Ceiba pentandra*, Gaertn.. Various vernacular names are given, none Sanskrit. Acording to the *Flora of British India* it occurs "in the forests throughout the hotter parts of India and Ceylon; distributed to South America, the West Indies, and Tropical Africa." Not common in India. "In southern Malabar there is little trade in the silk cotton, such trade as there is being more often in the cotton of the *Bombax malabaricum.*"

Gupta 1996, 38–40. The *Bombax ceiba* is the *salmali* tree in India. It is sacred. In Nadia, Sirohi Dist., Rajasthan, a 7th-century temple shows deities with flowers of this tree in the background.

Brücher 1989, 146–7. Radiation center of the genus is probably Central America.

Roys 1931, 298. Mayan *Yax-che*. Silk-cotton tree. (Important in Maya mythology.)

Nadkarni 1914, 59. *Bombax malabaricum*. Sanskrit: *shalmali*, *mocha*. Eng.: silk cotton tree.

Pullaiah 2002, I, 147. Sanskrit: *swetha salmali*. He distinguishes *Ceiba pentandra*, the white silk cotton tree (syn. *Eriodendron anfructuosum*), from *Bombax ceiba*, the red silk cotton tree (pp. 98–99), which has Sanskrit names *nirgandha pushpi* and *panchaparni*.

Tagare 1982, 408; 1983, 179. There are references to the silk cotton tree in the *Kurma Purana* of the 5th century AD and the *Brahmanda Purana* of the 10th century.

Chenopodium ambrosioides

Origin: Old World?

Summary: Distributed in China, Mesopotamia (there is an Arabic name), and India. It was grown in Mexico at the beginning of our era and at the time of the Conquest among the Maya.

Transfer: Old World to Mexico, or vice versa

Time of transfer: pre-Columbian

Grade: A

Sources: *Chenopodium ambrosioides*—apazote, Mexican tea, goosefoot

Bretschneider 1892, 261–2. Fa Hien, when he returned in AD 414 by sea from his long journey to the Buddhist countries, landed in the province of Shantung. Upon seeing the *li ho* vegetable (*Chenopodium album*) he was confident that this was indeed the land of Han (*i.e*., China). Also mentions *C. ambrosioides*.

Thompson 1949, I, 416–36. *Chenopodium ambrosioides* L. In Mesopotamia, the Arabic equivalent is *natna*.

Safford 1905, 224. Called Mexican tea. In Mexico, a medicinal tea is made of it.

Martínez M.1978, 123. Miranda speaks of only this one species in Chiapas. It is sometimes cultivated. 106. Leaves are cooked as a condiment. 107. Also the cooked fruit is useful for medicinal purposes. Archaeological remains have a proto-Classic date (*ca*. 1st century BC or AD). One variety (species not told) is used for anti-intestinal parasite therapy.

Roys 1931, 262. Mayan. "*Lucum-xiu*. *Chenopodium ambrosioides*, L. Apasote." A vermifuge.

Watt (1888–1893, II, 267) says, "An Old World, widely-spread species, now [?] introduced into the Americas, common in many parts of India;" also, "This plant affords the Mexican tea." He says (265, under the genus heading), "There are about 50 species of the genus met with in the world. These are distributed in all climates. India possesses seven species, with perhaps numerous varieties and cultivated forms of most of these."

Bretschneider 1892, 406. One of the names unchanged from classic times to today is *li*. *Chenopodium*. 261–2. *Chenopodium* has several Chinese names: *C. ambrosioides* is mentioned in Matsumura citing Japanese sources.

Note that Chopra *et al*. (1956, 61) and Torkelson (1999, 1684) both give Sanskrit: *vastuk* for *C. ambrosioides*, while Torkelson has Sanskrit: *sugandhavastuk* for *C. ambrosioides*, and Int. Lib. Assoc. (1996, 562) has *kshetravastuk* for it. Sanskrit nomenclature evidently recognized the relationship (in effect, recognizing the genus), although *album* is now credited with an Old World origin and *ambrosioides* with an American origin.

Chenopodium quinoa

Origin: South America
Summary: Langdon makes a fairly strong argument that this chenopod grew on Easter Island before European presence there, although facts are scarce.
Transfer: South America to Easter Island
Time of transfer: pre-Columbian
Grade: C

Sources: *Chenopodium quinoa*—quinoa
Langdon 1988, 327–9. Was present on Easter Island under cultivation by 1776 as documented in visitors' accounts. (Roggeveen had discovered the island in 1722. Nobody had visited from then until the Gonzalez expedition out of Peru in 1771. There is some possibility of confusion in naming with taro, but Langdon explains why he thinks this is not likely.)
Sauer 1993, 33–6. Earliest archaeological occurrence of quinoa is from before 1500 BC in the northern Chilean desert, but it is basically a high Andean crop.
Towle 1961, 36. Seeds of this plant are a staple food in Peru, replacing maize in higher altitudes. Found in numerous archaeological contexts including mummy bundles at Ancón.
Shady 1997, 18. Excavated at three sites of the Late Archaic (3000–1500 BC) in Peru.
Sauer 1967, 115. A tall chenopod of uncertain identity (perhaps *Chenopodium quinoa* Willd.), which strongly resembles quinoa, has long been grown as a grain crop in the hills of northwest India, where it shares the name *bathú* with grain amaranths (citing Thompson 1852 and Singh 1961). (Needs more research.)

Cichorium intybus

See *Sonchus oleraceus;* the two species are confused by some of our sources.

Cinchona officianalis

Origin: South America
Summary: This putative American species appears in India with Sanskrit names. How that could be needs further investigation.
Grade: incomplete

Sources: *Cinchona officianalis*—quinine bark, Peruvian bark
Pullaiah 2002, 158. Pullaiah lists both *C. offianalis* and *Cinchona calisaya*, which is called 'Peruvian bark' in India, but has no Sanskrit name. *C. officianalis* is given as Sanskrit names: *sinkona* and *kunayanah*. [Despite the fact that the date of one of the two Sanskrit names could be in doubt (because it seems to be derived from the name given this genus only in the 18th century by Linné, the term *cinchona* comes from the name of the wife of a 17th-century Peruvian ruler {Markham 1874}), the fact remains that there is the other Sanskrit name.]
Brücher 1989, 172–3. The generic name is related to the family name of the Viceroy of Peru (1629), Conde de Chinchon, whose wife fell ill with malaria and was saved from the disease by Indian 'curanderos,' who knew about the anti-fever qualities of cinchona bark. The successful treatment of the illness of Chinchon's wife with a native Indian remedy caused much publicity at the time, and Linné used the name of Cinchon (*sic*) for the botanical classification of the marvelous 'fever tree.' It is true that the bark of several cinchona trees contains a potent drug against feverish diseases, among them malaria. Modern pharmaceutical analysis has determined 30 different alkaloids in *Cinchona* species. The most important is quinine. It acts as a protoplasm poison in the cells of *Plasmodium*, the cause of malaria. The genus is represented by many species and natural hybrids in the rain forest of the Andes and Central American mountains. Brücher mentions five species that have been exploited for their quinine content. The nomenclature is, however, still confused and complicated by the existence of natural crosses.

Bruce-Chwatt 1965, 379. Therapeutic virtues of cinchona bark are believed to have been known to the native Indians of Peru, who confided their knowledge to Jesuit missionaries after the Conquest. However, there is no native written reference (including in Mesoamerica) to such a medicinal plant (called *quina-quina* indigenously in Peru).

Cocos nucifera

Origin: Asia (?)
Summary: Ethno-historic and archaeological data ensure the presence of the nut in Mesoamerica at least by AD 400 and perhaps earlier in Peruvian graves. The odds are strongly against a drift origin out of the Pacific on the coast of the Americas. The ocean-spanning voyages that moved plants between the hemispheres (demonstrated in this paper) provide a plausible medium for transmission of this plant (at least Polynesian voyagers regularly carried coconuts for drinking).
Transfer: Pacific islands to the Americas
Time of transfer: no later than AD 400
Grade: A

Sources: *Cocos nucifera*—coconut
Chopra *et al*. 1956, 72. Sanskrit: *narikela*
Robinson *et al*. 2000, 43. From an archaeological site in the Antigua Valley of Guatemala, remains of flora demonstrate the use of the coyol palm and the coconut ("la carne de coco") in subsistence in the Late Classic [*i.e*., *ca*. AD 600–850] (the coconut was also found at Copán, Honduras, dated AD 400.)
Bailey 1935, III, 2437. Palms probably do not greatly exceed 1200 species. Most of the genera are small, and many of them are monotypic. *Calamus* genus has about 200 species, all Old World, mostly Asian. *Geonoma*, about 100 species, of which all are American, and *Chamaedorea*, about 60. *Cocos*, 30 species, all confined to the Americas except the coconut, which is now cosmopolitan. Many of the species, particularly in the small genera, are restricted to a very small geographical region, often to one island or to a group of islands (which suggests that they do not spread far or readily by natural means).
Heyerdahl 1964, 121–2. The numerous species of the sub-family (*Cocoinae*) to which the coconut belongs are characteristic of tropical America; none occurs in Asia, and only the cultivated and highly useful species, *Cocos nucifera*, is found from Mesoamerica in aboriginal settlements all the way across the Pacific to Indonesia and coastal Asia. It was long supposed that the coconut came from Asia. Experiments had been conducted with coconuts in Hawaii by 1941. The results disproved the old belief that a nut could float across almost any ocean gap and germinate when washed ashore at the other end. Rather, the eyes will be attacked by fouling organisms and lose viability. Further research has also shown documented evidence that the coconut grew in Mesoamerica at the arrival of Columbus and the early Spaniards. The nut is also reproduced in Peruvian effigy jars. Merrill (1954, 267) granted that the coconut was "thoroughly established along the wet Pacific coast of Panama and adjacent Colombia before the arrival of the Spaniards." 131. The coconut was present in Indonesia at the beginning of the Christian era.
Heyerdahl 1952, 460–1. Coconuts kept in the ocean water between the logs of the Kon-Tiki raft were covered with microorganisms and many clusters of pelagic crabs and deteriorated seriously. Other nuts were kept in baskets on the deck; they remained edible to the end of the voyage and many sprouted early in the voyage. Heyerdahl planted the remaining nuts at the end of the voyage, and only those that had been on the deck germinated and grew as trees.
Cook 1901, 261–87. Presents *in extenso* the case for the coconut being widespread in tropical America before the Spaniards arrived, particularly citing chroniclers.
Bruman 1944, 220–43. After a review of the historical data, he concluded that the coconut did occur in Colima and probably elsewhere on the west coast of Mexico when the first Europeans arrived [but he supposed that coconuts reached the coast due to drift from Padific islands on the Equatorial Counter Current].
Spriggs 1984, 71–6. Radiocarbon dates on coconut remains excavated on Aneityum Island, Vanuatu, reach the fourth millennium BC, (presumed to be) prior to human settlement. Other possible early coconut remains are discussed. The dates indicate that coconuts were distributed by natural means [at

least in the western Pacific]. They also suggest an Indo-Pacific source for this plant rather than a Central American one with human carriage of the seed to the islands as claimed by Heyerdahl.

Dennis and Gunn 1971, 407–13. Evidence from the distribution of the coconut in the Indian Ocean shows that 3,000 miles is the effective limit for sea dispersion. It survives on the strand of coral islands much better than on a continent. Cook's and Heyerdahl's notion of an American origin for the coconut has long been discredited. It is a western-Pacific plant rather. But how it reached the islands off Panama is puzzling since no island with the tree was within the required distance. "The mystery of how the coconut reached western America, if it was brought by man, remains unresolved. But it seems far more reasonable to believe that primitive man, and not ocean currents, was involved."

Harries 1978, 271. Bruman (1944) considered that specimens could have reached Central America by drift from Palmyra atoll, the easternmost location in the Pacific islands where coconuts grow, but re-evaluation of the data on survivability now raises questions about that view. Apparently the coast of the Americas was just at or beyond the limit for viability of the nuts after sea drift. Furthermore, there is a question about whether nuts will sprout and become established naturally where they land or whether humans must assist them; the latter view is the general consensus today.

Heyerdahl 1965, 461–7. Heyerdahl's brief visit to the (Cocos) island (off Panama) provided evidence which he reviews here. He shows it to be consistent with the view that prehistoric people (presumably from the mainland) cleared areas and planted coconut groves on them, and thus that the coconut palm was present and economically significant off the Panama coast before European discovery.

Heyerdahl, 1965 461. Specific references early document establishing the presence of the coconut on Cocos Island, west of Panama. Also cites Edmondson 1941 *re*. controlled tests on Oahu by floating coconuts in sea-water. Short-term sea-exposed nuts sprouted successfully only if planted in soil, not sand. 458. "If Sellergren's analysis (1898, 27) of certain vegetable fibers found in prehistoric graves at Ancón, north of Callao, is correct, then these included material plaited from pre-Columbian coconut husk. Wienter (1880, 601) too, supported by the botanist André and later quoted by Harms (1922, 165), lists the coconut among plants reproduced in ancient Peruvian effigy jars.

Mahan 1983, 106. The Yuchi Indians of the southeastern U.S. had a tradition that their ancestors used rattles made of coconut shells.

Merrill 1954, 267. It is "most certain" that Polynesians introduced the coconut to the west coast of the Americas not long before the Spaniards arrived.

De Prez 1935, 58, Fig. 4. Coconut trees are shown at Borobudur (India) in bas-relief *ca*. AD 700–900.

Newcomb 1963, 57. If it is true that the coconut in West Africa was late in comparison to introduction of the coconut into East Africa, no one is going to suggest that the coconut moved overland between the two shores of the continent. Could Austronesians have rounded Cape of Good Hope?

Mangelsdorf, MacNeish, and Willey 1964, 434. Accept the coconut as one of "the cultivated plants of Middle America."

Robinson *et al*. 2000, 843. At the site of Urías in the Valley of Antigua, Guatemala, they have archaeological remains of a coconut in the Late Classic, *ca*. 700; the same plant was found at Copán, Honduras, around AD 400.

Lunde 1992, 50–5. A plant definitely shared between the two hemispheres was the coconut.

Patiño 1976, 54. Statements of the chroniclers about palms are relatively few. The coconut, although it was found by the Spaniards on their arrival in the Americas, cannot be considered rigorously as an American plant. Other than the oil palm (*Elaeis guinensis* Jacq.) and two others, originally from Africa, the rest of the *Cocoinae* are American. Patiño goes on to cite literature pro and con in relation to O.F. Cook's claim of American presence of the coconut when Europeans arrived. He also gives much historical information on additional species of palms cultivated in South America [some of these might prove to be distributed in both Old and New Worlds, but we have not investigated any besides the coconut]. 58–90. Extensive treatment of the historical sources *in re*. the nomenclature and early occurrences of the coconut, show its slow dispersion, even in colonial times. Map on p. 61 shows five localities in Colombia and isthmian Panama (including Cocos Island) where the coconut was present upon European discovery. Documents at least five locations on the Pacific coast of the Americas where the coconut was reported by Spanish chroniclers to have been in cultivation.

Guppy 1906, 62–69. Discusses the question of what plants and conditions lead to sea-borne transmission of seeds. 63. "It must be admitted that the effectual operations of the currents as plant-dispersers are limited to the shore-plants with buoyant seeds or fruits." The total of these worldwide would not reach 200 species. 64. For example, the number of littoral plants introduced into Hawaii only comes to about 16. And some of them include trees that are useful to the natives and that were probably introduced by them. This number declines from the western Pacific (*e.g.* Fiji, about 65) as one moves eastward. Easter Island has few [any?] Indo-Malayan beach trees, and, on Juan Fernandez and the Galapagos, no Indo-Malayan strand-plants are represented at all. 67. "The Coco-nut palm has been carried around the world through the agencies of man and the currents, whilst the home of the genus is in America" based on the principle that where the species are most numerous there is the home of the genus.

Parkes 1997. Archaeological evidence for coconuts has been found on Atiu Island (the Cooks) by 7820±70 BP.

Lepofsky *et al* 1992. Anaerobically-preserved domesticated coconuts have been found in the Society Islands, dated AD 600.

Bailey 1935, I, s.v. "Coconut" (page not noted). The coconut is the most important of cultivated palms. "Its nearest relatives, whether or not regarded as in the same genus, are natives of tropical America. For this and for other reasons which have been presented by Cook, it must be believed that the coconut is a native of America, and that it was carried westward across the Pacific in prehistoric times. While the nut will float and retain its power of germination for a considerable time, its propagation from island to island in known cases has practically always been the deliberate work of men, and it is probable that men were …" the normal agents of dispersion.

MacNeish 1992, 259. Lists *Cocos nucifera* as one of the "native cultivated and/or domesticated plants of Southeastern Asia."

Sauer 1993, 186. The coconut evidently evolved in the Indo-Pacific Ocean region where Tertiary and Quarternary fossils have been found. This remains the region of greatest genetic diversity and of its parasites, including many totally dependent insect species. Coconuts are known to be capable of remaining viable while floating in the sea for over 6 months, no maximum limit being established." [*sic*] [To the contrary, see Harries and Dennis, and Gunn above]. 187. "During Holocene time, the range of sea-dispersed wild coconut palms probably spanned the tropical Indian and Pacific Oceans from East Africa to the Pacific coast of Panama and Costa Rica. 188. "*C. nucifera* was absent from the Atlantic-Caribbean region until introduced by the Portuguese."

Bretschneider (1882, 38) lists plants in the *Nan fang Ts'ao Mu Chang*. The author was Ki Han, a Minister of State in the Tsin [Jin] dynasty, AD 290–307, who had previously been Governor of Canton. The 80-species list includes the coconut.

Hernandez 1942–1943 [before 1580], II, 507–10. In a long piece on the coconut: "This, which the hindues vulgarly call *maron*, and Strabo (as some say) called *palma*, and which gives a fruit that the Mexicans call *coyolli*, by the Portuguese *coco*, because of certain eyes that seem like those of a monkey, and by the Persians and Arabs *narel*, is a tall tree …." Pictured.

Heyerdahl 1965, 461. He presents persuasive evidence that the tree was being planted for economic purposes on Cocos Island, near the west coast of Panama, before the first Europeans visited there. He also noted that traces of coconut fiber had been found in ancient tombs at Ancón, Peru, while representations of the coconut palm could be seen in Peruvian art."

Heyerdahl 1996, 220. The early voyager Captain Porter was told by Marquesans that the coconut came to them by voyagers from the east on rafts.

Ward and Brookfield (1992) provide the definitive review of the literature on the drift of coconuts. They also report on an extensive computer simulation of coconut drift from which they conclude that it is highly unlikely that drift nuts would have reached the Americas from the nearest Pacific Island loci. The question of whether drift nuts would successfully sprout and mature to trees on the strand has also been contentious. (For example, no coconuts that have drifted to Australian shores are known to have survived.) Some biologists suppose that humans would have had to be involved to protect and plant or transplant germinating nuts to soil mixed with sand rather than sand alone, and especially to keep them safe from land crabs (Harries 1978, 271). Nevertheless, Spriggs (1984) reported coconuts from Vanuatu that dated to the 4th millennium BP, probably before any humans inhabited those islands.

Méndez P. 1944, 14–5, 50. Balboa encountered natives growing and using the nuts in 1513 when he arrived on the Pacific coast of Panama.

Colocasia esculenta

Origin: Americas
Summary: "Dry-land taro," found on Easter Island, is described by Heyerdahl as an American species. More detailed information is required to assess the botanical reliability of this statement.
Grade: incomplete

Source *Colocasia esculenta*—dry-land taro
Heyerdahl 1963, 31. Polynesian wet-land taro, *Colocasia antiquorum*, is grown in wet land in central and western Polynesia, whereas the rare Easter Island taro is grown between closely packed stones in entirely arid, eroded, lava-flows, and may perhaps be a dry-land taro such as is reported common to both east Polynesia and America.

Couroupita guianensis

Origin: tropical America
Summary: The unique flower of this tree is interpreted in Indian iconography, as shown in temple sculptures, as denoting the god Shiva. The tree originated in Middle America and grows only there and in India.
Transfer: Americas to India
Time of transfer: Medieval?
Grade: A

Sources: *Couroupita guianensis*—cannonball tree, *naga lingam*
Gupta 1996, 58. Naga lingam is a large tree, native of South America and the West Indies, but planted in South India "from very early times." The tree bears curious flowers that grow directly out of the trunk and main limbs. Stamens and pistil fuse in such a manner that the flower gives the appearance of a miniature lingam (symbol of the male generative organ) facing the hovering hood of a naga (cobra). For this reason, the tree is cultivated in Shiva temples, and its flowers are offered in worship before the sacred stone lingam in temples devoted to Shiva. Gupta names four temples in Tamil Nadu and one in Karnataka where the plant and flowers are shown in sculpture. Naga lingam flowers are left as offerings before stone lingams in Shivaite temples. [The only scenario one can imagine for anybody's transporting this New World tree to India would be that a worshipper of Shiva visited Mesoamerica, where he saw the tree's unique flower (no doubt with great astonishment) and felt that it ought to grow in India, the homeland of Shiva. No non-Shivaite would have paid particular attention to the blossom, and indeed the plant plays no role in Mesoamerican iconography.]
Pullaiah 2002, I, 186. Telugu name is *nagalingam*, but no name in Sanskrit is reported. It has medicinal uses.

Cucumis sp.

Origin: Old World
Summary: A poorly preserved cucurbitaceous seed was found in a 19th-century excavation in Peru and initially was considered to represent a possible *Cucumis* species, but the identification was later given up. Further examination would be desirable.
Grade: incomplete

Source: *Cucumis* sp.
Towle 1961, 96. Poorly-preserved cucurbitaceous seeds are mentioned by Constantin and Bois as possibly those of a species of the genus *Cucumis*. This is an Old World genus not otherwise represented in pre-Columbian Peruvian sites; these seeds were excluded from discussion in Towle's monograph.

Cucurbita ficifolia

Origin: Central America

Summary: Archaeologically, it was at Huaca Priéta in Peru before 2500 BC. [Note that the actual radiocarbon date at Huaca Priéta for the plant layer is 2578–2470 BC, according to Yen (1963), which calibrates to 3200–3070 BC.] Also widespread through much of western India and up into the Himalayas and Tibet as far as western China. The differentiation of the species evident in Asia would probably have required a longer period of time than the few centuries since the Portuguese advent.

Transfer: Americas to Asia

Time of transfer: several millennia ago

Grade: A

Sources: *Cucurbita ficifolia*—chilacayote, Malabar gourd

Brücher 1989, 258–60. One seed was found *ca*. AD 700 in the Valley of Oaxaca. The only other American find is from Huaca Priéta, Peru, set at 3000 BC [See note in brackets above].. Gives names as *C. ficifolia* Bouché, Malabar gourd, chilacayote, or chayote. It was considered of Afro-Asiatic origin ('Malabar') until Whitaker established its home definitively in Central America. There, it is closely related to the wild species *C. lundelliana* Bailey.

McBryde 1945, 137. Says Standley and Calderón (1925) suppose an Asiatic origin for this, but it is probably of Mexican origin, based on the existence of Aztec names.

Towle 1961, 90. The only archaeological find was at Huaca Priéta in the pre-ceramic levels (with other plants of Asian origin) and in the following Cupisnique period.

Whitaker and Bird 1949. *C. ficifolia* was present in Peru from the pre-ceramic period (*ca*. 2500 BC). It had never previously been reported from a South American archaeological collection. [See note above**.**]

Newcomb 1963, 29. C. Sauer says this is a perennial of Southern Mexico, Bolivia, Malabar, and Tibet, "the fig-leaf cucurbit." 31. The Malabar gourd is widely cultivated in Malabar, India, and on into the agricultural valleys of Tibet, and again east of there into the high country of Western China, where it is used as yak feed. This plant ranges over an extraordinary area of varying environmental conditions and its forms vary greatly, whereas the New World cucurbits do not vary too much from the common watermelon in shape, color, or markings. Surprisingly, the Malabar gourd is an American plant, identical with *C. ficifolia*. *C. ficifolia* originated in the Yucatan/Guatemala borderlands, says Sauer. It was introduced early into the Peruvian coastal area, based on archaeological evidence, and possibly into the Andes. But how did it reach India and thence the Himalayas and China? This plant was of no interest to Spaniards or Portuguese, so they provide no explanation. We are certain of the species' identity from Old to New World on morphological grounds. Malabar gourds are fertile when bred with New World stocks of *C. ficifolia*. Moreover, there are no wild cucurbits in the Old World. Nor, was it carried around by ocean currents. Perhaps it was taken along on voyages. Insufficient time has elapsed since the Columbian era for the plant to have been disseminated so extensively in Asia and differentiated so much. 35. This is the only perennial species of the cucurbits. There is archaeological evidence of its growth at sea level in coastal Peru, but today it is [also] found in upland sites. Also ranging from the Malabar coast of India, which is humid, to the Tibetan/Chinese borderlands, in the uplands. It is an odd and minimally useful vegetable with a strange distribution.

Cucurbita maxima

Origin: Americas

Summary: In India, there were at least three Sanskrit names for this. Vernacular names in India are patently related to Mayan names. In China, there is great varietal differentiation, indicating long presence and cultivation. In India, a medical text of the 8th century mentions this species as an ingredient. Some scholars consider the texts of reports by European explorers of Easter Island to refer to this cucurbit.

Case 1: Transfer: to Asia

Time of transfer: probably two millennia or more ago

Grade: A

Case 2: Transfer: to Easter Island

Time of transfer: pre-Columbian

Grade: C

Sources: *Cucurbita maxima*—squash, winter squash, Hubbard squash, giant squash

Nadkarni 1914,129. *Cucurbita maxima*. Sanskrit: *punyalatha*, *dadhiphala*. Eng.: squash, gourd.

Pullaiah 2002, I, 194. Sanskrit: *pitakusmandah*. Medicinal uses.

Johannessen and Wang Siming 1998, 26. Easter Island had acquired red-fleshed squashes (probably *Cucurbita maxima* and *moschata*—see Mellén B. 1986, 211).

Yarnell 1970, 225. Earliest remains in Peru, 2000 BP.

Towle 1961, 90. Represented in Mochica and Chimu pottery, one an exact reproduction of a warty Hubbard squash. Seeds were found in remains at Ancón (before our era).

Bronson 1966, 262*ff*. McQuown and Kaufmann have reconstructed plant names for proto-Mayan. Among them is a term for yellow squash. Maybe as early as 2600 BC [but more likely somewhat later.]

Watt 1888, II, 638–41. Under discussion of the genus: "The very greatest confusion exists in the Indian publications that deal with Gourds, Pumpkins, and Vegetable Marrows …." "All the forms met with exist in a state of cultivation only." De Candolle seems to incline to the opinion that *Cucurbita maxima* may be a truly Asiatic species and the origin of "the pumpkins cultivated by the Romans, and in the Middle Ages" in Europe generally; but that *Cucurbita pepo* is most probably a native of America …." He has not ventured to assign a habitat for *C. moschata*, although he states that all writers on Asiatic and African botany describe it as cultivated, and that "Its cultivation is recent in China, and American floras rarely mention the species." *C. maxima* he calls "Squash Gourd." "Atkinson, Dutt, and others confuse the pumpkin (*C. pepo*) with the White Gourd (*Benincasa cerifera*). Roxburgh describes only *C. pepo* and *C. moschata*, and Voigt, who wrote after Roxburgh, describes only *C. maxima*. Stewart gives an account of all three. Seeds used medicinally (*cf*. Levey). *C. maxima* produces the largest known cucurbitaceous fruit, in some cases weighing as much as 240 lb. and measuring nearly 8 feet in circumference [in India]. The fruit is wholesome" [but watery].

Bretschneider 1892, 196–8. Nowadays, the Chinese cultivate throughout the empire the *Cucurbita maxima*, or Melon Pumpkin … the *C. Pepo*, or Pumpkin gourd, and *C. moschata*. Of the *C. maxima* they have many varieties, varying considerably in size and shape of the fruit and in the color of the skin. 197. All the cucurbitaceous plants now cultivated for food in China "are probably indigenous to the country" [this presumption is based on the wide cultivation and degree of adaptation of the species] with the exception of the cucumber and watermelon. He lists Chinese characters for *C. moschata* and *Luffa cylindrica*, among others.

Brücher 1989, 262–4. *C. maxima* Duch., winter squash. He wants to call it *zapallo* to eliminate the imprecision of 'squash.' There are irrefutable proofs of South American origin and early domestication (Chimu and Mochica ceramic effigies). It is incompatible genetically with all other cucurbits. Descended from *C. andreana* (wild).

Levey 1966, 315. Lists *C. maxima* as referred to (along with *C. pepo*) in a medieval medical text from India (Al-Kindi, 9th century AD). Levey assumes both plants were cultivated in India at that time.

Nadkarni 1914, 129. Gives Sanskrit: *punyalatha* and *dadhiphala* for *C. maxima,* and widespread cultivation and adaptation of this squash confirms substantial antiquity for its presence there.

Mellén Blanco 1986, 211. Interprets the accounts of the González expedition (1776) to Easter Island as showing that *C. maxima* was growing there at the time of European discovery.

The plant had at least three Sanskrit names (Watson 1868, 319, 327).

Common names for the pumpkin current in India, as well as ones for *C. moschata,* echo the *kum* root in Mayan: *cumbuly, kumbala, koomra, kumhra, kúmara* (Watt 1988–1893, II, 641; Watson 1868, 92, 119, 310, 311).

Cucurbita moschata

Origin: America

Summary: Painted or modeled in Chinese art as early as the seventh-tenth centuries and later. Vernacular names in use in India are markedly similar to those in Mayan. Reports by European explorers of Easter Island may refer to this cucurbit in cultivation.

Case 1: Transfer: to Asia

Time of transfer: over one millennium ago

Grade: A

Case 2: Transfer: Americas to Easter Island
Time of transfer: pre-Columbian
Grade: incomplete

Sources: *Cucurbita moschata*—winter squash, banana squash, butternut squash
Schoenhals 1988, 141. Eng.: butternut squash.

Johannessen and Wang Siming1998, 26. Easter Island had acquired red-fleshed squashes (probably *Cucurbita maxima* and *moschata*, citing Mellen B. 1986, 211. 25. Known in China as *nangua*. Recorded by Jia Ming (1966) in a medicinal recipe published in AD 1473. A specimen is pictured in a Chinese painting by Shen Chou, an artist whose life spanned AD 1427–1509. A ceramic teapot in the definitive shape of a *moschata* squash and belonging to the Ming Dynasty (AD 1368–1644) has been published, but the exact date is not established. Similar pots are to be found in the Zhejiang Provincial Museum at Hangzhou dated to the Song Dynasty (AD 960–1279; see Johannessen and Wang’s Fig. 10). A similar porcelain teapot of Tang Dynasty age (AD 618–905) has also been published.

Bailey 1935, I, 910. *C. moschata*, Duch. Cushaw, crookneck squash. Winter crookneck squash. Nativity undetermined. He notes the variety *sylvestri*s, Naudin. A form found wild in the Himalayan region [? but Watt 1888, II, 638–41, says all cucurbits are cultivated, none wild, in India] with fruit as large as a man’s head.

Yarnell 1970, 225. Earliest remains: Peru: 4000 BP; Southern Mexico: 5000 BP; Northern Mexico: 3000 BP; SW U.S.: 1000 BP.

Towle 1961, 91. Found in pre-ceramic levels at Huaca Priéta, *ca*. 2500 BC (although it is apparently of Mexican or Central American origin) and shells and seeds appear with Cupisnique pottery and maize (1st millennium BC). [Note that the actual radiocarbon date at Huaca Priéta for the plant layer is 2578–2470 BC, according to Yen (1963), which calibrates to 3200–3070 BC.]

Shady 1997, 18. *Cucurbita* sp. only identified. Excavated at several sites dating to the Late Archaic (3000–1500 BC) in Peru. (Based on the find at Huaca Priéta, below; Shady probably refers to *C. moschata*.)

Whitaker and Bird 1949. *C. moschata* was present from the pre-ceramic period (2500 BC) at Huaca Priéta. (See Towle 1961, 91 above.)

Roys 1931, 258. “*Kum*, or *Kuum*. *Cucurbita moschata*, Duch.” Vernacular names in use in India in the 19th century for this economically important genus included *kumhra* and *kumra* (Watt 1888–92, II, 640), while from Yucatan we find a hononymic Mayan term *kum*, or *kuum*. Roys’ colonial-era source continues, “there are [in Yucatan] the *calabazas* [bottle gourds] of Spain, and there is also another sort of native ones [*sic*], which the Indians call *kum*. The close similarities of names for the same species in Mexico and India suggests, although, of course, it does not prove, that an historical event tied the areas together, linguistically as well as botanically.

Brücher 1989, 260–1. *C. moschata* Duch. ex Poir. pumpkin, crookneck. Remains from Ocampo caves in Mexico date to 2900–1500 BC (although his table on p. 258 gives the date for this as 4900–3500 BC, “earliest known”). Because it crosses with so many species, it is considered a basic species in the phylogeny of the American cucurbits.

Nicolson *et al*. 1988, 95–6. The element shown in *Hortus Malabaricus* is surely *C. moschata*, not *C. melopepo* or *C. maxima*. In Kerala today, this plant is called *mathan.*

Cucurbita pepo

Origin: Americas

Summary: The pumpkin has two Sanskrit names and is mentioned in several Hindu texts as early as the 4th century AD. It is also listed as an ingredient in medicine in an Indian text of the 9th century and is an ingredient in Ayurvedic medicine (today). It was also mentioned in a Chinese document as early as the 5th century AD.

Transfer: America to India
Time of transfer: no later than the 4th century
Grade: A

Sources: *Cucurbita pepo*—pumpkin

Aiyer 1956, 57. Pumpkin is mentioned in the *Atharvaveda*, dating before 800 BC. Also mentioned in the Buddhistic *Jatakas*.

Watson 1868, 310. Bengali and Hindustani have *Koomra* for *Cucurbita pepo*. The same word is also Bengali for *Benincasa cerifera*.

Pickersgill and Heiser 1978, 814. From Guila Naquitz cave, Oaxaca, from 10,750–9,840 BP.

Bretschneider 1882, 77–9. From a work on Chinese agriculture, *Ts'i Min Yao Shu*, by Kia Sz' Niu (Jia Sixie) authored in the 5th century AD, a list is published containing *C. pepo* that is framed by the heading, “Various Pumpkins and Gourds still Cultivated in China.”

Newcomb 1963, 33. Linnaeus assigned this species a home in Turkestan and Western Asia. Fuchs called it the “Turkish cucurbit” and established it in southeastern Europe by the early 15th century. *C. pepo* in “Asia has shapes and occurrences not known in New World forms. The ornamental gourds, the star-shaped ones, are not known in the New World. *C. pepo* does not occur in the West Indies nor South America (but it does in Mesoamerica). In the Old World, *C. pepo* inhabits the same area of North Africa, the Mediterranean, and Asia as does maize. Needs further work for clarification. 33. “*Cucurbita ficifolia* and C. *pepo* are the overseas strangers.” 36. In addition to the Americas, this is distributed in Turkey and from the Balkans to Turkestan. How did it get there?

Nayar and Singh 1998, 12. *C. pepo*, L. The fruit is considered in Ayurvedic medicine to be very cooling, astringent, a cure for thirst and fatigue, and a blood purifier.

Levey 1966, 315. Lists *C. maxima* as referred to (along with *C. pepo*) in a medical text from India (Al-Kindi, 9th century AD). Levey assumes both plants were cultivated in India at that time.

Torkelson 1999, 1704. Sanskrit: *kurkaru, kushmanda*.

Chopra *et al*. 1956, 83. Sanskrit: *kurkaru*.

Watt 1888–1893, II, 641. Vernacular name in Bengali is *Kumra, kúmara* among others. Sanskrit: *kurkareú*. Cultivated over most of India, in gardens and near houses. Seeds are supposed to possess anti-helminthic properties.

Bretschneider 1882, 57–61. Author of the famous Chinese volume of *Materia Medica*, *Pen Ts'ao Kang Mu* (*Ben cao gang mu*) was Li Shizhen, born in first quarter of 16th century, begun in 1552, first published 1590. This material is mainly about medicines and includes a compilation of older materials. The list mentions several American plants including this cucurbit.

Brücher 1989, 261–2. *C. pepo* L., summer pumpkin, summer squash, marrow. Oldest find is dated at 14,000 years BP (*sic*), from Tamaulipas. From the Ozarks at 5000 BP. Its wild ancestor is *C. texana*.

For a score of other references to *C. pepo* in historical Greece, India, Arabia, China, Egypt, Iraq, and Persia, see Johannessen and Parker 1989b, 16–17.

Curcuma longa

Origin: Asia

Summary: It is grown among isolated tribes in Peru under conditions and with uses that can be explained only by pre-Columbian importation. It was widely planted in Polynesia.

Transfer: Asia to South America (possibly via Polynesians?)

Time of transfer: pre-Columbian

Grade: B plus

Sources: *Curcuma longa*—turmeric

Nadkarni 1914, 135. *C. longa*. Sanskrit: *haridrá, nishá*. Eng.: turmeric. Indigenous (to India).

Torkelson 1999, 1706. Sanskrit: *haridra*

Int. Lib. Assoc. 1996, 563. Sanskrit: *haridra*

Newcomb 1963, 61. Of Southeast Asian origin, it is vegetatively reproduced, hence quite certainly human-transported across the ocean. Occurs in the eastern Andes where it is used for scent and food color.

Brown 1931, 162–3. *Curcuma longa* L. Mainly used for its yellow color. A native of India and the islands of the Indian Ocean. Of aboriginal introduction in the Marquesas. Turmeric. Marquesan, *eka*, or *ena*.

Watt 1888–1893, II, 659. Turmeric. Sanskrit and other names given. Names in Heb./Arabic: *kurkum*, and Chinese terms are also given.

Bretschneider 1892, 231. Yü kin. The description given of this plant by several ancient authors agrees with *Curcuma longa*. Yellow root.

Sopher 1950, 88, Map F—general summary information. 140. Linguistic and historical evidence shows the cultivation of this plant to be of great antiquity. It was probably a common cultural possession of [all] the Indonesian peoples. Botanical evidence indicates that the plant’s original home was India. “Early dispersal” manifested by distribution argues for spread by man east to Polynesia and “possibly beyond.” And “perhaps, also, westward to Madagascar.” 84. Probably in the islands of Polynesia was where *C. domestica* had its greatest importance outside India as a dye and pigment. 86–87. Distribution throughout most Polynesian islands is discussed and documented. “It is therefore very significant that *Curcuma* has been reported among forest peoples on the eastern slopes of the Peruvian Andes.” Tessman (1920, 161, 324; 1928) reported that a species of *Curcuma*, grown by the Amahuaca to the east of the Upper Ucayali in Peru, was a dye-plant, the color being used, together with bixa and genipa, for painting the body. He also says it is used by the Chama, while the Uitoto, nearby, use the yellow from *Curcuma* as face paint in their ceremonial dances. Sopher continues (page 88) “If these plants are indeed *Curcuma domestica*, and they can hardly be anything else because the genus *Curcuma* does not [otherwise] occur in the New World, then the evidence for a pre-European, transpacific introduction of the plant by man seems to be very strong indeed.” Polynesian occurrence is important because “the plant materials taken by them in their slow progress eastward belong to an early phase of South Asiatic culture.”

Herrera and Yacovleff (1934–1935) have found turmeric being cultivated in a valley in the Urubamba region below Cuzco, and identify it tentatively with the plant referred to by Cobo in 1653 as “azafrán de los Andes.”

Cyclanthera pedata

Origin: Americas
Summary: The fruit is cultivated in Mexico, the Andes, Nepal, and Taiwan.
Transfer: Americas to Asia
Time of transfer: pre-Columbian. (Needs better documentation *in re*. Asia.)
Grade: incomplete

Sources: *Cyclanthera pedata*

Zeven and de Wet 1982, 189. “Cultivated in Mexico for its young fruits and shoots.”

Nayar and Singh 1998, 13. *C. pedata* (L.) Schrad. grows in the Andes and, according to Herklots (1972) also in Nepal and south Taiwan. The flesh is eaten raw or cooked.

Bailey 1935, I, 935. All 30 species of this genus are tropical American. *Pedata*: Mexico south.

Brücher 1989, 265. *Cucurbitaceae*: *Cyclanthera pedata* (L.) Schrad., *pepino hueco*. Used throughout the Andes.

Cyperus esculentus

Origin: New World ?

Summary: The modern botanical distribution is American, which presumes an American origin. Indians in the Eastern United States also used it. Yet, it had Sanskrit names and was present in the ancient Near East as well as inpre-Columbian Spain.

Grade: B plus

Sources: *Cyperus esculentus* (Kew. syn. *Longus*; syn. *rotundus* {N., Middle, and S. America})—edible bulbous sedge, chufa, yellow nutsedge

Thompson 1949, 11. Mention of (ancient) Babylonian presence of *Cyperus esculentus* (Arabic: *hab el-azîz*).

Newcomb 1963, 59. Used in Spain, where it is boiled down to make a confection, or a milky, soft drink. It is a bulbous sedge, or cypress, relating to boiled chestnuts. *C. esculentus* is also reported in the Eastern U.S. among Indians “from the earliest days.” This transfer is difficult to account for.

Pullaiah 2002, I, 203. Sanskrit: *bhadrmusta, nagaramustakah*. Medicinal uses.

Cyperus vegetus

Origin: New World?

Summary: Edible roots used for food in times of extremity, as well as having other uses, in Peru and on Easter Island. A Sanskrit name in India indicates a transfer there anciently.

Case 1: Transfer: South America to Easter Island
Time of transfer: pre-Columbian
Grade: B

Case 2: Transfer: Americas to India
Time of transfer: while Sanskrit was still an active language
Grade: B

Sources: *Cyperus vegetus* (syn. *eragrostics*)—edible sedge

Schoenhals 1988, 142. *Cyperus* spp., Span.: *tule*.

Sauer 1969, 56. One of a group of plants found in both the Americas and Asia.

Heyerdahl 1963, 28. Useful in the Easter Island economy, with a native name. It also grows in Peru. Edible roots were used when other food was scarce. Grows in moist places next to the *totora* and *Polygonum* (*q.v.*)

Towle 1961, 25-6. Under “*Cyperus* sp.” Bird found small tubers of a species of *Cyperu*s in pre-ceramic levels at Huaca Priéta. Rhizomes used for food in Peru. 16. Leaves of a certain species of *Cyperus* are also used on the coast in the manufacture of matting, basketry, cordage, ‘reed’ rafts and small boats, along with *Scirpus* and *Typha* (*q.v.*)

Skottsberg 1934. Three American, non-endemic species, *Cyperus eragrostics*, *Scirpus riparius*, and *Polygonum acuminatum*, remain to have their origin on Easter Island accounted for.

Chopra *et al*. 1956, 88. Sanskrit: *kaseruka*

Torkelson 1999, 1709. Sanskrit: *kaseruka*

Datura spp. in general

Origin: Although opinions have varied greatly, the home of the entire genus is likely Central America.

Summary: The synonymies of species are quite unsettled, but the fact of the genus’ presence in Asia for a long time is well established by its being so abundant that early botanists (including De Candolle) considered some species native to the Old World. At least eight Sanskrit names for *Datura* are known, and sacred Hindu texts mention medicinal uses. Furthermore, Pokharia and Saraswat (1999, 90) recently excavated specimens of *Datura* (exact species not determinable) dating to the 1st–3rd centuries AD. A species (*D. ferox*, syn. *D. stramonium*) was grown in China, and Greek and Roman physicians are thought to have had the same or another species available (it has been proposed that oracles at the temple of Delphi were spoken under this drug’s influence).

Sources: *Datura* spp. in general. (Kew. syn. *stramonium*, syn. *fastuosa*, syn. *trapezia,* syn. *metel,* syn. *meteloides,* syn. *ferox*)—thorn apple, datura, Jimson weed

Schoenhals, 1988, 142. *Datura* spp. Span.: *toloache*.

Nadkarni 1914, 140–5. *Datura alba* and *D. fastuosa*. Sanskrit: *dhustoora, unmatta*. Eng.: thorn apple, datura. Pers.: *kouzmasab*. Found growing in waste places throughout India. The different species of this plant possess the same medicinal properties. Stupefies, has narcotic, anodyne, and anti-spasmodic properties. It has properties analogous to those of belladonna. Seeds have a strong aphrodisiac effect.

Chopra *et al*. 1956, 91. *D. metel*. Sanskrit: *dhustura*. *D. stramonium*. Sanskrit:*dhattura*. A native of Mexico introduced into India. In appearance, *D. innoxia* resembles it closely. 123. Sanskrit: *dhattura, dhustura*. Cultivated on the west coast.

Torkelson 1999, 1711–12. *D. metel*. Sanskrit: *dhattura, dhustura*. 1740. *D. fastuosa*. Sanskrit: *dhattura, dhustura*

Int. Lib. Assoc. 1996, 564. *D. metel*. Sanskrit: *dhustura*

Watson 1868, 257. Sanskrit: *khrishna-dhattura, D. fastuosa*. 280. *Khunubhon-mutta-shiva, D. metel*.

Dastur n.d., 106. *D. innoxia*, syn. *D. metel*. Name: *dhatoora*. *D. Innoxia* is very similar to the Asiatic species, *D. metel*. The plant is of American origin, very abundant in Bombay and other parts of India and Pakistan. Has the same medicinal uses as *D. metel*. The two species are known by the same common names, and in indigenous medicine are regarded as one and the same.

Pullaiah 2002, I, 207. *Datura innoxia* (syn. *D. metel*); Sanskrit: *dhatturah*. *Datura metel* (syn. *fastuosa*); Sanskrit: *dhatura*. *Datura stramonium*; Sanskrit: *dhattura, madakara.*

Pokharia and Saraswat 1999, 90. At ancient Sanghol, Punjab (Ludhiana Dist.), 1st–3rd centuries AD, they excavated remains of *Datura* (Dhatura); species could not be determined. The genus is represented today in their area of the Punjab only by *D. innoxia*, but five species are grown in adjoining regions of Pakistan. (See endnotes 59 and 60.)

Pandey 2000, 271. *D. innoxia* Mill., from Mexico, and *D. metel*, from tropical America, are species “naturalized throughout India.”

Nicolson *et al*. 1988, 247. Under this plant, they make clear there are “three confused species of *Datura* known to occur in South India:” *D. innoxia* Mill. (New World), *D. metel*, and *D. stramonium*. 248. Although *D. stramonium* is supposed to be a neo-tropical [*i.e.*, an American] species, Safford (1931) noted that it was “introduced at a very early date into the warmer regions of Europe, Asia, and Africa.” They identify here for the first time one of the plates in *Hortus Malabaricus* as *D. stramonium*.

Hernandez 1942–1943 [before 1580], II, 442. Hernandez’ *tecomaxóchitl* is identified by Mociño y Sess as *Datura maxima* Moc. y Sessé. They also call it *D. patula* Don., which the Kew Index has corresponding to *D. stramonium*. Standley says it is commonly cultivated in tierras calientes of Mexico.

Hillebrand 1888, 311. “A small genus, common to both worlds.” *D. stramonium* is a “troublesome weed” and spread over many of the islands. “… As the plant rarely produces seed, its presence … is probably due to the agency of man.”

DuBois 1908, 72. Introduction by A.L. Kroeber. Characteristics of a *Datura* cult in southern California. “The succession of births or existences [believed in by this religion], some of them psychic, evidences an unusual point of view for an American people, and is reminiscent of Oceanic and Asiatic ways of thought.” 76. “The religion of Chungichnish was a genuine missionary movement in a primitive Indian religion.” It involved ingestion of *Datura meteloides* (Jimson weed, *toloache*, Luiseño: *naktamush*), obedience, fasting, self-sacrifice, tattooing, treading on fire, and sand painting. The Milky Way was considered a symbol of where spirits go when humans die, and the raven was a sacred bird. 99. She considers this complex of ideas and practices to have come from “one of the islands of the sea.”

Watt (1888–1893, III, 40–1) calls it Thorn Apple. Grows in the temperate Himalayas from Baluchistan and Kashmir to Sikkim. In some areas, it is hard to know whether *D. fastuosa* or *D. stramonium* is present. The Flora of British India regards it as indigenous to India, but De Candolle considered *D. stramonium*, L. only to be indigenous to the Old World, probably the borders of the Caspian Sea or nearby, but not native to India. It is very doubtful that it was in Europe in Roman times but spread to there before AD 1500. De Candolle held that *D. tatula*, “a form most writers express the strongest hesitation in accepting as specifically distinct from *D. stramonium*,” is a native of Central America. Much used medicinally in India. Leaves are “smoked with tobacco for asthma.” Also, “its value as a curative in asthma is known both to Europeans and Natives, who smoke the seed in their hukas when so afflicted.” (Quote from Baden Powell). 42. *D. metel* grows wild in every part of the country and seeds are used extensively. 43. Var. *tatula* (of *D. stramonium*). Young fruits imported into India from Persia. Common everywhere around villages in Afghanistan. The name *Tatula* is the Turkish corruption of *dhatura*, through the Persian, the Sanskrit being *dhattura*, or *dhustura*; it would be equally applicable to any form of datura. He quotes O’Shaughnessy (Beng. Disp.): “It [*i.e.*, *D. metel*] is a native of North America, very nearly the same as *D. Stramonium* ….” But in this opinion (Watt says), he was most probably in error, the plant he regarded as *D. tatula* being more likely a cultivated state of *D. metel*. De Candolle appears, however, to consider *D. tatula* to be of Central American origin, and if that be so its Turkish name would be a most misleading accident ….”

Burkill 1966, I, 778–9. A rather small genus of herbs, shrubs, and little trees of the family *Solanaceae*, found throughout the tropics, but chiefly in Central America. Safford (1921, 173) maintained that *D. stramonium*, Linn., now common in Europe, was introduced from the Americas at an early date after Columbus. If that is so, the Greek and Roman physicians, who had a datura, or other, cannot have employed it (*i.e*., *stramonium*). The similar *D. ferox*, Linn., he admits as native of the Old

World, but as it is Chinese, it is scarcely likely to have reached the Levant during the Roman Empire. *D. metel*, Linn., for which *D. fastuosa* and *D. alba* are but other names, he admits as occurring naturally in Asia and Africa. This species the Greeks and Romans had. It is supposed that as a drug it was used in the temple of Delphi. Apart from these species, the rest of the genus is American. If Safford’s view is accepted, interest in the genus in the East is concentrated upon *D. metel*, which is in Malaya. But of *D. stramonium*, which does not occur in Malaya, a few words must be said. *D. stramonium* may be found in parts of Asia very remote from ports, and for that reason it is possible to argue in favor of its occurrence in the Old World before the discovery of the New World.

Chopra *et al*. 1958, 134. (1) *D. innoxia* is a native of Mexico now found growing in the western parts of the Deccan Peninsula and a few other places in India. Used in India for the same purposes as *D. stramonium*. 134–5. (2) *D. metel* (syn. *D. fastuosa* Linn.; syn. *D. alba* Nees.) occurs throughout India. (3) *D. stramonium* (syn. *D. tatula* Linn.) Vernacular names: Jimson weed, stink weed, mad apple, thorn apple, stramonium. Sanskrit: *dhattura*, *unmatta*, *kanaka*, *Shivapriya*. Known to ancient Hindu physicians; smoking seeds was a treatment for asthma and was known during the Vedic period. The drug is frequently mentioned in the literature in its use for suicidal and homicidal purposes. “*D. stramonium* is indigenous to India and grows abundantly throughout the temperate Himalayas from Kashmir to Sikkim.”

Reko 1919, 115. In Mexico, “The name *toloache*, which coincides with the Chinese name *tolo-wan*, for the same plant (*Datura strammonium*), could indicate transpacific communications.”

Lozoya 2003, 89. Psychotopic plants are those that guide the soul (from the Greek roots). The origin in our territory (Mexico) of these plants goes back, probably, to very ancient times. For example, among the ancient writers of the world (and, among those, the Chinese were truly the most ancient), a Chinese geographer of the 16th century BC, Guo Pu, stated in his work called *Shan jing* (*Book of the Mountains and the Seas*) that the sea on their east, the Pacific Ocean, was crossed by Chinese navigators as they headed towards the origin of the sun, America. He adds that the emperors of the Zhou era sent great ships bearing their *fangshi*, or alchemists, astrologers, and founders of Taoism, to this eastern region, called the White Coast, in search of *busicao*, or “plants of undying.” It was believed that ingesting these plants would cleanse the senses, clarify the perception of the world, and provide immortality. All of these properties were acquired by consuming *busicao*. The two intangible forces in the substance circulate through the channels of the human body, performing a revitalizing function that prolongs human life and permits plenitude. These ancient Asian travelers may have sought *busicao* in the Americas; prevailing currents would surely have brought them to the coasts of northern America. If this was not the case, how can we explain the fact that plants (some of them also present in Asia) now classified as psychotropic, are in the Americas? Plants like *Amanita muscaria*, *Datura* spp., *Brugmansia* spp., *Lophophora* spp., and *Ipomoea* spp., among others, gradually became part of the rituals, later termed as ecstatic, that were performed by American peoples many centuries later.

Ancient Mesoamericans believed that the human body consisted of flesh and bone as well as two intangible, luminous entities known as *tonalli* and *yályotl*. They had received this knowledge from enigmatic Toltec sages, a people who also came from over the sea. These substances were administered in sacred contexts. Among them, *Nicotiana rustica*, tobacco chewed or smoked to induce a trance, and the *tolohuaxíhuitl*, or *toloaches*, “the revered lord” (*i.e*., *Datura stramonium, D. inoxia, D. metel*) that allowed them to “see clearly.” Also used were *péyotl*, or peyote, (*Lophophora williamsii*) and *teonanácatl*, “flesh of god” (*Psilocybe mexicana*, *P. semperviva*, *P.yungensis*, *P. caerulescens*).

In the captions accompanying this article’s illustrations the following hallucinogens are discussed: *Trichocereum* sp., a cactus, endemic in South Amercia and rich in mescaline; *Turbina corymbosa*, *ololiuhqui*; *Ipomoea violacea*, *tlitliltzin* (one of the principal hallucinogens in Oaxaca); and *Pasiflora incarnata*, passion flower. One might check all these plants for Asian equivalents.

Ramírez 2003, 88. Indigenous peoples in northern Mexico and Southwestern United States used *datura* medicinally, for diagnostic purposes, to have visions, as an amulet to win bets, as an aid in hunting (success), and in initiation rites.

Díaz 2003, 80. The Náhuatl name of *Datura stramonium* is *tlápatl*, or *toloache*. It is classed as a deliriogen. Those plants cloud and reduce consciousness and can be described as true ‘narcotics.’ In high doses, they produce delirium similar to that caused by fever. “These are plants of a dark and secret tradition, used in rites of witchcraft, occasionally to harm enemies, or to confuse an unfaithful spouse.”

At least two species of *Datura* are identified specifically in both Asian and American sources:

***Datura metel* (syn. *meteloides,* syn. *innoxia,* syn. *fastuosa,* syn. *alba*)**

***Datura stramonium* (syn. *tatula,* syn. *patula*)**

Origin: Americas

Summary: Since these two cannot be untangled historically on recent data, we suppose that their transfer from the Americas to Asia (pre-eminently India) took place either via a single transoceanic boat passage that brought both the species at once, or by separate voyages perhaps to separate destinations. Inasmuch as the transport across the ocean between Eurasia and America of at least four other drugs (*Argemone mexicana*, *Cannabis sativa*, *Erythroxylon novagranatense*, and *Nicotiana tabacum*) has been established (see above and below), it would not be surprising for the *Daturas* to have been part of the movement (one name in India for *A. mexicana* means "foreign datura").

Time of transfer: of the *Daturas* would probably be on the order of two or three millennia ago in order to account for their Sanskrit names, references to the plants in ancient Hindu texts, and the archaeological find.

Grade: for each of the two species: A

Datura sanguinea

Origin: South America.

Summary: Needs further research, but this additional narcotic species that is used to induce prophetic states in Peru may have been a pre-Columbian transfer to Asia along with the other daturas.

Grade: incomplete

Sources: *Datura sanguinea*

Bailey, 1935, I, 970. The seeds of this plant are said to have been used by Peruvian priests that were believed to have prophetic power. Plant is native to Peru.

Pandey 2000, 283. *D. sanguinea*, an import from South America to India, is one species "naturalized throughout India."

See also the material under *Datura* sp. in general.

***Derris* spp.**

Origin: tropical Old World (?)

Summary: On the basis of the extensive questions raised by Quigley about the piscicidal plants shared between Africa and South America, it seems advisable to look further into the question of whether there may have been a transatlantic link. More research is obviously required.

Grade: incomplete

Sources: *Derris* spp.

Burkill 1966, I, 798. The root is used to make a piscicide. Its use extends throughout Indo-China and Malaysia to Australia and Fiji, and throughout tropical South America. "It is obvious when the distribution of the species of *Derris* is studied that sometimes one species is used and sometimes another; but the choice is limited to a few species."

Quigley 1957. Raises general questions about the use of this genus for fish poisoning in both Africa and South America. The taxonomy is so confused that one cannot tell from the ethnographic accounts whether the parallels and the substances are specific or not. [Johannessen observes: Since these are reproduced by placing pieces of the stem in the ground, any mutagens that are reproduced may give the appearance of different species.]

Dioscorea alata

Origin: Southeast Asia

Summary: The sources have a number of references to the presumed presence of this species at and immediately after the Conquest. Modern botanists, however, generally accept that only certain native American species of *Dioscorea* were present in the Western Hemisphere. Further research is needed to reconcile the disparate views.

Grade: incomplete

Sources: *Dioscorea alata*—yam

Heyerdahl 1964, 128. The yam had acquired a truly transpacific distribution in pre-Columbian times, with edible forms cultivated from the Americas to Indonesia. A spread from Melanesia to Polynesia has been generally assumed, but if the use of the yam bean in conjunction with cultivation of yams is assumed (*sic*) then a spread from the Americas may also be postulated. The New World tropics hold a number of wild species of *Dioscorea*, some with edible tubers, but it is not known whether the domesticated American forms have been developed out of wild American parents.

Alexander 1970. The genus is found wild in Africa, Asia, and the Americas in 600 species. It is agreed by botanists that cultigens have been developed from local wild forms on the three continents. Southeast Asia: *D. alata* and *D. esculenta* are held to be of Asian origin, and a third, *D. bulbifera*, originated either there or in the islands. On literary evidence, yams were known and presumably domesticated in South China by the 3rd century AD and India by the 6th (but in India not much earlier). Direct archaeological evidence does not exist. In the Pacific islands, yams are a major and perhaps a staple crop. Botanically, the island species are those of the Asiatic mainland. In the further islands, where wild yams are not found, arrival of domestic species are recorded in oral tradition and dated to the 1st and 2nd millennia AD. Groups with equipment similar to that possessed by farmers on the mainland have been found and dated, as on the mainland, to the 2nd and 1st millennia BC. In Madagascar and the East African Coastal Plain, Southeast Asian species are grown. On linguistic and physical anthropological grounds, settlement of Madagascar is considered to be of Southeast Asian origin, and movement of peoples and plants across and around the Indian Ocean in the 1st millennium AD is generally accepted. In Africa, a comparable body of evidence has been accumulated. Two important cultigens and several minor forms have developed from indigenous species. Several yam pests exist in Africa in four species, which may be significant in relation to age of the crop. In South America, wild yams are found in Brazil and Venezuela and at least one cultigen, *D. trifida*, is accepted by botanists as derived from local wild forms. Equipment like that used by later cultivators is present in the area in the 2nd, or possibly even the 3rd, millennium BC. These facts do not square with the general theories so far advanced by Burkill and Sauer.

Piperno 1999, 126–7. Phytolith spectra from pre-maize (pre-7000 BP) archaeological evidence is reprised supporting the hypothesis that arrowroot and other native plants such as *Dioscorea* spp. were cultivated in Panama before the introduction of maize.

Tozzer 1941, 196. Discussing the four root crops mentioned by Landa, Stewart (in W. Gates 1937) suggests that one of them was the yam, *Dioscorea alata*; in Náhuatl: *mexcal*, *macal*. It is “not native to America.”

Hernandez 1942–1946 [before 1580], II, 487–8. For this plant, *Tepactli*, or *Tepatli*, found in Panuco province, the editors suggest “*Dioscorea alata*?” M. Martínez in *Plantas Medicinales de Mexico*, 546, thinks that this plant is *maaxcal*, which is sometimes glossed as *D. alata*.

Hatt 1951, 853–914. Myths and rituals in Asia associated with the cultivation of cereals, including maize, and of the origin of the yam (*Dioscorea*), agree with myths in the Americas.

Canals Frau 1956–1957, 28–42. Multiple species of *Dioscoreas* have a long history of use in South and Southeast Asia, from which they extended into Oceania. The ancient word for the plant and its valuable edible root, *ubi*, ended up as *uhi* in Eastern Polynesia. *D. trifida*, a different species, was domesticated in the Antilles and lowland South America in pre-Columbian times, and in Colombia, its name is also *uhi* (and obvious variants, cited, including those among the Huitoto, Sumu, and Miskito Indians). Furthermore, a myth on the origin of the plant’s name is the same in Southeast Asia and the Americas. E.D. Merrill has finally given up his absolute opposition to transfer of this plant and considers *Dioscorea* a possibility.

Mellén B. 1986, 129. Hervé’s early diary *in re*. Easter Island mentions *uhi*, or *D. alata*. Martínez (1913) identified names of 41 varieties. Spaniards called all these *ñame*.

Newcomb 1963, 55–7. Canals Frau suggests the *D. trifida* of the Caribbean may have derived from *D. alata*, due to the plant dropping out of cultivation with disruptions resulting from the Conquest. (*D. bulbifera* is grown for bulbs which form on axials between stems. It is supposed to be of Chinese origin but shows up in coastal Mexico and South America; not at all in Africa.) (This is an additional question to be studied.)

Johannessen observes: (source cannot be recalled) Stanton Cook’s research concluded that *D. alata* had been growing on Trinidad at the time of Spanish contact.

Roys 1931, 262. “*Macal*. *Dioscorea alata*, L. *Ñame*. This, of course, is an Old World importation, but the name *macal*, designated a native plant originally.” In a 16th-century account we read of “a root which they call *macal* and which directly resembles the root of a lily. These are eaten boiled.” “This description suggests one of the *Araceae*, possibly *Xanthosoma violaceum*, Schott., a well known food plant of Central America which apparently appears in Yucatan.” (Citing a letter from Standley.)

Patiño 1964, 26–9. *Re*. the name *ñame*: This name was diffused from the west coast of Africa by Hispano/Portuguese navigators. It is known that the principal *ñame*s cultivated nowadays in the circum-Caribbean area, *D. Alata* L. and *D. cayenensis* Lam., are species of African origin, or at least were introduced to the Americas from Africa. But it seems that the name *ñame* was applied not only to *Dioscorea* but to tuberous plants of other families. There exist in the Americas several native species of *Dioscorea*, of which some can be and were domesticated or utilized by the aborigines. In recent years, since the discovery of the existence in these plants of the hormone cortisone, search for them has intensified. He goes on to discuss native names of *Dioscorea* plants in various localities.

Dioscorea cayenensis

Origin: Africa

Summary: The ambiguous historical position of *D. cayenensis* in Africa, South America, and the Marquesas leaves questions that cannot yet be answered. More study needs to be given to the distribution of this species in order to determine whether there was a possible transfer (either Polynesia/Americas or Africa/South America).

Case 1. Transfer: Africa to South America
Grade: incomplete

Case 2. Transfer: Americas to Polynesia
Grade: incomplete

Sources: *Dioscorea cayenensis*—guinea yam

Newcomb 1963, 56. Murdock reported *D. rotundata* and *D. cayenensis* in West Africa. Burkill calls these ‘guinea yams,’ of white and yellow type. Yams were undoubtedly taken out of the wild and cultivated in the West African tropics. They occur in the New World too. *D. cayenensis* was described by Linnaeus from Guiana and given the name ‘cayenne’ the same as the West African yam. Why then is the (South American) Guiana yam said to be morphologically distinguishable from the *D. cayenensis* of Africa? [Work needs to be done to resolve this question.]

Baker 1931,155–6. There are approximately 450 species [*sic*; varieties?] of *Dioscorea* widely distributed in the tropics; two or three species are widely distributed in Polynesia and are probably of aboriginal introduction. 157–8. His fourth species of *Dioscorea* he gives as simply *D*. sp., from a single specimen found on Fatuhiva, the Marquesas. “The material is not sufficient for accurate determination, but it appears to be near to, if not identical with, *D. cayenensis* Lamarck, a native of Africa, widely cultivated at an early date in tropical America.” … “Doubtless of early aboriginal introduction in the Marquesas, and, if *D. cayenensis*, which it closely resembles, it would further indicate contact with America.”

Diospyros ebenaster

Origin: Americas

Summary: Despite some confusion in the taxonomy, there is little question that *D. ebenaster* was present both in Tropical America and in India and probably China.

Transfer: to Asia from Americas
Time of transfer: pre-Columbian
Grade: B

Sources: *Diospyros ebenaster*—black sapote (Kew. syn. *ebenum*)

Schoenhals 1988, 142. *Diospyros digyna*, black sapote (synonymy?), Indian ebony persimmon.

Zeven and de Wet 1982, 189. Probably Mexico is the center of gene diversity.

Dressler 1953, 132. A popular fruit in parts of Mexico. Related to the better-known persimmon and produces fruit of good size. Some have thought it a native of the East Indies, but the evidence seems to indicate a Mexican origin (citing Merrill 1918).

Roys 1931, 284. "*Tauch*, or *Tauch-ya*. *Diospyros ebenaster*, Retz." *Sapote negro*. 297. *Achras Zapota*. *Chicozapote*, *Zapote*. Bears the sapodilla fruit. Its gum, *tzicte*, is the chicle of commerce; Mayan: *ya*."

Newcomb 1963, 61. A common garden tree in Mexico and Central America, it was called *tlilzapote* in Nahuan. Also cultivated in the Philippines and in Southeast Asia. However, there is no suggestion of its having been introduced from one area into the other. "A mysterious question of its nativity remains. Some botanists suggest that it is New World, but others say Old World. It is a little more likely to be Old World in origin, because there are so many persimmons in East Asia. In Mexico and Guatemala, it is always associated with human habitations. There is a native cast to it. …. It is deeply embedded in native use."

Chopra *et al*. 1958, 505. Grown throughout practically all India.

Watt 1888–1893, III, 138–40. *D. ebenaster* is taken as synonymous with *D. ebenum*, ebony. Found in South India, Ceylon, Malaya. "The utmost confusion exists in the writings of popular authors regarding this tree …." Apparently, the term 'ebony' is used for woods of several trees.

Bretschneider 1892, 407. Name unchanged from [Chinese] Classic times to today, *she*, *Diospyros.*

Brücher 1989, 227–8. *Diospyros* spp. This is a rare botanical family with few (5–6) genera distributed in all tropical hemispheres [*sic*]. The best known is the Asiatic *D. kaki* L., now widely cultivated as a prolific fruit tree. In the Americas, four species are native: *D. virginiana* L., *D. digyna* Jacq., *D. ebenaster* Retz., and *D. inconstans* Jacq. Origin in Central America (Guat. and Mexico) and grows also in the Antilles. In the south of the U.S., the fruits are more appreciated than the local *D. virginiana*, both called 'persimmon,' or black sapote.

Balfour 1871–1873, I, 23. *Åchra Sapota*, Eilld., syn. *Diospyros sapota*. Eng. terms: 'bulli,' or 'buily tree,' common sapota, sapodilla plum. "A native of China, cultivated in the West Indies and South America." In India, it is grown only as a fruit tree. Balfour, II, D–105. *Åchra sapota*, syn. *D. ebenaster*, Retz., English ebony.

Dolichos lablab

Origin:Old World

Summary: A possibility seems to exist that the Peruvian specimen originally assigned to this species might prove, on further study, indeed to be this bean. The Peruvian coast in the 3rd (or 4th) millennium BC seems to have been a zone of interchange of Old and New World flora, making it conceivable that this bean was present.

Grade: incomplete

Source: *Dolichos lablab*

Kelly 1951, 208–9. This Old World bean was originally reported from Huaca Priéta, Peru, as an early cultivar, but the identification was subsequently changed. 29. One of the Old World pulses with others listed, including *Dolichos lablab* and *Lupinus albus*. 39. An African plant. It is a possible Negro African introduction before Columbus, although missing from Arab Africa. It was supposed to have had a New World origin until De Candolle studied it.

Elaeis guineensis

Origin: Africa

Summary: Since two species of the same genus face each other across the narrow part of the South Atlantic ocean, it may be desirable to know more about how the anomalous South American species reached its position. While that distribution is thought by some to result from continental drift, that is not, of course, known for a fact. DNA examination might reveal how long since the African and South American taxa have been apart.

Grade: incomplete

Sources:*Elaeis guineensis*—Guinea oil palm

Newcomb 1963. 60–1. The guinea oil palm and a black-seeded species in Brazil are of note. L.H. Bailey claimed that the Guinea oil palm (see more by him under *Cocos nucifera*) had been carried into West Africa from the New World.

Steentoft 1988, 223. *Palmae* (*Arecaceae*)—palm family. There are 12 genera of indigenous plants in West Africa. Of these, only *Elaeis* and *Raphia* also have New World species.

Patiño 1963, 54. Statements of the chroniclers about palms are relatively few. The oil palm (*Elaeis guinensis* Jacq.) and two others were originally from Africa.

Bailey 1935, III, 2438. "As a rule, the members of any single genus of palms are found in one hemisphere, either the Eastern or Western as the case may be, probably the greater number of species being of Asiatic and American origin, rather than African."

Sauer 1993, 189–92. *Elaeis* includes two wild species, *E. oleifera* of Central and South America, and *E. guineensis* of West Africa. 190. *Elaeis* is monoecious, so dispersal of a single seed is enough to start a new colony. Aboriginal use of *E. oleifera* in the American tropics was very minor, and the species has never become a plantation crop.

Erigeron albidus

Origin: Americas

Summary: The fact of the plant's native name plus its ubiquitous distribution in Hawaii suggests that it had reached there before Europeans. (Even in early historical times as a weed this is an unlikely transfer.)

Transfer: Americas to Hawaii

Time of transfer: pre-Columbian

Grade: C

Source: *Erigeron albidus*—(Kew, syn. *bonariensis*)

Hillebrand 1888, 196. Interspersed with *E. canadensis*, gregarious in parts of Molokai and Maui. A native of Tropical America, but now a common weed in many countries of the warmer zones. The editor, W.F. Hillebrand (son), explains on page XCIII that his father at first considered this species introduced after Capt. Cook but changed his mind and ended up concluding that it had arrived before that event.

Erigeron canadensis

Origin: Americas

Summary: The presence of *E. canadensis* in India must be old to have naturalized quite completely, as it has, in addition to bearing two Sanskrit names.

Case l: Transfer: Americas to India

Time of transfer: more than one millennium ago and probably two

Grade: B plus

Case 2: Transfer: Americas to Hawaii

Time of transfer: pre-Columbian

Grade: C

Sources: *Erigeron canadensis*—(syn. and preferred modern taxon is *Conyza canadensis* (L.) Cronq.)

Hillebrand 1888, 196. A common weed on all Hawaiian islands. Native name: *iliohe*. "Of American origin, but now naturalized in most parts of the globe, particularly in the temperate latitudes" The editor, W.F. Hillebrand (son), explains on page XCIII that his father at first considered this species introduced post-Capt. Cook but changed his mind and concluded that it was pre-European.

Pandey 2000, 272. *E. canadensis*, from North America, is a species "naturalized throughout India."

Torkelson 1999, 1726. Sanskrit: *jarayupriya*, *makshikavisha*

Chopra *et al*. 1958, 556. An annual herb found in the western Himalayas, Punjab, and Rohilkhund up to an altitude of 4,000 ft. Plentiful in Kashmir. Also in Shillong (Assam), the Western Ghats and the Nilgiris up to 6,000 ft. Leaves produce irritation of parts of the body they touch.

K.T. Harper (personal communication, 2004). This species is a follower and close associate of man, highly unlikely to have dispersed by natural means across an ocean. It is everywhere a common garden weed, so its seeds could be expected to be found in any soil used to sustain crop rootstocks that early humans might have carried on colonizing voyages.

Erythroxylon novagranatense

Origin: South America
Summary: The evidence for early Egyptian use makes inescapable acceptance of the fact that coca plants were being grown in Eurasia; their use for many centuries precludes the possibility that a continuing supply of leaves was imported from the Americas.
Transfer: South America to at least Egypt
Time of transfer: as early as the 2nd millennium BC
Grade: A

Sources: *Erythroxylon* sp.—coca
Balabanova *et al*. 1992, 358. Nine Egyptian mummies, dated from approximately 1070 BC–AD 395 were examined by radioimunoassay and gas chromatography/mass spectrometry. Cocaine and hashish were found in all nine mummies, and nicotine in the hair, soft tissue, and bones of eight. That 1992 article educed letters critical of the authors and their findings; see *Naturwissenschaften* 80 (1993), 243*ff*. Parsche responded that, "our analysis provides clear evidence for the presence of [the reported] alkaloids" and is not due to post-discovery contamination.

Plowman 1984, 135–6. The archaeological record of the use of Huánuco coca. Earlier investigators did not distinguish among different species and varieties of cultivated coca. Re-examination of extant archaeological coca leaves from coastal Peru revealed that they all represent Trujillo coca, *E. novogranatense* var. *truxillense.* Gold and ceramic artifacts depicting coca chewers have been discovered at Tiwanaku. They suggest that coca was in use there perhaps as early as the 4th century AD (that is a quote from Carter *et al*. 1980). 138. *Erythroxlum novogranatense* has two well-defined varieties, var. *truxillense*, Trujillo coca, and var. *novogranatense*, Colombian coca. They are chemically different from *E. coca* var. *coca*. 140. The archaeological record of Trujillo coca starts by suggesting that coca-chewing on the Peruvian coast began in Late pre-Ceramic Period 6 (2500–1800 BC.) (species undetermined) from a site dated around 2000 BC. Also at *ca*. 1800 BC, 1750–1900 BC, and 1800–1400 BC. Archaeological coca leaves from much later sites on the Peruvian coast have been available for study; all belong to *E. novogranatense* var. *truxillense*. From AD 1000–600, etc. 144. "There is sufficient evidence now to postulate that Trujillo coca was cultivated and chewed on the Peruvian coast at least by 2000 BC and possibly earlier." 146. Perhaps the earliest known record for coca chewing comes from the Valdivia culture in southwestern coastal Ecuador. Lime containers (lime is typically chewed along with coca leaves) have been found there that date to Valdivia Phase 4, about 2100 BC (uncalibrated radiocarbon dating). In Machalilla and Chorrera periods (1000–300 BC.) "Based on the archaeological evidence [but not on actual plant remains], it appears that coca cultivation and the habit of coca-chewing were fully established in the Valdivia area by 3000 BC."

Towle 1961, 58–60. Widely recovered from archaeological sites; both Nazca and Mochica jars picture men with distended cheeks or dipping lime. Also, there are many finds of bags of leaves and lime pellets, as at Ancón, Paracas Cavernas, and Paracas Necropolis.

Shady *et al*. 2003. At Caral (*ca*. 2600–2000 Cal BC) near the Peruvian coast, excavations revealed actual coca seeds as well as lime containers like those later used by consumers of coca.

Cartmell *et al*. 1991. Coca was in use in northern Chile (implying trade of the substance) determined from analysis of hair.

Jett 2004 reprises the growing literature on chemical identification of cocaine as evidenced in mummies in Egypt, Nubia, etc.

Addenda, too late to enter: Jett. 2002a; Guthrie 2002.

Garcinia mangostana

Origin: Southeast Asia
Summary: The evidence for transfer to the Americas consists of the remains of the fruit that have been recovered from tombs in Peru.

Transfer: Asia to Peru

Time of transfer: The tombs where the fruits were found are probably those at Ancón or Paracas, which means the late BC centuries.

Grade: B

Sources: *Garcinia mangostana*—mangosteen

Nadkarni 1914, 166. *Garcinia mangostana*. Eng.: *mangosteen*. Hind. and Ben.: *mangustin*. A native of the Straits Settlement and Singapore.

Pullaiah 2002, I, 264. Surprisingly, no Sanskrit name is given.

Chopra *et al*. 1956, 123. Cultivated on the West Coast of India.

Towle 1961, 97. Rochebrune (1879, 346, 351) reported that fruits of this plant, usually cut in half, had been found in string bags recovered from graves in Peru. His identification, however, was questioned by Wittmack (1888, 341), (only?) since mangosteen is considered a native of Asia and was brought to the New World as a horticultural importation well after the period of discovery.

De Prez 1935, 61. He pictures a sculpture at Borobudur (*ca*. AD 700–900) that shows mangosteen fruit (simultaneously with the mango, *Mangifera indica*).

Watt (1888–1893, III, 470–1) calls this a native of Malaya (“the Strait”), cultivated in Burma for its fruit. Its distribution was very localized; it does not grow successfully if transplanted to most of India. [Hence, it could easily fail to stay on in Peru even if transferred to there across the Pacific.] “A congenial amount of heat and moisture throughout the year seems to be necessary for its successful cultivation.” Used as a remedy for diarrhea and dysentery.

Bailey 1967, II, 1312–3. Genus has upward of 150 species in the tropics of Asia, Africa, and Polynesia. The name *mangostana* is credited to the Malay region.

Gnaphalium purpureum

Origin: Americas

Summary: In Hillebrand’s expert opinion this species reached Hawaii in pre-European times. In light of its widespread distribution in India, one wishes to know more about when the species was introduced there.

Case 1: Transfer: to Hawaii

Time of transfer: before European discovery

Grade: C

Case 2: Transfer: to India

Time of transfer: unknown

Grade: incomplete

Source: *Gnaphalium purpureum*—(syn. *americana*, syn. *spicata*)

Hillebrand 1888, page XCIII. The editor, W.F. Hillebrand, notes that in his father’s tabulation of plant species from Hawaii that were introduced after Capt. Cook’s arrival, his father changed his mind about some plants which he had assumed were introduced pre-Cook but which “may in reality have been of earlier introduction” (in the elder Hillebrand’s judgment.) “Of 9 non-endemic species which existed before the discovery … one, *Gnaphalium*, [among others is] American ….” 201. “A native of the American Continent, on which it extends under a variety of names from the United States East and West to the southern extremity. Has migrated also to Hongkong [*sic*] and a few other places of the Old World.”

Pandey 2000, 271. *G. purpureum*, a native of Tropical America, is one species “naturalized throughout India”.

Gossypium spp. in general

Sources: *Gossypium* spp. in general

Brücher 1989, 149. Old World cottons, going back to Mohenjo-Daro and Egypt, were only diploid species. “The situation in the New World in ancient times was quite different. Many thousands of years ago a unique phylogenetical event occurred there: a combination, followed by polyploidy of the Old World A-genome with a New World D-genome. Until now, nobody has been able to explain how and where it happened; but that this genome fusion took place on American soil is without doubt.”

Wendel 1995, 362. The earliest cotton cloth documented by archaeology in Asia is 4,300 years old, from sites in India and Pakistan [specimens from the Americas, given on p. 362 as 5,500 years in Peru, for *barbadense*; the earliest *hirsutum* finds are between 400 and 5000 BP in the Tehuacán valley of Mexico]. Which species is represented in these earliest remains is not clear. *G. arboreum* is known only as a cultivated plant with a center of diversity in India and a range from China and Korea westward into northern Africa. Wild ancestral forms have not been verified.

Yarnell 1970, 225. Earliest remains, Peru: 4000 BP; Southern Mexico: 8000 BP; Northern Mexico: 9000 BP. [The latter two are probably excessively early, given the re-dating of MacNeish's maize specimens reported in Long, *et al*. 1989, 1035–40].

Yen 1963, 112. Notes that at Huaca Priéta, Peru, Bird (1948) found seeds of *Gossypium*, dated *ca*. 2578–2470 BC. (Cal.ibrated to 3200–3070 BC.)

Johnson 1975, 340, 348. Opponents of the concepts of an agricultural origin of the tetraploids point to the difficulty of explaining how Old World cotton could have been transported to the New World in prehistoric times, and to the illogic of assuming that man would have brought cotton, but not his basic food plants (Purseglove 1968). [That argument is passé in the light of the present data.] At least "With respect to the latter one, however, there is little reason to believe that biologically and culturally unadapted food plants from the Old World would survive long in Mesoamerica, an area already rich in improved food-producing species. On the other hand, the known absence in that area of a comparable fiber plant would make cotton a prized addition to the culture." Note also that "An A-genome cotton indigenous to the Americas has never been found, either living or in archaeological contexts, yet such a cotton clearly was involved in the origin of the tetraploids. This inconsistency is explainable assuming that the A donor was an unadapted type capable of existing only under agricultural conditions (Stephens 1947) as long as the needs of man placed a premium upon its survival, and that it became extinct, or nearly so, when supplanted by better-adapted tetraploids of competing quality. Furthermore, "The idea that the tetraploids could have survived geological epochs [*i.e*., since the Cretaceous] as adapted species only to vanish as such since the rise of agriculture, and yet that they could have produced successful escapes from cultivation, seems highly improbable."

Wendel 1989, 4132–4136. A major conclusion of this paper is that the chloroplast genome of New World tetraploid *Gossypium* is derived from an Old World diploid cotton. Concludes that the initial hybridization and polyploidization events that led to the evolution of tetraploid cotton were "relatively recent." 4136. The low level of sequence divergence argues against a Cretaceous age for the origin of the tetraploids, but suggests occurrence "relatively recently," perhaps within "the last 1–2 million years."

Townsend 1925, 3. The major insect enemies of the plant point to the Americas as this plant's native home. The Mexican boll weevil and the Peruvian square weevil, which attack no other plant in nature, have evidently been adapted to cotton and close American allies for "tens of thousands of years." They are not carried in the seed and hence were not transported to the Eastern Hemisphere when the seed was taken there from America (*sic*)." Had cotton seed been brought by the ancients from India to the Americas, it is certain that the pink bollworm would have been introduced here at that time. [This author is not very reliable, generally.]

Merrill 1954, 165–385. Gives reasons for thinking that more than one form of *Gossypium* was present in the Society Islands soon after European contact and refers to "numerous hybrids between New World and Old World cotton species" which might well have reached Tahiti through the agency of man "before the long voyages of the Polynesians had ceased."

Hutchinson 1962, 5–15. Updates the research on cottons that he had carried on with Silow and Stephens from 1934 to 1947 and reaffirms their conclusion that the two key American cottons are from a hybrid involving Old World cotton which arrived in the New World long before Columbus. The Bering Strait could not have been the route.

Silow 1949, 112–8. A major synthesis of the geography and cytogenetics of New World cottons. Diploid *Gossypium arboreum* came from South Asia, most likely from India, to the Americas, where it hybridized with a native diploid cotton, from which the two tetraploid domesticated species (*G. hirsutum* and *G. barbadense*) in the Americas sprang. Furthermore, it is significant that the domesticated American cottons occurred exclusively along with the same type of spindle "used by the fine spinners of Dacca muslin in India, and the looms also are identical with those used in the Old World." Those looms "involv[ed] at least eleven independent technical inventions." To him, then, "It seems most unlikely that such an assemblage of developments …, should have appeared in the New World by independent invention." He gives decisive arguments why chance transfer by seed floating from Asia to the Americas is not an acceptable explanation. Only one American species (of eight wild species), *G. raimondi*, has characteristics of the subsequent hybrid-domesticated, tetraploid cottons. And *raimondi* is limited to northwestern South America, which must then be the home of the earliest tetraploid hybrid. The most plausible explanation is the transference of the Asiatic diploid (linted) parent by humans across the Pacific Ocean.

Stephens 1971,401–15. Wild cottons existed on all continents with suitable climates. If seeds could thus be naturally carried [*sic*], then presumably natural means could also have carried cultivated species [not so, Stephens, 1947, himself argued]. Moreover, the Spaniards and other discoverers in the Pacific islands quickly spread cottons, further complicating a reading of history from distribution. Difficulties in reliable identification of cotton varieties from archaeological materials are also discussed. In two situations, the Cape Verdes and the Marquesas, the presence of wild cottons of American origin suggests human transmission in pre-Columbian times, although the evidence is not conclusive.

Stephens 1963,1–22. Wild *G. hirsutum*, scattered in southern Polynesia, was much more recent. It is difficult to account for its disjunct distribution (Caribbean, Central America, and South Pacific) by ocean drift alone. Possible it was brought by Spanish expeditions some of which actually planted cotton. [But what could be the source in the Americas from which they picked up *tomentosum*; there is no trace of it as such anywhere on the mainland; since genetically it has characteristics like *hirsutum* and *barbadense*, it appears to have descended from the ancestral tetraploid in parallel with the latter two; see Wendel, Schnabel, and Seelanan 1955.]

Stephens 1947, 431–2. It is believed that South America was where chromosomes doubled to produce the American forms. *G. tomentosum* in Hawaii is the only remaining proposed endemic cotton in Polynesia after eliminating those of the Marquesas, Fiji, and Galapagos. (Those three are actually {descended from}American cottons, he had noted.) A chance crossing by air or ocean currents is possible but seems unlikely over such immense distances as would be required. Cotton seed loses viability quickly in moist air. And *Gossypium* does not survive in the wild [taken to mean that domesticated species do not, as far as he knows, survive as the same species in the wild]. The facts all suggest that American cottons may have been used by man at their outset and not independently developed from wild ancestral species.

Johnson 1975, 340. The data indicate that *G. barbadense* (AADbetaDbeta) originated in northern South America from *G. herbaceum* x. *G. raimondii* and that the cultivated races of *G. hirsutum* represent various degrees of introgression involving *G. barbadense* and the Mexican *hirsutum* complex.

Schwerin 1970. A possibility is that Africans were blown to the New World between 8000 and 5700 BC and brought cotton. [Date is highly doubtful for cotton in West Africa. No agriculture is known to have existed anywhere near either date.]

Lathrap 1977, 713–51. Proposes that West African fishermen were carried to sea to Brazil by 16,000 years ago, bringing with them *Lagenaria*, fish poisons, watercraft, two-toned log signalling, and cotton. [There is no sign of *Lagenaria* use in Africa at that date.]

Sauer 1988, 229. It is "generally accepted" that the common polyploid species of *Gossypium hirsutum* originated in the Pleistocene by hybridization on tropical American seacoasts between native diploids and an African diploid whose seeds had dispersed by ocean currents. [Such a position is not "generally accepted." *Cf.* Silow on *G. arboreum* as the Asian diploid source. There is no direct evidence that it was in existence in the Pleistocene, at least not in Africa. And if the D-genome came from Africa, how did it meet up with *G. raimondi*, which is in North<u>west</u> South America. Further, if the hybridization took place in the Pleistocene and dispersal was by oceanic drift, why did tetraploids not float to all other continents in the intervening millennia?]

MacNeish and Smith 1964, 675–6. Cotton finds are so early from the Tehuacán Valley that the idea of importation by human voyaging is unacceptable. [? In any case, the dates there may not now be as old as originally claimed. *Cf.* Long *et al*. 1989.]

Mellén B. 1986, 134. References have been made to cotton being on the (Easter) Island. That is an error, coming from a statement in a letter that spoke of a plant fiber (*háu*, or *mahúte*) being used somewhat <u>as if</u> it were cotton.

Wendel 1989, 4132. Current classifications recognize approximately 42 species, comprising either 5 or 6 tetraploid taxa and about 36 diploid species divided into 7 cytogenetic groups or 'genomes.' Asian/African diploids, *Gossypium arboreum* L. and *Gossypium herbaceum* L., differ from the New World tetraploids *G. barbadense* L. and *G. hirsutum* L. Pioneering cytogenetic investigations by Beasly and others demonstrated that the New World tetraploid cottons are allopolyploids containing one genome of the Old World diploids (the A-genome) and one genome similar to those found in New World diploids (the D-genome). This textbook example of allopolyploid speciation has been studied and corroborated from many perspectives (citations on all points). "Yet, the identity of the ancestral parental taxa remains unresolved. *G. raimondii* is considered by most authors (but not all) as the likely D-genome donor. There is also uncertainty regarding the identity of the A-genome donor. *G. herbaceum* is slightly more congenial in that role. The tetraploids are highly heterogeneous *inter se*, including *G. tomentosum* (Hawaii), the species from the Galapagos (*G. darwinii),* and other specimens from the Pacific islands, Central America, tropical South America, and the Caribbean. The literature contains a plethora of scenarios concerning the time and place of origin of the tetraploids (one of those cited is that of Hutchinson, Silow, and Stephens). Here, he re-examines the evolution of tetraploid cottons using new DNA data. Table 1 gives taxa and other info on multiple specimens from 17 species examined in the study. 4135. Concludes that the chloroplast genome of New World tetraploid *G.* is derived from an Old World diploid cotton. Time involved: views have ranged widely from Cretaceaous, arising from separation of continents, to suggestions of very recent origins in archaeological times involving transoceanic human transport (citing Hutchinson *et al*. and Johnson 1975). Only came up with 12 mutations out of a total of 3920 restriction sites assayed among 7 species of A-genome and tetraploid cottons. This suggests that the initial hybridization and polyploidization events that led to the evolution of tetraploid cotton were "relatively recent." 4134. The data they obtained are interpreted as evidence that the ancestral plastid donor of tetraploid cottons was a plant with a chloroplast genome that is similar to present day Old World cotton. He cannot determine whether *G. arboreum* or *G. herbaceum* was more likely. 4136. Time [based solely on the apparent mutation rate]: "Perhaps within the last 1–2 million years."

Newcomb 1963, 42–4. C. Sauer's observations here are based mainly on Hutchinson *et al*.'s work at the Empire Cotton Growing Corporation Cotton Research Station, Trinidad. *Gossypium* goes back into the Tertiary, with species in North and South America, Australia, and Africa. The three groups each have distinctive chromosome patterns and shapes: American, Australian, and African. All wild spp. are lintless. Linting came from (with?) domestication. How did man become interested in it? The Australian *Gossypium* is not exploited. African strains—*G. arboreum* and[/or] *G. terrestrium* are the progenitors of cultivated Old World cottons. But the Africans are not cotton growers, even in Ethiopia (until late). Species taken into Asia and India were developed into Old World diploids but with unblemished African ancestry.

(Newcomb cont'd.) The American wild cotton that qualified to hybridize to produce later cottons looks to be in the Peruvian highlands, namely the diploid *G. raimondii*. Found in lower valleys on the west coast from Trujillo northward. It is not an escaped cotton. Mexican cotton is ancestral to most of today's cottons. Polynesian cottons: the plant found in Tahiti is [closest to] *G. barbadense* (*i.e*., South American). Hawaiian is of Mexican, not South American, ancestry. It was formed by the introduction of a *hirsutum* strain out of Mexico. This has bothered S.G. Stephens no end, for how are we to account for this distribution; by a Spanish vessel shipwrecked in Hawaii? Hutchinson is also puzzled by it. A stray Manila galleon? But a ship returning from Manila to Mexico would be unlikely to have Mexican cotton seed aboard. Besides, Hawaii is far from the usual route. Galapagos cotton is *barbadense* type and almost lintless.

Roys 1931, 282. "Taman. *Gossypium herbaceum*, L." [*sic*.; probable error]

Johnson and Decker 1980, 249–307. 250. "Unless data are incomplete, Polynesian *vavae* to *vavai* are lacking in Melanesia and Micronesia." Stephens (1963) and Fryxell (1965) both "pointed to the presence of indisputably wild and probably indigenous species scattered across the Pacific from the Galapagos to northern Australia and Saipan." Summarize three points from Stephens [from which St.] who concluded that the wild *Gossypium* species were known to and effectively used by Polynesians before the arrival of Europeans. 251–2. Austroasiatic languages farther west in mainland Southeast Asia do provide proto-forms for *vavae/vavai* that are reflected in the languages of Ceram and Polynesia. (See their Table 2). 256*ff*. The Relationship between Austronesian, Austroasiatic, and Indo-European Words for "Cotton": A Case for Affinity.

(Johnson and Decker, cont'd) 288. Amerindian Words for Cotton. "… the semantic set for 'cotton' in 'cloth' or 'weaving,' as of 'cotton' and 'hemp' (*maguey*), the forms appear to be very similar to the South Indian *bat-pat* and Austroasiatic *baç-paç* (Crau, Table 5) forms for 'cloth' that were particularly connected with 'cotton'. (Table 35)." The table cites Amerindian forms for 'cotton.' From Goajiro (Arawak), Jicaques (Honduras), Arawak, Tlappanecan, Inca, Kayuvava (Bolivia), Pochutla (Oaxaca), Mexican, Timote (Paez), Maku (Brazil), and Arawak. Table 35 on p. 289 lists South American Indian Forms for 'Cloth' (but includes Otomian, Xinca, Miskito, as well as "Proto-Amerindian and Fox." Table 36 is also on p. 289: American Indian Proto-Forms Connected with the Spinning of Thread (Chipaya of Bolivia, Uru-Chipaya, Chol, Yunga, and Proto-Mayan). "Inasmuch as we have previously argued a possible connection between 'grass' (*i.e*., as 'cane,' 'reed,' 'bamboo') in the fiber set for 'cordage' and also in tools for weaving, we encounter a remarkable similarity between the forms for 'cotton' in connection with 'hay,' 'grass,' and 'down,' and those for 'fire' [because, as shown earlier, cotton was used for 'wick'.], "particularly found in North American Indian languages" (see Table 38 on p. 290: Dakota-Teton, Ponca, Osage, Pilox (?), Oto, Siouan, Arawakan). Also on p. 290 is Table 37: Additional American Indian Forms for 'Cloth' and 'Cotton' (for Tzeltal, Paez, Proto-Amerindian, Proto-Arawak, Proto Piro-Apuriná, Culina, Proto-Tacanan, and Amahuaca). On p. 291: Table 39: Forms for 'Cane' and 'Loom Comb' in South America (includes Proto-Aztecan, Zoque-Mixe, and languages from Honduras and Brazil-Uruguay). Table 40: American Indian Forms for 'Cloth,' 'Thread,' 'Kindle' (includes Quechua, Inca, Atakapa-Chitimacha, Mexico, Fox, Miskito, Coeur d'Alene, Shoshone). 293. Wild *hirsutum* varieties [rather *barbadense*, probably?] that resemble their Central American and Caribbean relatives are known from the South Pacific part of Polynesia, Melanesia, Micronesia, the Sulu Islands, south coastal New Guinea, northern Australia, and in the Indian Ocean as far west as Madagascar. The lexical evidence we have summarized suggests that knowledge of cotton predates European influence in the Pacific islands cultures that did not spin or weave, and farther west, knowledge of cotton predates introduction of cotton-weaving [assumed to be] over 2000 years ago."

Gossypium arboreum or *herbaceum*

Origin: Old World

Summary: In order to account for the genetic history of American cottons, by any scenario, one or the other of these Old World diploids (there are arguments for each) must have been transported to the Americas to provide the D-genome that was in all succeeding tetraploid American species.

Transfer: Asia to Tropical America (preferentially northwest South America).

Time of transfer: Guesses range from 1–2 million years ago to agricultural times. We consider the scenarios that depend upon purely natural means of transfer (ocean drift) of domesticated cotton to include fatal flaws. We accept as most credible the original reasoning of Hutchinson *et al*. to the effect that human beings from South Asia must have sailed across the Pacific bringing about the first A-genome-to-D-genome transfer, *ca*. the 4th millennium BC.

Grade: A minus

Sources: *Gossypium arboreum* or *herbaceum*
See material in *Gossypium* spp. in general.

Gossypium barbadense

Origin: South America

Summary: (1) This species is credited as the genetic source of the cottons that were discovered on several Polynesian islands. The explanation must involve transfer of *G. barbadense* from the American mainland (it was on the coast of Peru by ca. 2500 BC) to one or more of the islands of Polynesia where it suffered mutation sufficient to set it apart (at least) subspecifically from *barbadense*. (2) Hillebrand found in Hawaii not only cottons (*G. tomentosum* and *G. drynarioides* and perhaps his *"G. peruvianum")* that are or could be derivative from *G. barbadense*, but *G. barbadense* itself, he says. If not post-Cookian, that find might be the result of transfer of *barbadense*, directly from the continent and recognizably like that species on the mainland. (3) Additionally, the presence in India of *G. barbadense* with a Sanskrit name (Chopra *et al*. 1956, 127; Torkelson 1999, 1745) indicates the actual transfer of the American tetraploid across the Pacific to the land whence it's A-genome ancestor probably came long before.

Case 1: Transfer: Americas to Polynesia
Time of transfer: pre-Columbian
Grade: A

Case 2: Transfer: Americas to Hawaii
Time of transfer: pre-Columbian
Grade: incomplete

Case 3: Transfer: Americas to India
Time of transfer: before AD 1000
Grade: B

Sources: *Gossypium barbadense*—(syn. *G. vitifolium*)

Langdon 1988, 329. Fuentes, a botanist, spent a year on Easter Island in 1911 and reported finding a few "isolated and semi-wild specimens" of this cotton (1913, 325, 334). The first missionary (*ca*. 1800) in the Marquesas found cotton (which proved to be of American tetraploid ancestry). The first visitors to Tahiti found cotton there too. (It too proved to be of American ancestry).

Sauer 1993, 101. The oldest cotton textiles in South America, presumably made from *G. barbadense*, are from 3600 BC at Quiani in the northern Chilean desert. On the Peruvian coast, *G. barbadense* also enters the archaeological record from the pre-agricultural fishing village of Huaca Priéta, Peru. Cotton bolls from about 2500 BC in northern Peru show transitional forms between the wild [?] forms and the improved cultivar forms." [Note that the actual radiocarbon date at Huaca Priéta for the plant layer is 2578–2470 BC, according to Yen (1963), which calibrates to 3200–3070 BC.]

Shady 1997, 18. Great amounts of cotton (considered *G. barbadense*) were grown at the site of Caral, 2700–2000 BC.

Langdon 1982,179. Hutchinson, Silow, and Stephens (1947) claimed that Marquesan and Society Island cotton was a variety of *G. hirsutum*. Langdon now points out that that is probably incorrect; the Pacific forms are from *G. barbadense*, whose center of distribution is Ecuador. Wild forms derived from that species are in the Galapagos Islands. [Hillebrand (1888, 51) referred to "*G. religiosum*, L., which grows on the islands of the Society group." (Kew: *religiosum*, syn. *barbadense*). Kew also calls it "*G. Tahitense*, Parlat." But that variety (?) is not found in Hawaii.] [Kew: *G. tatlense* (Ins. Tahiti). I consider this spelling to be a scribal error for *G. tahitense*, perhaps from the days of handwritten records at Kew.] 183–7. Langdon explains why he concludes that "a wild form of a cultivated New World cotton was present in only two Pacific groups—the Marquesas and Society Islands—when European contact began in the 18th century. But there is some evidence that it might have been growing on Easter Island." [This, Mellén B. denies.]

Stephens 1971, 406–8. Explains why the seeds of wild cottons could easily be dispersed by natural means, while the seeds of the cultivated forms would be far less likely to survive exposure to seawater because the seed fibers of the latter are aggregated into "compact locks" which greatly reduce their natural portability. Stephens felt that such portability was minimized to the point that only human carriage of cultivated cottons was feasible. But would birds carry cotton seeds? 181. Sauer reported that birds of the area he studied do not eat cotton seeds [that should be simple enough to determine for anywhere else, since there are few, if any, species of birds that fly the several thousand miles from the cotton-growing portion of the mainland to a Polynesian island.] Furthermore, cotton seeds of domesticated species stay buoyant for no more than about 1000 miles.

Wendel, Schnabel, and Seelanan 1995, 298–313. In another clade, *G. barbadense* (Bolivia, Peru) and *G. darwinii* (one of two species from Galapagos) are immediately related and both relate at further genetic distance to *G. hirsutum* (Mexico) and *G. tomentosum* (Hawaii).

Towle 1961, 64–5. The cotton used to make string, from pre-ceramic Huaca Priéta, is considered one of the earliest cultivated *barbadense* cottons. [Note that the actual radiocarbon date at Huaca Priéta for the plant layer is 2578–2470 BC, according to Yen (1963), which calibrates to 3200–3070 BC.)

Hillebrand (1888, 50–1) reports that besides *G. tomentosum* and *G. drynarioides*, "there are or have been in cultivation [in Hawaii] *G. barbadense*, L., with its smooth-seeded variety, the Sea-Island Cotton" and also *G. peruvianum*, Cav." [Since Hillebrand worked less than a century after Capt. Cook's discovery of the islands and was meticulous in attending to when plants arrived, it is questionable that he is referring unwittingly to the post-Cook-imported *G. barbadense*.]

Chopra *et al*. 1956, 127. Sanskrit: *maghani* (*G. barbadense*)

Torkelson 1999, 1745. Sanskrit: *maghani* (*G. barbadense*) [Note: This Sanskrit name, which is reported specific to *G. barbadense* would seem to indicate that the American tetraploid, *G. barbadense*, made the trip back across the Pacific to India. But this would have had to be while Sanskrit was an active language, no later than *ca*. AD 1000 and probably much earlier.]

See also material under under *Gossypium* spp. in general.

Gossypium brasiliense Macfadyen

Origin: South America

Summary: Were it not for Brown's puzzling report (just below under sources), we would ignore *G. brasiliense* as being simply a subspecies of *G. barbadense*. But if Brown intended that this odd, distant, South American cotton species was transferred to the Marquesas Islands in pre-European times, it becomes of interest and possibly of some moment. We need to know more, of course.

Grade: incomplete

Sources: *Gossypium brasiliense*

Brown 1935, 177. *Re*. Marquesas. [This species is]"Indigenous to Tropical America; widely cultivated in the Tropics; of late introduction in the Marquesas. The native name is *uru* in Nukuhiva." [What is intended by his expression "late introduction?" His monograph typically discusses native fauna, not obvious imports of modern times.]

Burkill 1966, I, 1124. *G. brasiliense*, Macfad., was found in Brazil, both in a wild state and in cultivation, by the early European voyagers. Watt (Wild and Cultivated Cottons of the World, 1907, 296) gives quotes on this species, beginning with Jean de Léry, who went to Brazil with a French Huguenot colony in 1557, 1126). Some botanists claim that *G. brasiliense* should be classified under *G. barbadense*. (Fryxell 1973, 91–2). Fryxell gives, authoritatively, *G. barbadense* Linnaeus var. *braziliense* (Rafinesque) Fryxell.

See also material under *Gossypium* spp. in general.

Gossypium drynarioides

Origin: Hawaii (?)

Summary: This species has not previously been connected with American cotton, but, given the presence in the Hawaiian Islands of *G. tomentosum*, with its tetraploid genetic structure, as well as other cottons of eastern Polynesia that are American-derived, we infer that the source for *G. drynaroides* is not likely to be anything but American, although it may refer to an episode of voyaging to Hawaii distinct from those involving other American cottons.

Obviously more information is needed, but the question of the source of *G. drynarioides* should not just be ignored**.**

Grade: incomplete

Source: *Gossypium drynarioides*—a cotton

Hillebrand (1888, 50–1) reports this as "truly indigenous," along with *G. tomentosum*, in Hawaii. It was imperfectly described by Seeman from a specimen in the British Museum collected by Nelson, the companion of Capt. Cook. Hillebrand's specimens of this came from R. Meyer, who discovered three trees of *G. drynarioides* (12–15 feet height) on the western end of Molokai. Native name: *Kokio*. Hillebrand found a variant of this species (two surviving trees only) on the eastern end of Oahu in cattle-grazing territory; fearing that they would be destroyed, he took other specimens on the big island of Hawaii.

Gossypium gossypioides

Origin: Mexico

Summary: This species, confined to a limited area in Oaxaca, Mexico, provides in its ribosomal DNA internal transcribed spacer (ITS) region "robust" evidence of phylogenetic placement of its ITS sequence as a member of the African clade of cottons. *G. gossypioides* may be implicated in the initial polyploidization of the A-genome and D-genome that was ancestral to American cultivated cottons. The notion that this presence of the African ITS sequence in Mexico was purely a result of natural means of transport of an African cotton which reached (only) remote Oaxaca we find utterly incredible. Its presence can be explained more economically by supposing that transoceanic voyagers brought the cotton that contained the D-genome. This agrees with significant cultural data supporting the proposition that a transfer of Old World elements to southern Mexico took place at some early historical moment.

Transfer: to Old World (Asia or Africa)

Time of transfer: pre-Columbian

Grade: B

Sources: *Gossypium gossypioides*— a cotton

Wendel, Schnabel, and Seelanan 1995, 298–313. The New World allopolyploid (AD-genome) cottons originated through hybridization of ancestral diploid species that presently have allopatric ranges in Africa and Asia (the A–genome) and the American tropics and subtropics (the D-genome). Phylogenetic analysis of sequence data from the ribosomal DNA internal transcribed spacer (ITS) region … reveals two strongly supported clades, one corresponding to African species and the other containing all American D-genome species except *Gossypium gossypioides. G. gossypioides* is narrowly distributed in Oaxaca. 308. "The central observation of this study is the unexpected phylogenetic placement of the *G. gossypioides* ITS sequence as a member of the African clade" (this is a "robust result"). 309. Their favorite proposal to account for the data and relationships places the introgression (via hybridization and recombination with an A-genome ITS sequence) as having taken place in the American tropics, perhaps in the vicinity of the state of Oaxaca, Mexico. 310. One might suggest that introgression took place as recently as during the last several thousand years, subsequent to the origin of domesticated *G. hirsutum* and its spread into Oaxaca, but they view this as unlikely. Alternatively, it could have happened prior to domestication. [But how then would the Africa-to-America transport—to Mexico, not, say, Brazil—be accounted for? Since the cotton that contained the original D-genome from which American tetraploids sprang probably had an African beginning, although perhaps shaped in Asia as *G. herbaceum* enroute, it might have been transported across the ocean either from Asia or Africa.]

Wendel *et al*. 1995, cont'd. 298, abstract: Probably the preferred explanation for their data "involves an ancient hybridization event whereby *G. gossypioides* experienced contact with an A-genome … as a consequence of hybridization with a New World allopolyploid and repeated backcrossing of the hybrid into the *G. gossypioides* lineage." They suggest that this process may implicate *G. gossypioides* rather than *G. raimondii* as the closest living descendant of the ancestral D-genome parent of the allopolyploids. 306. Fig. 5 is a descent tree based on the three most-parsimonious trees from analysis of *G*. ITS sequences. Among relevant data shown in this manner: *G. gossypioides* is basally related to the clade including *G. arboreum* (Asia) and *G. herbaceum* (South Africa and India), but also *G. mustelinum* (northeast Brazil) is closely related to those two. In another clade, *G. barbadense* (Bolivia, Peru) and *G. darwinii* (one of two species from Galapagos) are immediately related and both relate at further genetic distance to *G. hirsutum* (Mexico) and *G. tomentosum* (Hawaii).

Zeven and de Wet 1982, 194. It crosses poorly with most of the species of the D genome. However, it is similar to the pattern of *G. klotzschianum* (a cotton from the Galapagos).

Foster 1992b. "… The Mixe-Zoque languages of southern Mexico (which includes the area where *G. gossypioides* grows) … are demonstrably closely related to, and probably descended from, ancient Egyptian." "An … Egyptian influence in the New World is very probable … perhaps introduced through successive oceanic crossings." (*Cf*. Foster 1992a, 1998).

Xu 1998, 2002. Gives specific inscriptional evidences that Chinese arrived by sea in the Isthmus of Tehuantepec area, near where *G. gossypioides* grows.

Gossypium hirsutum

Origin: Mexico
Summary: Stephens presents historical information demonstrating that this American tetraploid must have reached West Africa before Columbus in order to have shown up historically in the Cape Verde Islands by 1466.
Transfer: Americas to West Africa and the Cape Verde Islands
Time of transfer: no later than AD 1466
Grade: B plus

Sources: *Gossypium hirsutum*—a cotton
Johnson 1975, 340. Using 50 collectons of the commonly recognized tetraploid New World cotton species, *G. barbadense*, *G. hirsutum*, and *G. tomentosum*, from South and Central America, the Caribbean and Pacific Islands, they gave identical seed protein electrophoretic patterns. Among 44 collections of the Mexican tetraploid *G. palmerii*, included in *G. hirsutum*, 6 gave patterns like that of the recognized species, while 38 gave a uniform but different pattern. Other indigenous Mexican cultigens suggested that *G. hirsutum* may have originated from more than one primary amphiploid including *G. palmeri*. Transitional forms between indigenous cultigens and the cultivated *G. hirsutum* are abundant in southern Mexico, and intermediate forms between *G. hirsutum* and *G. barbadense* are widespread under cultivation. The data indicate that *G. barbadense* (AADbetaDbeta) originated in northern South America from *G. herbaceum* x *G. raimondii* and that the cultivated races of *G. hirsutum* represent various degrees of introgression involving *G. barbadense* and the Mexican *hirsutum* complex. 297. “Out of the Americas several tetraploid species have dispersed from time immemorial.” Noteworthy are the varieties *G. hirsutum*, which occur as far west as Madagascar. Their occurrence west of Polynesia before 1700 is suspected but not confirmed by existing evidence.
Pickersgill and Heiser 1978, 825. In the Tehuacán Valley from about 5000 BP [species assumed; it is nowhere specified in the source].
Brücher 1989, 151–2. Relative similarity of *G. vitifolium* and *G. hirsutum* Lam. leads him to treat them together. The two taxa can be distinguished by presence or absence of “fringed hairs” surrounding the floral nectary. *G. vitifolium* does not have them. 152. *G. vitifolium* is generally called *G. barbadense* by archaeologists. Var. *darwinii* of *G. vitifolium*, found on the Galapagos. 153. *G. hirsutum* had main range on eastern coast of South America, Caribbean islands, and Central America. Pickersgill *et al.* (1975) found a “wild cotton in Northeast Brazil,” raising again the old question whether *G. mustelinum* Miers and Watt, which had been collected in 1838 in the state of Ceara as a “wild species,” and 100+ years later was described as tetraploid *G. cicoense*, may be a real ancestor in the evolutionary history of the tetraploid cottons. It has an AADD-genome. Pickersgill *et al.* conclude it is perhaps genetically descended from both *G. hirsutum* and *G. barbadense*.
MacNeish, Nelken-Turner, and Johnson 1967, 191. Found this plant dated to before 5000 BC in the Tehuacán Valley of Mexico. (Some of the early dates from their studies have now been called into question; Long *et al*. 1989.)
Stephens 1971, 413–4. The Cape Verde Islands were discovered around 1460, at which time there were no signs of former habitations. By 1466 cottons from Guinea had been introduced and had already become semiferal. During the subsequent colonial period, cotton was collected in the wild and also grown under primitive cultivation for export. Modern botanists have found it growing feral in arid areas of most of the islands. It is a New World cotton, *G. hirsutum*, var. *punctatum*. If these feral cottons today are descended from the cottons introduced from Guinea between 1462 and 1466, then New World cotton must have been established in Africa approximately thirty years before Columbus’ first voyage. Of course we do not know where today’s feral cottons came from. [But] one would not expect the original, well-established feral form to have disappeared completely.
Chopra *et al*. 1956, 127. “Cultivated in India” (meaning only modern?)
See also the material under *Gossypium* spp. in general

Gossypium religiosum, Roxb.

Origin: of genetic affiliation from *G. barbadense*, *i.e*., American ancestry

Summary: Hillebrand reported *G. religiosum* in Hawaii, while Roys gives it for the Yucatec Maya ("*Gossypium religiosum* L Algodon sagrado {Standl.; Gaumer.}"). The specificity of these designations invites, or demands, more careful study of the facts behind them.

Grade: incomplete

Sources: *Gossypium religiosum*—a cotton (Kew. syn. *G. barbadense*)

Hillebrand (1888, 51) seems to give this as (?) equivalent of *G. tomentosum*, yet notes that "*G. religiosum*, L., which grows on the islands of the Society group," differs in specified ways. "This form (*G. Tahitense*, Parlat.) has not, to my knowledge, been found on our group [Hawaii], although Mann (Enum. no. 43) enumerates it, besides *G. tomentosum*." Referred to "*G. religiosum*, L., which grows on the islands of the Society group." Kew also calls it "*G. Tahitense*, Parlat.," which is not found in Hawaii.] [Incidentally, Kew. *G. tatlense* (Ins. Tahiti) we consider a scribal error for *G. tahitense*, probably from the days of handwritten records at Kew.]

Roys, 1931, 311. Mayan word "*zooh*. *Gossypium religiosum* L. Algodon sagrado. (Standl.; Gaumer.)" Reported from the suburbs of Merida. ("Millsp. I, 377.")

Langdon 1982,179. Hutchinson, Silow, and Stephens (1947) claimed that Marquesan and Society Island cotton was a variety of *G. hirsutum*. Langdon now points out that that is probably incorrect, that the Pacific forms are *G. barbadense*, whose center of distribution is Ecuador. Wild (meaning feral—it is a tetraploid) forms of it are found in the Galapagos Islands.

Gossypium tomentosum

Origin: Hawaii

Summary: This species occurs only in Hawaii but is genetically grouped with American tetraploid cottons. It must be descended from *G. hirsutum* or from the original American tetraploid (now extinct), and its germ plasm must have been carried by voyagers; we consider transmission by purely natural means to such a small island target not to be credible (there is no credible evidence—only speculation—of oceanic drift from the Americas to any other Pacific islands).

Transfer: Americas to Hawaii

Time of transfer: pre-Columbian

Grade: B

Sources: *Gossypium tomentosum*

Johnson and Decker 1980, 250. "Unless data are incomplete, [forms connecting] Polynesian *vavae* to *vavai* are lacking in Melanesia and Micronesia." Stephens (1963) and Fryxell (1965) both "pointed to the presence of indisputably wild and probably indigenous species scattered across the Pacific from the Galapagos to northern Australia and Saipan." Johnson and Decker summarize three points from Stephens from which Stephens concluded that the wild *Gossypium* species were known to and effectively used by Polynesians before the arrival of Europeans. 251–2: Austroasiatic languages farther west in mainland Southeast Asia do provide proto-forms for *vavae/vavai* that are reflected in the languages of Ceram and Polynesia. (See their Table 2). 256*ff*. Section entitled, The Relationship between Austronesian, Austroasiatic, and Indo-European Words for "Cotton": A Case for Affinity.

Johnson and Decker cont'd. 288. Amerindian Words for Cotton, " … the semantic set for 'cotton' in 'cloth,' or 'weaving,' as of 'cotton' and hemp' (maguey), the forms appear to be very similar to the South Indian *bat-pat* and Austroasiatic *baç-paç* (Crau; see Table 5) forms for 'cloth' that were particularly connected with 'cotton'. (Table 35)." The table cites Amerindian forms for 'cotton.' From Goajiro (Arawak), Jicaques (Honduras), Arawak, Tlappanecan (Mexican), Inca, Kayuvava (Bolivia), Pochutla Oaxaca), Mexican [presumably Náhuatl], Timote (Paez), Maku (Brazil), and Arawak. Table 35 on p. 289 lists South American Indian Forms for 'Cloth' (but includes non-S. American Otomian, Xinca, Miskito as well as 'Proto-Amerindian and Fox.'). Table 36 on p. 289: It lists American Indian Proto-Forms Connected with the Spinning of Thread (includes Chipaya of Bolivia, Uru-Chipaya, Chol, Yunga, and Proto-Mayan). "Inasmuch as we have previously argued a possible connection between 'grass' (*i.e*., as 'cane,' 'reed,' 'bamboo') in the fiber set for 'cordage' and also in tools for weaving, we encounter a remarkable similarity between the forms for 'cotton' in connection with 'hay," 'grass,' and 'down,' and those for 'fire' [because, as shown earlier, cotton was used for 'wick'], "Particularly found in North American Indian languages" (see Table 38 on p. 290 {Dakota-Teton, Ponca, Osage, Pilox (?), Oto, Siouan, Arawakan). Also, on p. 290 is Table 37, Additional American Indian Forms for 'Cloth' and 'Cotton' (for Tzeltal, Paez, Proto-Amerindian, Proto-Arawak, Proto Piro-Apuriná, Culina, Proto-Tacanan, and Amahuaca). 291. Table 39, Forms for 'Cane' and 'Loom Comb' in South America (Proto-Aztecan, Zoque-Mixe, and languages from Honduras and Brazil/Uruguay). Table 40, American Indian Forms for 'Cloth,' 'Thread,' 'Kindle' (Quechua, Inca, Atakapa/Chitimacha, Mexico, Fox, Miskito, Coeur d'Alene, Shoshone).

Johnson and Decker, cont'd. 293. Wild *hirsutum* varieties that resemble their Central American and Caribbean relatives are known from the South Pacific part of Polynesia, Melanesia, Micronesia, the Sulu Islands, south coastal New Guinea, northern Australia, and in the Indian Ocean as far west as Madagascar [not documented]. "The lexical evidence we have summarized suggests that knowledge of 'cotton' predates European influence in the Pacific islands cultures that did not spin or weave, and farther west, knowledge of 'cotton' predates introduction of cotton-weaving over 2,000 years ago." 297. "Out of the Americas, several tetraploid species have dispersed from time immemorial. Noteworthy are the varieties *G. hirsutum*, which occur as far west as Madagascar. Their occurrence west of Polynesia before 1700 is suspected but not confirmed by existing evidence."

Stephens 1963, 1–22. Wild *G. hirsutum*, scattered in southern Polynesia, was much more recent. It is difficult to account for its disjunct distribution (Caribbean, Central America, South Pacific) by ocean drift alone. Possible it was brought by Spanish expeditions some of which actually planted cotton.

Stephens 1947, 431–2. *G. tomentosum* in Hawaii is the only remaining proposed endemic cotton in Polynesia after eliminating those of the Marquesas, Fiji, and Galapagos. (Those three are actually American cottons, he notes.) A chance crossing by air or ocean currents is possible but seems unlikely over such immense distances as would be required. Cotton seed loses viability quickly in moist air. And *Gossypium* does not survive in the wild [meaning that domesticated *hirsutum* and *barbadense* do not?] The facts all suggest that American cottons may have been used by man at their outset and not independently developed from wild ancestral species.

Johnson 1975, 340. Using 50 collections of the commonly recognized tetraploid New World cotton species, *G. barbadense*, *G. hirsutum*, and *G. tomentosum* from South and Central America, the Caribbean and Pacific Islands, gave identical seed protein electrophoretic patterns. Among 44 collections of the Mexican tetraploid, *G. palmeri*, included in *G. hirsutum*, 6 gave patterns like those of the recognized species, while 38 gave a uniform but different pattern. Other indigenous Mexican cultigens suggested that *G. hirsutum* may have originated from more than one primary amphiploid, including *G. palmeri*. Transitional forms between indigenous cultigens and the cultivated *G. hirsutum* are abundant in southern Mexico, and intermediate forms between *G. hirsutum* and *G. barbadense* are widespread under cultivation. The data indicate that *G. barbadense* (AADbetaDbeta) originated in northern South America from *G. herbaceum* x *G. raimondii* and that the cultivated races of *G. hirsutum* represent various degrees of introgression involving *G. barbadense* and the Mexican *hirsutum* complex.

Johnson cont'd. 348–49. The proposed polyphyletic origin does not minimize the difficulty of accounting for the presence of *G. tomentosum* in the Hawaiian Islands. But, in the course of a tetraploid history of more than 4,000 years, it is not impossible for that species to have been transported from the Mexico/Central American area with the aid of man or ocean currents. Opponents of the concepts of an agricultural origin of the tetraploids point to the difficulty of explaining how Old World cotton could have been transported to the New World in prehistoric times, and to the illogic of assuming that man would have brought cotton but not his basic food plants (citing Purseglove 1968). [But these arguments are moot as of the year 2000.] This study sheds no light on these questions.

Wendel 1989, 4132. The tetraploids are highly heterogeneous *inter se*, including *G. tomentosum* (Hawaii), the Galapagos (*G. darwinii*), other specimens from other Pacific islands, Central America, tropical South America, and the Caribbean.

Newcomb 1963, 42–4. Based mainly on Hutchinson *et al*. researching at Empire Cotton Growing Corporation Cotton Research Station, Trinidad. Concerning Polynesian cottons: The Tahitian plant is *G. barbadense*. The Hawaiian is of Mexican, not South American, ancestry. It was formed by introduction of a *hirsutum* strain out of Mexico. This has bothered S.G. Stephens no end, for how are we to account for this distribution, he asks, by a Spanish vessel shipwrecked in Hawaii? Hutchinson is also puzzled by it. A stray Manila galleon? But a ship returning from Asia would be unlikely to have Mexican cotton aboard. Besides, Hawaii is far from the Manila route. Galapagos cotton is *barbadense* type but almost lintless.

Fosberg (1951, 204–206), *contra* Silow's statement that *G. tomentosum* of Hawaii is closely related to cultivated cottons, Fosberg finds little similarity.

Langdon 1982, 189. *G. tomentosum* is a problem entirely unrelated to the cotton of the Marquesas. 186. Cotton spread in colonial times from the Society Group to Rarotonga and then to Samoa, Tonga, Niue, and then Futuna and Wallis Islands.

Heyerdahl 1964, 124. The American cottons, including the Polynesian, are the only tetraploids in the entire cotton genus. On genetic grounds, therefore, Hutchinson, Silow, and Stephens (1947) were forced to suggest that the linted cotton had necessarily reached Polynesia "since the establishment of civilization in Tropical America." Sauer showed in 1950 that birds do not eat *Gossypium* seeds, while cotton is most unsuited to long dispersal by sea. In his last publication before his death, Merrill wrote: "That there were occasional and accidental associations between the peoples of Polynesia and America, and even occasional ones between the American Indians and the eastern Polynesian islands, actually must be accepted … " (1954, 190). "We may admit … that natives of South America may have reached some of the Pacific islands on balsa rafts" (Merrill 1954, 242).

Silow 1949,112–8. This Hawaiian wild tetraploid can be explained only as derived from American cotton "which reached Hawaii only after the establishment of civilization in Tropical America" being "perhaps a degenerated escape from early attempts at cultivation [in Hawaii]."

Stephens 1963, 1–22. The earliest introduction was *G. tomentosum*, which came into the Hawaiian Islands, most likely by oceanic drift (perhaps on a 'natural island' of vegetation such as a mass of trees), where it became endemic. [Sorenson observes: Such "islands" could come only from the temperate American coast (northern California or farther north), where alone there was sufficient biomass to form a jetsam "island," but no cotton grew there. The arid coast of most of western Mexico would not yield "a (floating) mass of trees" of the type hypothesized by Stephens.]

Hillebrand 1888, 50–1. Reports this cotton along the seacoast here and there on all the Hawaiian islands. Native names: *mao* and *huluhulu*. Occurs also in Fiji. "The species is unfit for cultivation on account of the short staple" (although it is a tetraploid).

Burkill 1976, I, 1120. In a way that is interesting phytogeographically, Pacific species are attached to the American group.

Helianthus annuus

Origin: Americas

Summary: Art of India represents the sunflower blossom in a context that signifies the sun's cyclic, calendrical significance. This plant was mentioned in a Hindu text prior to AD 400 and also had a pair of Sanskrit names.

Transfer: India from Americas; thence elsewhere in Asia

Time of transfer: possibly by the beginning of our era or soon after

Grade: A

Sources: *Helianthus annuus*—sunflower

Lentz *et al.* 2001. Review of all known early American specimens of *H. annuus* shows that the earliest domestic sunflower was growing in Tabasco by around 2600 BC.

Patiño 1964,179. This involves the difficulties of constructing a history of plants using common names. Since *girasol* and *heliotropo* were plants known to the Europeans before the discovery, it is not possible to know, for example, to what species Oviedo might have referred when he mentions in the Indies "*tornasol, girasol* o *helitoropia*" (citing Oviedo 1851, I, 375).

Nadkarni 1914,177–8. *Helianthus annuses* (*sic*) (*i.e.*, *annuus*). Sanskrit: *suriya-mukhi*.

Pullaiah 2002, II, 282. Sanskrit: *adityabhakta, suryamukhi*. Medicinal uses.

Aiyer 1956, 67. The sunflower, *H. annuus*, is mentioned in the Hindu *Charaka Sahmita* dated no later than the 4th century AD.

Torkelson 1999, 1749. Sanskrit: *suriya-mukhi*

Chopra *et al.* 1956, 131. Sanskrit: *surya-mukhi*. "A native of America."

Johannessen and Wang Siming 1998, 14–6. Carvings of sunflowers are found on the same Indian temples where maize is shown in the sculpted decoration. The representation of sunflowers can be readily distinguished from those of the lotus flower. They also almost always relate to solar directions. For example, sunflowers are carved on the heads of statues of Nandi, the bull, which is Lord Shiva’s transport, or signature, at the entrance to the interior holy of holies in Shiva temples. The sunflowers are placed in a fashion such that the rising sun passes over the sunflower carving so as to illuminate the statue of Shiva beyond, within the inner sanctum, for a few minutes on solstitial, equinoctial, or half- or quarter-term dates. Sunflower carvings also exist at the feet of the gods and goddesses who hold maize ears. Moreover, a carving on a stone pillar of a temple shows a parrot perched on a sunflower seed head in a position as if it had just eaten the several seeds that are visibly missing from the edge of the seed head.

Addendum by Johannessen, 2004: At the Gaviganga Deschvara temple in Bangalore, Karnataka State, a sunflower symbol is etched on the back wall in the garden, where it is aligned at equinox sunset with another sunflower image carved into the door sill at the holy of holies of the temple.

Gupta 1996, 86. Sunflowers are native to Central and South [*sic*] America but have been cultivated in India “from very early times,” which is proved by a graphic depiction of the plant in flower in the Rani Gumpha cave, Udaigiri, dated to the 2nd century BC (see her plate 29). The panel shows a hunting scene. On the extreme right is a breadfruit tree, and a woman has climbed it out of fear. The sunflower plant with five large capitula can be seen on the right of the hunter. The variety of the sunflower floral heads depicted is the large type where the plant reaches a height of 5–6 metres and the capitula have a circumference up to 80 cms. In plate 104, the panel from Sanchi shows a bunch of sunflower capitula, or some other member of the same family, that resembles a sunflower present between two mythical animals. The capitula appear to be of *Helianthus* and the panel is purely decorative. One of the best depictions of the sunflower capitula is from Sanchi (her plate 222), showing a pastoral scene with parrots, buffalos, a mango tree, grapes, a *kadamba* tree, and on the extreme left are three large capitula of a sunflower.

Heyerdahl 1986, 2, 176. He found what he considers images of sunflowers and other sun symbols carved on pre-Islamic worked stones in the Maldives. They are situated precisely at the equator, which he considers significant.

Watt 1888, IV, 209. The genus has no species indigenous to India. Two, however, are much cultivated, and are very important economically. One is *H. annuus*, Linn. Names: Sanskrit: *Suria-mukhi*; Hind.: *Surajmúkhí*.

Balfour 1871–1873, II, 492. Sanskrit: *suria mukhi* is the sunflower.

Brücher 1989, 118. Soviet agrobiologists found so much variation in sunflowers in the USSR that they claimed a “secondary centre of variability” there. [Implies long presence of the plant.]

Johannessen, personal observation, 2003. The variation in DNA in sunflowers in Russia and Turkey has a distribution that is different by at least a standard deviation from the wild and cultivated sunflowers from the Americas. In China, the size of the seed is significantly larger than almost all commercial sunflowers of the U.S. Both these phenomena point to substantial age for adaptation since *H. annuus* was introduced into Asia.

Heliconia bihai

Origin: Americas
Summary: By the Age of Discovery this species was found spread to Pacific Islands.
Transfer: Pacific islands from the Americas
Time of transfer: pre-Columbian
Grade: B

Sources: *Heliconia bihai*—platonillo, balisier

Cook 1903, 490. *H. bihai*, the leaves of which are used for plaiting, is somewhat similar to banana but without an edible fruit; it reached the islands of the Pacific in prehistoric times and is now found, though no longer cultivated, in New Caledonia. This prehistoric transfer was recognized by Schumann and Lauterbach (1901, 224).

Newcomb 1963, 41. Used for flowers and shade leaves. A relative of the banana. Origin: the Americas. Also in the Pacific islands. Was it carried thence by Spaniards, who had no interest in it, to islands which they never saw?

Heyerdahl 1964, 127. Natives of the West Indies and into South America use the starchy rootstocks of this plant for food, and the leaves served for roof- and wall-thatch, as well as for making hats, mats, and baskets. Baker showed that this plant was native to Tropical America, and that the Pacific island *Heliconia* appeared to him to be only a cultivated form closely related to the Mexican and Peruvian species. Cook (1903, 490) supported Schumann, who inferred a prehistoric introduction of this American plant to the islands: "Though no longer cultivated by the Polynesians, it has become established in the mountains of Samoa and in many of the more western archipelagoes. In New Caledonia the tough leaves are still woven into hats, but the *Pandanus*, native in the Malay region, affords a better material for general purposes and has displaced *Heliconia* in cultivation among the Polynesians."

Bailey 1935, II, 1450–1. There are perhaps 35 species in Tropical America. Many additional species are being described from Tropical Asia [as of 1935]. *H. bihai*, Linn. is called *balisier*, or 'wild plantain.' "It is naturalized in the Old World tropics and is the parent of many horticultural forms …."

Hibiscus tiliaceus

Origin: China

Summary: A name in Sanskrit seems to place it in India perhaps two millennia ago. China is credited as its place of origin. Yet it was widespread in the Americas. It was also cultivated in pre-European Polynesia. Its uses are similar in both the Americas and Polynesia, and vernacular names are rather similar, enough so that we consider human transfer the preferred scenario.

Case 1: Transfer: Asia to the Americas (? or possibly vice versa)
Time of transfer: pre-Columbian
Grade: B

Case 2: Transfer: Americas to Polynesia (? or possibly vice versa)
Time of transfer: pre-Columbian
Grade: B

Sources: *Hibiscus tiliaceus*—linden hibiscus, beach hibiscus

Heyerdahl 1963a, 482–5. Gives a rounded summary of the evidence in the literature, pro and con, regarding *H. tiliaceus* as a transfer between the Americas and Oceania.

Heyerdahl 1964, 129. *H. tiliaceus* has seeds adapted for natural dissemination by sea, yet it is discussed due to its deliberate cultivation in Polynesia, combined with data from linguistics. Cook and Cook (1918, 156) discussed it thus: "Though many botanists have written of the *maho* as a cosmopolitan seashore plant, its wide dissemination may be due largely to human agency, as with the coconut palm." In Middle America, it is widespread, even a dominant species in many localities, [southward] to the banks of the Guayaquil River, where it was used by natives for bark-cloth manufacture, to make water-resistant cordage and strings, and for kindling fire. Both the special uses and names of this plant were much the same among the Polynesians. In Tropical America, the tree was known as *maho*, or *mahagua*, or something close to that, while in Polynesia it was known as *mao*, *mau*, *vau*, *fau*, *hau*, or *au*. Cook and Cook (169) say: "Though considered a native of America, the *maho* appears to have been distributed over the islands and shores of the Pacific and Indian oceans before the arrival of Europeans." "The names of the *maho* afford almost as definite indications of human contacts as in the case of *kumara* [*i.e*. the sweet potato]." "The making of fire by friction of wood, and of cloth by beating the bark of trees with grooved mallets, are specialized arts which may have been carried with the *maho* from the Americas across the tropical regions of the Old World" [*Cf.* Tolstoy on the bark cloth/paper complex?]

Whistler 1991, 64–5. Because of its seawater-dispersed seeds, it is probably native over most of its range, but because of its great utility, the tree may have been introduced [by humans] to much of Polynesia (especially Hawaii).

Carter 1950, 164–5. Recapitulates Cook's arguments for, and Merrill's arguments against, the idea that this plant was human carried. Contra Merrill, Carter concludes that "man carried the name for the plant and quite possibly the usages across the … seas. It even seems probable that he carried the plant also."

Cook and Cook 1918, 156. *H. tiliaceus*, while capable of natural dissemination by sea, had both particular uses and names in common between Polynesia and Middle and South America. (Merrill rejects the argument from names.)

Torkelson 1999, 1752. Sanskrit: *bala*

Chopra *et al.* 1956, 134. Sanskrit: *bala.*

Pullaiah 2002, II, 289. No Sanskrit names given.

MOBOT 2003. A native of China according to the Flora of China.

Hibiscus youngianus

Origin: Hawaii

Summary: This species is confined to Hawaii but is said to be closely related to the Middle and South American species, *H. bifurcatus*, from which it may be derived. More information is needed to clarify a possible transfer.

Grade: incomplete

Sources: *Hibiscus youngianus*—a hibiscus (Kew. {apparently confined to} Hawaii)

Hillebrand (1888, 47, 49) says this plant occurs in marshes and abandoned taro patches here and there on all Hawaiian islands. Native name: *akiohala*. The plant "Is nearly [*i.e.*, closely] related to the American *H. bifurcatus*, Cav." Hillebrand considered it part of the pre-European flora. *H. youngianus* was commonly found in old planted areas on all the Hawaiian islands, suggesting that it was dependent on ecological disturbance owing to horticulture.

Miranda 1952–1953, Pt. I, 184. *Hibiscus bifurcatus* Cav. Found in the high tropical forest of Chiapas, Mexico.

MOBOT 2003. *H. bifurcatus* is distributed in Middle and South America.

Indigofera suffruticosa

Origin: Asia, ultimately (depending on synonymy, which apprears confused by some sources)

Summary: This case is of interest only if *Indigofera anil* is synonymous with *I. tinctoria*, which is not certain to us but might possibly be.

Grade: Incomplete

Sources: *Indigofera suffruticosa* (=*I. anil*) (Kew =*anil*=*guatemalensi*=*tinctoria*)—indigo

Townsend 1925. *Indigofera anil* is only a derivative from the Indian *I. tinctoria* introduced into the Americas some 2,000 or 3,000 years ago. The habits of the American form indicate that it is not native.

Towle 1961, 46. This plant is a source of the añil of commerce, obtained primarily from *I. tinctoria* of Asia and *I. suffruticosa*, a native of the American tropics. Wittmack (1888, 347) states that in pre-Columbian times, Peruvians used as a dye indigo obtained from a wild species ordinarily designated as *I. anil*.

Langdon 1988), 185. A 1767 visitor to the Marquesas reported the presence of cotton and also of the plant "indego." Marquesan cotton turns out to be of American derivation (*i.e. Gossypium barbadense*).

McBryde 1945, 143. The origin of American indigo (both *Indigofera suffruticosa* and *I. guatemalensis* are used) is probably Mexican. An Old World species was later introduced (*I. tinctoria*) and is much used today.

Roys 1931, 238. "*Choh* (the first 'h' has a line through the upper stem=explosive 'ch'). *Indogofera anil*. L."

Jett 1998, 143. Indigo has been identified at Nazca, Peru, in the 7th century B.C. and at Paracas Necropolis, *ca*. 450–175 B.C. At least three other species are used to produce indigo dye: *Fuchsia parviflora*, *Cybistax antisyphilitica*, and *Muehlenbakia hastiuta rupestris* (*mullaka*) (citations given).

Indigofera tinctoria

Origin: Asia

Summary: Arnold presents a comprehensive case for the introduction of *Indigofera* on the west coast of Mexico two or three thousand years ago. However, he does not provide clear evidence on any area from which such a transfer might plausibly have come. He assumes that the introduced plant, *I. tinctoria*, gave rise to the New World *I. Anil*, but the evidence is not strong. In the case of the Marquesas, a slim case can be made that an *Indigofera* plant may have been transferred from the Americas.

Case 1: **Transfer**: Oceania or Asia to Americas
Time of transfer: two millennia ago?
Grade: C

Case 2. Transfer: Americas to the Marquesas Islands
Time of transfer: pre-Columbian
Grade: incomplete

Sources: *Indigofera tinctoria*—indigo (Kew. syn. *añil*, syn. *guatemalensis*, syn.? *tinctoria*)

Townsend 1925. (American) *Indigofera añil* is only a derivative from the Indian *I. tinctoria* introduced into the Americas some 2,000 or 3,000 years ago. The habits of the American form indicate that it is not native. (Caution: Townsend reveals in his article considerable botanical naivete.)

Towle 1961, 46. This plant is a source of the añil of commerce, obtained primarily from *I. tinctoria* of Asia and *I. suffruticosa*, a native of the American tropics. Wittmack (1888, 347) states that in pre-Columbian times, Peruvians used it as an indigo dye obtained from a wild species ordinarily designated as *I. añil*.

Langdon 1988, 185. A 1767 visitor to the Marquesas reported the presence of cotton and also of a plant, "indego." [Where did they come from? From the Americas is more plausible than from anywhere else, especially since Marquesan cotton proves to be genetically descended from American *G. barbadense*.]

Jett 1998, 143. Indigo has been identified at Nazca, Peru (7th century BC), and at Paracas Necropolis (*ca*. 450–175 BC).

Chopra *et al.* 1956, 141. Sanskrit: *nilika*. Widely cultivated in India.

Torkelson 1999, 1759. Sanskrit: *nilika*

Int. Lib. Assoc. 1996, 567. Sanskrit: *nili*

Pullaiah 2002, II, 305. Sanskrit: *nilini, nilika*, comon indigo

Zeven and de Wet 1982, 174. *Indigofera añil* (syn. *suffruticosa* Mill.). Center of maximum gene diversity is in South America.

MOBOT 2003. *I. tinctoria* (syn. *indica*)

Arnold 1987, 53–84. Compares the morphology of the *Indigofera* plants in the Old and New World and finds great similarity between them. They have the same number of chromosomes, which suggests a common origin. The introduction of the genus *Indigofera* must have occurred in the zone where the largest number of species pertaining to this genus are found. Michoacán possesses 11 species and Guerrero 10, while Brazil and the U.S. have only 4 species. These data support the thesis of a marine introduction of indigo in the west of Mexico, someplace in Guerrero or Michoacán, several millennia ago. A voyage by sea between Asia and the American coasts, some 5,000 or 6,000 years ago, seems improbable given the developmental level of that period, but recent studies have found human inhabitation of Australia since at least 32,000 years ago, which makes the time of possible marine voyaging much earlier than had been thought.

See also the data from Heyerdahl (1996) below under *Mangifera indica*.

Ipomoea acetosaefolia

Origin: Tropical America
Summary: It was in Hawaii before European discovery of the island.
Transfer: Americas to Hawaii
Time of transfer: pre-Columbian
Grade: B minus

Source: *Ipomoea acetosaefolia*—(Kew. syn. *carnosa*)

Hillebrand 1888, 314. Native of West Indies, Guiana, or Brazil. Hillebrand considers this plant of pre-Cook age in Hawaii.

Ipomoea batatas

Origin: South America

Summary: In addition to archaeological evidence recapped here that shows that the sweet potato spread from the Americas to Polynesia, apparently two separate times; a variety of other evidence—linguistic and historical—confirms that position. Further, a document puts the plant in China in early AD times, and Sanskrit names are recorded confirming such a date for South Asia.

Case 1: **Transfer**: Americas to Polynesia via Hawaii
Time of transfer: AD 400–700
Grade: A

Case 2: **Transfer**: South America to Polynesia via Easter Island
Time of transfer: early AD centuries
Grade: A minus

Case 3. Transfer: Americas to Asia
Time of transfer: early AD centuries
Grade: A

Sources: *Ipomoea batatas*—sweet potato

Brücher 1989, 5. The claim for a South American center of origin is supported more by archaeological and historical evidence than by botany. Fossil *batatas* from the cave, Puna de Chilca in Peru, have been dated by Engels at 10,000 BP. There are no wild-growing plants [known] in South America that could be ancestral. "The hypothesis of a Central American origin has a weak basis." [No source or supporting evidence is cited for this statement.]

Patiño 1964, 62. Lengthy list with references to native South American names of sweet potato. Gives *cumara*, *cjumara*, *cumal*, *comal*, names used in certain sectors of the Peruvian and Ecuadorian Andes for one variety of sweet potato.

Langdon 1988, 326, 333. Reporting the first lengthy visit to Easter Island, in 1770. A lengthy survey of chroniclers' references indicates *I. batatas'* presence.

Shady 1997, 18. *I. batatas* remains have been excavated at two Late Archaic (3000–1500 BC) sites on or near the coast of Peru.

Shady *et al.* 2001, 725. The phenomenal city of Caral in the Supe Valley of Peru, radiocarbon-dated between 2627 and 2020 BC (calibrated), yielded remains of *Ipomoea batatas* among other domesticated plants.

Bronson 1966, 262*ff*. McQuown and Kaufmann have reconstructed ten plant names apparently present in proto-Mayan in the 2nd millennium BC. Among them is sweet potato.

Rensch 1991, 108. Linguistic study of the names for sweet potato result in "the hypothesis that the sweet potato reached Polynesia at least twice: once via a northern route through Hawaii under the guise of **kuara*/**kuala*, and once via a southern route under the guise of **kumara*, with Easter Island as its point of entry." In both places, a great number of varieties of sweet potato is attested, "pointing to the antiquity of cultivation."

Yen 1974. Tests three hypotheses for the distribution of the sweet potato in the Pacific. On the basis of his especially comprehensive investigation of sources for plant history, he concludes that the plant was probably transfered from South America to Polynesia between 400 and 700 AD.

Brand 1971, 343–65. An extensive review and critique of the literature. He maintains that mistaken identification of plants by early explorers in the Pacific makes unreliable the common conclusion that the sweet potato was present in Polynesia before Spanish transfer of the plant from South America. He also claims that the name *kumara* in Ecuador was known only in the highlands and that only if we had the name attested on "the coast" could he accept that name in relation to the Polynesian name [lexicons surviving for coastal tongues are almost nil; moreover the "highlands" are less than 60 miles from the coast].

Langdon and Tryon 1983, 40–1. Early explorers did not record existence of sweet potato in Western Polynesia. No evidence suggests that it had arrived in Western Polynesia in pre-European times, while certain evidence strongly suggests that it had not. For example, it has no place in traditional ceremonies in Tonga, and there are no local names for varieties of it.

Heyerdahl 1963, 29. It was cultivated under the aboriginal name of *kumara* in the Urubamba Valley of Peru, a Cuzco variety was known as *cusi-kumara*, and in various parts of early Peru the name of this plant has been recorded as *kuymar*, *kumar*, *cumar*, *umar*, and *kumal*. It was grown in highland Ecuador under the name of *cumar*, and in Colombia as *umala* and *kuala*, the latter name extending as far north as the Cuna language. Cites on this Markham, Seemann, Hillebrand, Middendorf, Cook, Imbelloni, Hornell, Merrill, and Bingham. (A majority of these were not cited by Brand.) Dried tubers have been excavated from early tombs in coastal Peru, including Paracas.

Johannessen and Wang Siming 1998, 27–8. Douglas Yen in a personal communication (1996) acknowledges that the sweet potato has the same name in Sanskrit as in northwestern South America.

Herbert Baker (1971) acknowledged the pre-Columbian presence of the sweet potato in Asia but thought it of limited consequence.

Murdock 1959, 217–18. In reconstructing the culture history of Madagascar, the author notes that the Malaysian food complex (rice, taro, bananas, yams, manioc, sugarcane, and sweet potato) is basic to agriculture in much of central Africa. Plants of American origin are also of much or considerable significance (manioc, maize, peanuts, haricot and lima beans, pumpkins, and tobacco). 222–3. Indonesian ancestors of the later Malagasy of Madagascar immediately preceding or following the time of Christ introduced the Malaysian plants on the Azanian coast—Kenya, Zanzibar. (The plants are referred to as being there in the document, *The Periplus of the Erythraean Sea*, dated AD 60). They became basic to agriculture across Central Africa ("the Yam Belt") all the way to the Guinea Coast.

Here, Murdock explodes a 'bombshell'—he asserts that the sweet potato was part of this Malaysian food complex and quickly diffused across the continent to West Africa. Murdock knows about the American origin of the sweet potato. Furthermore, the distribution of the sweet potato in many parts of West Africa coincides in distribution with other American root crops, notably malanga (arrowroot) and manioc, so as to suggest that it arrived with those others (via the Portuguese or Spaniards). He is also aware of the controversy over the question of the spread of the sweet potato from South America into Polynesia and Melanesia "as far west as New Guinea, where it has long been established as the staple crop in the mountainous interior." But most authorities have supposed it did not reach Indonesia or the Philippines until the beginning of the colonial period. If the sweet potato actually arrived in East Africa across the Indian Ocean along with bananas, sugarcane, taro, and yams, then 'its transpacific spread must have taken place very much earlier than even the most uninhibited theorists have as yet dared to assume." We are quite sure, on linguistic grounds, that the Indonesian source for the voyages to Malagasy, and the resulting terminology, was Borneo, where the sweet potato could have joined the Malaysian food complex. Murdock is reluctant to accept such an early date for the spread of sweet potato westward across the Pacific as this implies, but feels the evidence must be faced. He also notes that in societies in the area (Africa) who segregate their crops into groups with differential ritual associations, sweet potatoes receive the same ceremonial treatment as plants that were unquestionably introduced across the Indian Ocean and are differentiated in this ritual respect from other crops that were brought to Africa by Europeans. Incidentally, he further observes, among the Chaga, near Mt. Kilimanjaro, the only other American crop of consequence is maize, and this falls into the most recent grouping of crops in terms of ritual treatment.

Fage 1961, 299–309. In general, he believes that Murdock handles the sources of Africa inappropriately. He gently refers to Murdock's dogmatism and lack of experience of Africa (309). 308. In regard to the date of the Indo-Malaysian crop complex arriving in East Africa, Murdock depends upon the *Periplus of the Erythraean Sea*, but, Fage says, the *Periplus* is not an easy document to interpret. "It is not easy to be categorical about what crops were and were not cultivated in eastern Africa at this time."

Newcomb 1963, 42. Murdock's African hypothesis is off base in respect to this plant, C. Sauer feels.

Merrill 1954. The sweet potato must have been transmitted (from South America) consciously and with much care, in fact it would have been packed in soil in order to remain viable on a voyage to Polynesia from South America.

Mellén B. 1986, 131. Easter Island: *kumára*. At least 20 varieties existed according to Metraux. [This degree of differentiation either required a long period of cultivation on the island or else the importation of varieties from other islands.]

Darlington 1973, 147. While some species of *Ipomoea* are distributed by sea, the hexaploidy of *I. batatas* in both Peru and Polynesia makes its identification more certain and demonstrates "the spread of the sweet potato from Peru to Polynesia, a spread which proves the meeting of Old and New World Peoples …."

Roys 1931, 249. "*Iz*. *Ipomoea batatas*, L. [Mayan] Camote."

Evans 1998. In the process of sailing a replica Polynesian canoe from the Society Islands to New Zealand, the crew (following tradition) took with them several varieties of sweet potatoes which they presented ceremonially in the next group visited, and then received a new set of varieties when they set sail for the next destination.

Yen 1998, 168. In table: "Easter Island—early AD, burnt tubers," citing Hather and Kirch 1991,169. They also present arguments for the sweet potato in the New Guinea highlands before European contacts. 170. On lexical grounds, Scaglion and Soto (1994) have questioned the acceptance of the supposed AD post-1500 introduction from the west into New Guinea. The presence of the word *kumara* and cognates in southeastern islands of New Guinea is treated as a separate set of terms for the plant, implying diffusion from Polynesia. 173–4. Quotes from Quiros, pilot on the 1595 Mendaña voyage from Peru to the Marquesas. He said they (Spaniards) sowed maize, beans, onions, cotton, and "all the most profitable seeds and vegetables." [That is not how a Spaniard would have referred to the sweet potato in the 16th century. Besides, even if the sweet potato should have been among crops planted, would any of Mendaña's transplants have survived without knowledgeable care until the late 1,700s when the Gonzalez expedition next reports their presence?]

Brown 1935, 238–9. Five varieties were once grown, "none of the varieties originating under cultivation in the Marquesas was of good quality … and it seems clear that, although the sweet potato was one of the earliest food plants to be cultivated in the Marquesas, it was poorly adapted to the soil, climate, topography, and related conditions."

Barthel 1971, 1165–86. An Easter Island text deciphered by him refers to an ancient directional model of their world that included a "path of the sweet potato" (from the east) and a "path of the breadfruit tree" (from the west). These directions of course correspond to the directions of botanical origin of the plants.

Bretschneider (1882, 38) lists plants in the Chinese document *Nan fang Ts'ao Mu Chang*. The author was Ki Han, a Minister of State in the Tsin (Jin) Dynasty, AD 290–307, who had previously been a Governor of Canton. The 80-species list includes: Banana, *Canna indica*, Sweet-potato (*Batatas*), and Coconut. Bretschneider 1892, 418. Japanese source [Matsumura] gives (Chinese) characters for the name of the sweet potato [it might not be of pre-Europea date, however].

Chopra *et al*. 1956, 141. Hin. and Pun.: *shakar kund*

Aiyer 1956, 71. Sanskrit: "*Valli* (*Ipomoea batates*?)" The sweet potato was mentioned in the Hindu record known as *Silappadikaram*.

Pullaiah 2002, II, 307. Sanskrit: *pindalah*, *raktaluh*. Medicinal uses.

Sauer 1993, 39–41. Purseglove (1968) suggests the introduction of *I. batatas* to Polynesia came by natural dispersal: seeds are viable for more than 20 years and impervious to salt water; the seeds are not buoyant but the capsule is. "I doubt that the seedlings could survive in the drift zone on an ocean beach, but conceivably capsules could have been picked up by some Polynesian beachcomber or seeds might have germinated along the banks of a tidal estuary." [Is there any field evidence in support of this speculative notion?]

Kelley 1998, 73. A name for sweet potato among Chibchan speakers of Colombia or Panama precisely matches the Hawaiian spelling of the name.

Lagenaria siceraria

Origin: Hemisphere of origin uncertain

Summary: The bottle gourd is apparently in evidence in both hemispheres; from early in the Holocene, *i.e*., probably in the pre-agricultural era (13,000 BP in Peru, 9,000 or 10,000 BP in Mexico, 10,000 BP in Thailand), so perhaps the fruit drifted one way or the other across the ocean. However, it is now clear that the species did not occur in western Polynesia, although in eastern Polynesia the bottle gourd was abundant. This distribution makes sense only if human-aided transfer took place into eastern Polynesia from the Americas.

Transfer: South America to eastern Polynesia

Time of transfer: pre-Columbian
Grade: B plus

Sources: *Lagenaria siceraria* (syn. *vulgaris*)—bottle gourd

Whistler 1990, 1991. He reinvestigated the identification of supposed bottle gourds in western Polynesia at the time of first European contact and found that the species was actually absent from those islands, although in eastern Polynesia it is common. This absence of specimens from western Polynesia of course casts doubt on a drift hypothesis (eastward from Asia via Oceania to the Americas) to account for *L. siceraria* in the New World. In his judgment, “The most likely hypothesis is that it was introduced [by voyagers] to eastern Polynesia from South America.”

Whitaker and Carter 1954, 697–700. *L.* Experimentation by Whitaker demonstrates that the gourd could possibly have been distributed to the New World without the aid of man, but there is no proof that this happened. [This experiment to assess the duration of viability was carried out in a tank that probably lacked the ocean boring-worms and other potential sources of damage that would be found in the open sea.]

Nadkarni 1914, 213. *Lagenaria vulgaris*. Sanskrit: *alâbu*. Eng.: bottlegourd. Found wild and cultivated nearly all over India.

Pullaiah 2002, II, 323. Sanskrit: *kutukumbi*. Medicinal uses.

Nayar and Singh 1998, 3. *Lagenaria siceraria* dates to earlier than 10,000 BP in both Peru and Thailand.

Yarnell 1970a, 225. *L. siceraria* dated to 5000 BP in Peru; 7500 in Southern Mexico; 9000 in Northern Mexico.

Camp 1954. Summarizes the results of experimental studies of the viability of drift specimens of bottle gourd. The possibility of a gourd remaining viable after extended floating at sea remains inconclusive. He believes that while there is some possibility that a gourd might have crossed from Africa and might have sprouted on shore in the Americas, there would still be no satisfactory explanation for how the offspring could become established in the plant’s normal habitat inland.

Sauer 1993, 51–2. (Syn. *leucantha, biconurta*). The species was taken eastward from India bearing a Sanskrit name into Malaya and the East Indies. It was in China by AD 100. “Comparative studies show that New World bottle gourd cultivars are derived from the African subspecies, not from *asiatica.* The puzzle of how *L. siceraria* arrived in the New World was solved long ago by Whitaker and Carter, Sauer asserts, citing their 1954 publication. Suspecting that the species had been introduced by ancient seafarers, they experimented with flotation of gourds in seawater to see if the possibility of natural dispersal could be excluded. Unexpectedly, they found the gourds could float and retain viable seed for many months, no limits being established, time enough for westward drift from Africa to Tropical America, or eastward drift in high latitudes to the Pacific coast of South America. [This is an inaccurate summary of their actual findings, as Carter (1953) makes clear.] … The likeliest hypothesis [though purely speculative] is that drift gourds were found by ancient beachcombers, carried inland out of curiosity, and that volunteer seedlings came up in kitchen middens and other artificial habitats.” The species was taken eastward bearing a Sanskrit name into Malaysia and the East Indies. It was in New Guinea by 350 B.C. and China by 100A.D. Use and cultivation of *Lagenaria* spread prehistorically through the Pacific islands all the way to Hawaii.” [Western Polynesia is left without specific reference.]

Carter 1953, 62–71. The bottle gourd could have floated to South America from Africa, but it would progressively have lost fertility under attack by boring worms and microorganisms, making sprouting on the strand unlikely.

Patiño 1964, 244. *Lagenaria siceraria* is one of three plants (the others are the coconut and cotton) which surely were present in the inter-tropical area of the world, on more than one continent, at the European discovery of the Americas. Some have suggested sea transport of the seeds from Africa; however, the gourd was unknown in the Antilles or in eastern South America, but did appear on the Pacific side. [The plant’s absence from the Antilles casts doubt on even the supposition of viable drift seeding from the mainland to those Middle American islands.]

García-Bárcena 2000, 14. *L. siceraria* dates in Tamaulipas and Oaxaca from 7000 BC.

Langdon and Tryon 1983, 37. Almost invariably in Eastern Polynesia the name for gourd is *húe*. But in 1770, Easter Island had *geracona*, gourd. [This suggests a separate introduction to Easter Island?]

Lathrap 1977, 713–51. Proposes that West African fishermen were swept out to sea from Africa to Brazil by 16,000 years ago, bringing the gourd and other features. [There is no evidence of the cultivation of gourds, or any other plant, nor of fishing boats, anywhere near that date in Africa.]

Towle 1952,171–84. Her study of seeds from two sites with a review of the literature on the archaeological occurrence of the gourd in Peru leads her to conclude that it is likely the gourd crossed the ocean by drift.

Roys 1931, 245. Mayan: "*Homa*. Probably a large variety of *Lagenaria siceraria*" (Molina). "The large homa is used to store food, such as tortillas and atole …." 61. "Lec. Probably *Lagenaria siceraria* (Molina)."

Mellén Blanco 1986,133. For Easter Island. This plant, called *húe*, is, without doubt, one of the two plants reported in the manuscripts as "calabaza blanca y colorada." Fuentes (1913) identified one variety as *L. vulgaris* (syn. *siceraria*) and noted that they had other *cucurbitaceae* not yet classified.

Brücher 1989, 265–6. "Biologists suppose that the fruits floated on the oceans and maintained the viability of their seeds for many months." Finds in Ocampo Caves, Mexico, at 9000 BP and the Tehuacán Valley 7500 BP is an "astonishingly early time for a cultivated plant in America." "Even if it is not very convincing that 'boat-people' from Africa brought the bottle gourd to the Western Hemisphere," he observes, "we must ask why it did not arrive before the Pleistocene if the natural dispersal of floating fruits was so easy? [And] if *Lagenaria* had in one or another way come from Africa, the puzzling question remains how it crossed the whole [South] American continent and appeared so early on the Pacific side?" Lathrap cited the caves of Pikimachay in the Ayacucho Basin (13,000 BP?) as the earliest find. [The date of 13,000 BP in Peru and 10,000 BP in Thailand (see above) would seem to place the earliest transoceanic transfer as probably too early for human intervention. Or we must extend the time of sailing by people on the oceans.]

Also, Brücher notes "the peculiar ritual importance of *Lagenaria* fruits as penis sheaths, selected for this purpose independently [*sic*] in Africa, South America, and New Guinea" (citing Heiser 1973).

Addendum: Too late to enter in detail: Carter 2002, 261-3.

Lonchocarpus sericeus

Origin: Old World

Summary: Distribution on either side of the South Atlantic of a tree that can serve as fish poison raises a question of whether transfer across to the Americas was human-aided. Only further study may answer that question.

Grade: incomplete

Sources: *Lonchocarpus sericeus* (Poir.) H.B.K. (Kew. syn. *palmeri*)

Two plants found on both shores of the South Atlantic are *Lonchocarpus sericeus* (Poir.) H.B.K. and *Serjania pinna* L. The former is listed by some authorities as an African native and by others as South American. Some writers list it as a piscicide but how it might have been transferred across the ocean remains a puzzle. Similarly ,*Paullinia pinnata*, L. requires explanation. This is used as a piscicide in South America but not in Africa, possibly because it was replaced by more toxic species. Chevalier's conclusion is that human groups use similar plants for similar purposes on both sides of the Atlantic due to "a truly marvelous genius of intuition." "But it would require much more than that to produce the same species of plant on both sides of the ocean." That must have been by floating or else by human agency. And the human agency cannot be the Portuguese or Negro slaves. (521.) (Fish poisoning had been outlawed by the Spanish king by 1453 and for the Portuguese in 1565.)

Luffa acutangula

Origin: in dispute; Old World more likely

Summary: This gourd has long been cultivated and used in both hemispheres. That there must have been a transfer is clear, and that it might have been by purely natural means is unlikely to account for the places where it is and is not grown; hence, intentional human transport is the only logical remaining explanation. (Since *L. cylindrica* definitely was transported anciently between the hemispheres by human beings, it is not unreasonable that the two closely-related species traveled together.)

Grade: B

Sources: *Luffa acutangula*—ribbed gourd
Torkelson 1999, 1776. Sanskrit: *koshataki*
Chopra *et al.* 1956, 156. Sanskrit: *rajakoshataki*
Heiser *et al.* 1989, 14–5. There are two American species: *L. acutangula* and *L. cylindrica* (the latter syn. with *L. aegyptiaca* Mill). However, Brücher (1989, 267) calls both species Old World, but in any case both have been cultivated since ancient times in the Americas as well as in Asia.
MOBOT 2003. Distribution North and Middle America and also India.
Chopra *et al.* 1958, 354–5. There are ten Sanskrit names, including those given by Torkelson and Chopra *et al.* 1956. The gourds are cultivated in most parts of India and are found growing wild in northwest India, Sikkim, Assam, and East Bengal. Seeds have medicinal value. 677. One more Sanskrit name is given.
Pullaiah 2002, II, 323. Sanskrit: *kosataki, jalini*. Medicinal uses.
Zeven and de Wet 1982, 72. *L cylindrica* was domesticated probably in tropical Asia, possibly in India, and it gave rise to *L. acutangula*.
See also the information under *L. cylindrica.*

Luffa cylindrica

Origin: Asia (others say Americas)
Summary: Extensive use in East and South Asia can be compared with a 1200 BC occurrence in an archaeological site on the coast of Guatemala that suggests transfer across the Pacific from Asia (probably coincident with other plant transfers demonstrated in the present report), without excluding possible movement in the opposite direction. Sanskrit names testify to its early presence in India at least. The apparent absence of this plant at such an early date in many other parts of both Old and New World increases the likelihood of intentional human transmission from Asia to Mesoamerica.
Transfer: Asia to Mesoamerica
Time of transfer: before 1200 BC
Grade: A minus

Sources: *Luffa cylindrica* (syn. *aegyptiaca*)—loofah, vegetable sponge, sponge gourd
Torkelson 1999, 1776. Sanskrit: *dhamargava, rajakoshataki*
Chopra *et al.* 1956, 157. *Luffa cylindrica.* Sanskrit: *rajakoshataki*
Aiyer 1956, 55. The flower (whose color was compared to that of gold) and fruit are mentioned in several Tamil sources (cited) of pre-modern age.
Watson 1868, 273. Sanskrit: *kereleh*. Hindi: *kerula.* Persian: *Luffa amara*.
Pullaiah 2002, II, 338–9. Sanskrit: *mahakosataki*, vegetable sponge. Medicinal.
Heiser (1985, chap. 2) discusses species of *Luffa* from both the Old and New Worlds, leaving a possibility open for human transmission between the two areas.
Newcomb 1963, 50. This is pretty close to being a naturalized species in the American tropics. It is a plant of the field margin, that is, it thrives in land disturbed by cultivation. It is used in its youthful form as a green vegetable, and when mature, as a cheap substitute for the bath sponge or scouring pad. How and when was this plant introduced in the Americas?
Nayar and Singh 1998, 14–5. Long cultivated in South and Southeast Asia. In Japan and China it has several medicinal uses. In Guyana it is used as a poultice, while in India it has a number of uses in Ayurvedic medicine.
Heiser *et al.* 1989, 14–5. There are two American species: *L. acutangula* and *L. cylindrica* (syn. *L. aegyptiiaca* Mill). (Brücher assigns the origin of both these to the Old World.) Vernacular names in English are sponge gourd, loofah, or vegetable sponge. Cultivated in America since ancient times. Also long cultivated in South and Southeast Asia. In Japan, an extract of the stem is used to treat respiratory ailments. There were other medicinal uses in China.
Watt 1888–1893, V, 96. *L. aegyptiaca* is a native of India and naturalized in most hot countries of the world. 94. *Luffa* "comprises ten species, natives of the warmer regions of the Old World, and one indigenous in America."

Bretschneider 1892,196–8. *T'ien kua* (sweet kua), nowadays the common name for melons, is also known as *kan kua*. Li Shizhen suggested that the *kua* mentioned in the passage from the *Li ki* [see I, 82] was a melon. He seems to be right. But as to the other quotations, we are left in doubt whether the *kua* there mentioned were melons or were what we call pumpkins, gourds, squashes, *i.e.*, species of the genus *Cucurbita*. 197. "All the cucurbitaceous plants now cultivated for food in China are probably indigenous to the country, with the exception of the cucumber and watermelon, which, as their Chinese names indicate, were introduced from the West." He gives Chinese characters for *C. moschata* and *Luffa cylindrica*, among others.

Kosakowsky *et al.* 2000, 199. In an Early Preclassic archaeological site of Pacific coastal Guatemala, pottery from the earliest levels (1200 BC) bears a secondary decoration of loofah (sponge) impressions and other impressions on the storage jars. ("Other impressions" on the pots include rocker stamping, a ceramic decoration feature shared with early East Asia.)

Brücher 1989, 267. *Luffa* spp., sponge gourd, luffa. The genus includes 6 to 10 taxa that are mostly of Old World origin, but one species, *L. operculata*, is native to the neotropics (*i.e.*, North America). Its main application is as sponges, etc. "Due to the habitual similarity of the different species which now have worldwide distribution, it is not easy to separate the different taxa." The Old World species are *L. acutangula* (L.) Roxb. and *L. cylindrica* (L.) Roem. The latter is often designated as *L. aegyptiaca* Mill.

Hernandez 1942–1946 [by 1580], I, 159. Náhuatl: *tzonayotli.*

Zeven and de Wet 1982, 72. Domesticated probably in tropical Asia, possibly in India. This plant gave rise to *L. acutangula*. Maximum gene diversity is probably in India.

Lupinus cruickshanksii

Origin: Peru (?)

Summary: The similarities between European lupines and this species of Peru invite closer investigation of their taxonomic relationship.

Grade: incomplete

Sources: *Lupinus cruickshanksii*—lupine, field lupine (Kew. *cruckshanksii* [*sic*] Peru, Chile) (syn. *mutabilis*.)

Johannessen and Wang Siming 1998, 25. Safford (see next entry) claimed that cultivated *Lupinus* plants in the New and Old Worlds are so similar that they must have been derived from the same wild species.

Safford 1917, 16. *Lupinus cruickshanksii* found in Peru bears close resemblance to *L. albus* of southern France, and another lupine from Peru is also related. "The presence of these lupines in South America, so distinct from the endemic species of that continent and so very similar to those used for food in the Old World, is of great interest to the ethnologist."

Brücher 1989, 80–81. *Lupinus mutabilis* Sweet., syn. *L. cruickshanksii* Hooker, syn. *L. tauris* Hooker. Peru: *tarhui, chocho, ullu. Leguminosae* are worldwide, with a strong background in the New World, where 200 taxa have been established. From the Old World, only a dozen species are known, the most important being *L. luteus* and *L. albus*. Cytogenetic barriers exist between the Euro-Asiatic group with 1n=50 and 52 chromosomes and the American lupines, which in general have 2n=48 chromosomes. The latter are depicted in Peruvian ceramics.

Patiño 1964, 191. Cites *Lupinus* spp. and says in the Peruvian Andes a certain people are said in a *Relación of 1586* to eat the leaves. 178–9. *Lupinus mutabilis* (Kew syn. *cruckshanski*) or *Lupinus* sp., called *tarwi,* or *tarui*, in Quechua and *chocho,* or *altramuz,* in Spanish, "because of its similitude with the European *Lupinus*." Various species of *Lupinus* are endemic in the Andean cordillera, from 1800–4000 meters. "Cobo considered the altramuz, or *tarui*, common to both continents."

Yacovleff and Herrera 1934–1935, 305. *Chochos* is the common name, for which Garcilaso gives *tarvi*;Cobo, t*arui*; and Holguín, *tarhui*. Yacovleff and Herrera identify it as *Lupinus tauris* Benth. Garcilaso says, "They have *chochos*, like those of Spain …." Cobo: "There are to be found a great abundance of wild lupines in the countryside, that the Indians call *tar-ui*." In a footnote, Yacovleff and Herrera say: "The tarwi collected by Cook at Ollantaytambo, which is very similar to *Lupinus albus* L. in Europe, Safford mentions with the name *L. cruckshanskii* (*sic*)."

Lycium carolinianum

Origin: Americas

Summary: On Heyerdahl’s authority, this plant’s occurrence on Easter Island implies transfer from South America, along with a dozen other useful species. Given the evidence from Dumont and Skottsberg of American species having reached Easter Island, we see the presence of this species on the island as unsurprising, another transplant by voyaging.

Transfer: South America to Easter Island

Time of transfer: pre-Columbian

Grade: B

Source: *Lycium caroliniamum*

Heyerdahl 1963, 28. It is the only wild Easter Island shrub, yet it is an American plant.

Lycopersicon esculentum

Origin: Americas

Summary: There are some suggestive indications that the tomato was in pre-Columbian Asia, but concrete evidence remains questionable or absent. The topic is worth further investigation, particularly in China.

Grade: incomplete

Sources: *Lycopersicon esculentum*—tomato (Kew. syn. *cerasiforme)*

Langdon 1988, 329. Thompson in 1886 found the tomato (tomatillo) growing wild on Easter Island. Langdon takes this as indication of pre-European cultivation. (This was probably {?} *Physalis peruvianum*, Langdon observes.)

McBryde 1945, 140. Both potato and tomato were domesticated from poisonous nightshades. Apparently, those (at least in Guatemala) were little developed, being only half-wild, before white men came.

Roys 1931, 217. Mayan: “*Beyan-chan*. *Lycopersicum esculentum*, Mill.” 272. “*Ppac*. *Lycopersicum esculentum*, Mill. Tomate grande.” 315. *Culub* [backwards C=tz]-*ppac*. *Lycopersicum esculentum*, Mill. Small-fruited wild form. Tomate chico.”

Bretschneider 1892, 364. List of *Solanaceae* mentioned in Matsumura (Japanese) includes *Lycopersicum esculentum*, Mill. and gives Chinese characters for a name (but the source does not make clear whether the name is of pre-Columbian date in China or Japan).

Johannessen, personal communication. He was told while visiting China of tomato seeds that had been found in a coffin in a Chinese tomb and later germinated. But seeds from the purported specimens cannot now be recovered for examination. Without reliable archaeological documentation, it remains possibe, Johannessen observes, that the seeds were an intrusion after the tomb/coffin was opened.

Brücher 1989, 277. Despite the fact that it is highly probable that the tomato descended from a gene pool of wild species in South America, “remains of the tomato plant have never been found [in Peru] nor do any reproductions exist on ancient potteries in the Andean region ….” Apparently, it was domesticated in the Mexico/Guatemala area, which is completely devoid of autochthonous wild-growing *L*. species. *L. cerasiforme* is the now-cosmopolitan ‘weed tomato’ that is a direct ancestor of our tomato by some theories, in spite of some morpho-genetic contradictions. *L. cerasiforme* has very small fruits, no bigger than a cherry; native to a narrow west coastal region of Peru. 279. There is a set of wild species from the coastal region and low Andean valleys of Ecuador, Peru, Bolivia, and N. Chile, all with green fruits when ripe. They are separated genetically from the red-fruited *Eu-lycopersicon* group, with which they do not cross. They are grown in the “Lomas,” where vegetation is limited to misty months of August to November. Another wild tomato was discovered on the Galapagos Islands, called *L. cheesmanii*. The *Eu-lycopersicon* (red) group includes *L. cerasiforme* and the cultivated *L. esculentum*.

Pullaiah 2002, II, 339. Sanskrit: *raktamachi*. (Two local names are *tamatur* and *tamata*.) [It might be speculated that *raktamachi* could have been derived from modern ‘tomato’ in recent centuries and then was somehow accepted as a Sanskrit term.]

Macroptilium lathyroides

Origin: Americas

Summary: Found as specimens in several early archaeological sites in India, these 'beans' can only be accounted for by human transport across the Pacific, along with other species of *Phaseolus* (see below).

Transfer: Americas to India

Time of transfer: before 1600 BC

Grade: A

Sources: *Macroptilium lathyroides* (syn. *Phaseolus lathyroides*)—phasey bean, phasemy bean

Smartt 1969, 452. *Macroptilium* is a distinct group within the genus *Phaseolus*, consisting of very small seeded American forms.

Pokharia and Saraswat 1999, 99. *Phaseolus* "… beans of American origin have been encountered from proto-historic sites in peninsular India." *P. vulgaris* is recorded from pre-Prabhas and Prabhas cultures at Prabhas Patan, Junagadh Dist., Gujarat, dated from 1800 BC to AD 600 (endnote 153). Also, these come from the Chalcolithic site of Inamgaon (about 1600 BC), and another site in Pune Dist., Maharashtra (endnote 54), and from Neolithic Tekkalkota (C14: 1620±108 BC), Bellary Dist., Karnataka (endnote 155). *P. vulgaris*, *P. lunatus*, and Phasey bean (*P. lathyroides*, syn. *M. lathyroides*) have also been recorded by Vishnu-Mittre, Sharma, and Chanchala (endnote 156) from deposits of Malwa and Jorwe cultures (1600–1000 BC) at Diamabad in Ahmednagar Dist., Maharashtra.

Zeven and de Wet 1982, 66. They give the name as "Phasemy bean."

Mangifera indica

Origin: Southeast Asia

Summary: This fruit was widely and early used in India and Southeast Asia. Landa apparently reports it from 16th century Yucatan, judging by the description of the fruit: yellow, soft, and sweet, "which when eaten leaves the stone like a soft hedgehog …." Tozzer notes the fit, but cannot imagine that Spaniards could have imported the tree at that early date (the only possible origin he considered). Pending more information, we consider this fruit he spoke of as likely the mango.

Case 1: Transfer: Southeast Asia to Mesoamerica

Time of transfer: pre-Columbian

Grade: C

Case 2: Transfer: Mesoamerica to Polynesia

Time of transfer: pre-Columbian

Grade: incomplete

Sources: *Mangifera indica*—mango

Tozzer 1941, 199. "Another tree [in Yucatan] bears another fruit also yellow and not as large as the other and soft[er] and sweeter than it, which when eaten leaves the stone like a soft hedgehog …." Note 1086 says, "PM suggests *Couopia dodecandra*, (DC.) Hemsl., in Maya *uzpib*. There is an Asiatic species, *Mangifera indica* L. It is evident that a foreign importation would not have been cited by Landa at the time he wrote" [*sic*]. [The description of the fruit fits *M. indica* so exactly, it is difficult to imagine the Yucatan fruit being of any other species. Had the plant resulted from Spanish importation {they do not mention any such introduction from Asia}, there would not have been time for the imported tree to have grown and multiplied sufficiently to be noticeable as a fruiting tree by Landa.]

Bailey 1935, II, 1984. The Malay Archipelago is home to nearly the entire genus. *M. indica* has been in cultivation since such a remote period that its exact origin is somewhat doubtful, but it has been considered by the best authorities to be indigenous to the Himalayan foothills of eastern India, extending possibly through Burma into the Malayan region. The genus has about 30 species, natives of tropical Asia. Allied distantly to the hog plum, cashew, and pistachio. *M. indica*; Mango. Northern India, Burma, and possibly Malaya, as noted above.

Pullaiah 2002, II, 346. Sanskrit: *amrah*, *chutah*. Medicinal uses.

Dastur n.d., 152–4. Local names: *am*, *amba*, and *ambi*. The leaves, bark, gum resin, fruit, and seed are used medicinally.

Zeven and de Wet 1982, 71. The center of maximum diversity is said to be Assam and the Chittagong Hills of India.

Heyerdahl 1996, 149–57. In the Marquesas (Hivaoa), Von den Steinen, Linton, and Heyerdahl discovered and then rediscovered large, non-Polynesian stone carvings showing long-tailed quadrupeds that could represent only some form of felid and whose nearest analogues were on the monuments of San Agustín, Colombia. He connects these representations (radiocarbon-dated by charcoal taken from under the statues at *ca*. AD 1300) with several plant species of American origin that have been identified in remote locations in the Marquesas. They can only be accounted for by the arrival of voyagers. 78. Among these species was the mango.

Sauer 1993, 17–20. Evidently domesticated in the northeastern India/Burma region. It was probably being planted in India by 2000 BC and is prominently recorded in ancient Sanskrit writings. It came to figure symbolically in Hindu and Buddhist mythology and ceremonies. Not widespread in the East Indies until after the European incursion. Earliest known introduction of *M. indica* to the New World was to Bahia in Brazil about 1700, with seed from West Africa. In 1742, it was successfully introduced to Barbados. A quite separate introduction had taken place across the Pacific from the Philippines to Mexico. Mangoes were not grown around Manila until over a century after trade with Mexico began.

Manihot sp.

Origin: South America

Summary: Manioc was observed by the earliest Europeans to examine Easter Island, and there is evidence that it may have been in use also in the Marquesas. The report of two Sanskrit names from India sheds a new and puzzling light on the plant's ancient distribution.

Transfer: South America to eastern Polynesia

Time of transfer: pre-Columbian

Grade: B

Sources: *Manihot* sp.—manioc, cassava

McBryde 1945, 139. Both varieties ("sweet" and "bitter") were used in pre-Columbian Mesoamerica.

Sauer 1993, 57. "The crop is always propagated by cuttings of the woody stems, not by seed." 59. "The first records of establishment of manioc planting in the Old World were in West Africa in the mid-17th century."

Langdon 1988, 326–8. Called *yuca* in various native languages of Peru and other Central and South American countries. Apparently, the name was derived from *mandioca*. Citing Purseglove, there is one center of speciation in Brazil and another in southern Mexico and Guatemala. It was seen in "beds" on "small plots of ground" on Easter Island in 1770 by Hervé.

Mellén Blanco 1986, 132. Hervé's *yuca*, or *mandioca*, is surely *Manihot utilissima*. Introduced into Tahiti only in the mid-19th century.

Shady 1997, 18. Remains of this plant have been excavated at the Late Archaic (3000–1500 BC) site of Los Gavilanes in the Huarmey Valley of Peru.

Ugent, Pozorski, and Pozorski 1985, 81–2. *Manioc*, a Brazilian word, was called *rumu* in ancient Peru, while Aztecs called it *guacamote*. Based on C14 assays, they now report specimens of the plant from the Casma Valley of Peru ranging in age from 1800 BC (uncalibrated) to AD 1532.

Martínez M. 1978, 111–3. Miranda (1952-1953, II, 277) reports five species for Chiapas, one being *M. esculenta*. It is eaten cooked or prepared in the form of bread. Heavy yield: 12–15 tons per hectare. He found at his site in Chiapas (1st century AD or BC) two carbonized seeds (species not known) and lots of pollen, these being the only evidence from archaeology of the use of *mandioca* in Chiapas. Lowe supposed its use anciently, based on finds of what he presumed to be obsidian grater chips.

Yarnell 1970, 225. Earliest archaeological remains: Peru, 2700 BP; Southern Mexico, 2100 BP.

Towle 1961, 132. Associated with Early, Middle, and Late Nazca ceramics (1st to 9th century AD). 61. Found in remains of Cupisnique Period (BC) on the north coast, and there was a root of *yuca* in a burial at Ancón (BC date) and another in a Paracas (also BC) grave. Many representations can be seen on effigy pots and textiles.

Bronson 1966, 262*ff*. Named in the proto-Mayan language of the 2nd or 3rd millennium BC. Among them is manioc, or *yucca*, *Manihot esculenta*, and *M. dulcis*, sweet yuca, *yuca dulce*, or *mandioca*.

Roys 1931, 225. "*Cici-cin* ['c' of second word pronounced 'tz']. *Manihot aipi*, Pohl. Yuca dulce." 314. "*Tzin. Yuca brava*." Motul dictionary: "The yucca [*sic*] from which they make cassave." Or sweet yucca.

Pullaiah 2002, II, 346–7. *M. esculenta*. Sanskrit: *darnkandah, kalpakandah*.. Medicinal uses.

Maranta arundinacea

Origin: Americas

Summary: *M. arundinacea* is an old crop in Central and South America. It was growing wild on Easter Island at the time of European discovery. It was also present in India, where it bore a Sanskrit name and was referred to in Tamil (southern India) texts long before European commerce with India began.

Case 1: Transfer: to Easter Island
Time of transfer: pre-Columbian.
Grade: B

Case 2: Transfer: to India
Time of transfer: while Sanskrit was still active
Grade: A

Sources: *Maranta arundinacea*—arrowroot

Piperno 1999, 126. Phytolith spectra from pre-7000 BP archaeological strata in Panama are revealing the presence of *M. arundinacea*. 127. Evidence is reprised supporting the hypothesis that arrowroot and other native plants, such as *Dioscorea* spp., were cultivated here before the introduction of maize.

Heyerdahl 1964, 126. This is one of the American plants present in deserted locations on Easter Island when the flora were first recorded by Europeans.

Aiyer 1956, 44. Sanskrit: *kuvai*. *M. arundinacea*, arrowroot, is mentioned in the Tamil source *Malaipadukadam*, as well as in the *Mathuraikanji* (also Tamil), long preceding Portuguese arrival.

Chopra *et al.* 1956, 162. There are names in Hin., Ben., Tam., etc. "Native of Tropical America."

Pullaiah 2002, II, 348. Sanskrit: *tavakshiri*, *tugaksiri*. Medicinal uses.

Patiño 1964, 22–23. *Sagú* is the name of *M. arundinacea* in various parts of South America. This name was originally that of a palm of the genus *Metroxylon*, native of Southeast Asia and the Polynesian archipelago. How it came to be applied to this tuberous plant of Venezuela and adjacent areas is not known.

Mimosa pudica

Origin: Tropical America

Summary: Known in India in time to receive at least three Sanskrit names, and also grown in the Marquesas Islands, apparently before those islands' discovery by Europeans.

Case 1: Transfer: Americas to India
Time of transfer: probably two millennia ago
Grade: A

Case 2: Transfer: to Marquesas from Americas
Time of transfer: pre-Columbian
Grade: B

Sources: *Mimosa pudica*——sensitive plant, humble plant

Brown 1935. Approximately 250 species, centering in Topical America. A native of Brazil. "Of early introduction in the Marquesas, where it has escaped from cultivation."

Bailey 1935, II, 2053. Probably 300 species of *Mimosas*, chiefly of Tropical America. Cultivated as an annual (at least nowadays). Brazil is the possible origin, but it is widely naturalized in warm countries.

Roys 1931. 267. [Mayan] *x-mutz*. *Sensitiva*.

Watt (1892, V, 248) calls it the "sensitive plant." Probably introduced from Tropical America; it is naturalized over most of tropical and sub-tropical India.

Pandey 2000, 271. *M. pudica*, from Brazil, is one species “naturalized throughout India.”

Torkelson 1999, 1785. Sanskrit: *anjalikarika*, *lajja*

Chopra *et al.* 1956. Sanskrit: *lajja*. Probably a native of Tropical America; naturalized more or less throughout India.

Int. Lib. Assoc. 1996, 569. Sanskrit: *lajja*

Nadkarni 1914, 233. *Mimosa pudica*. Sanskrit: *ajàlikalika, namaskâri*. Eng.: sensitive plant. A native of Brazil, has long been naturalized in India and is plentiful (as a forage crop) in the hotter regions.

Pullaiah 2002, II, 358–9. Sanskrit: *lajjalu, namaskari*. Medicinal uses.

Mirabilis jalapa

Origin: South America

Summary: At least four Sanskrit names for this flower combine with wide distribution in India to witness the fact of transfer from the Americas long ago.

Transfer: Americas to India

Time of transfer: probably at least two thousand years ago

Grade: B plus

Sources: *Mirabilis jalapa*—four o’clock (flower)

Roys 1931. 291. Maravilla, Four-o’clock. *Tzutzuy-xiu*. Its showy and fragrant flowers are closed during midday.

Hernandez 1942 [before 1580}, I, 194–5. He identifies two varieties. Very common on the Mexican Mesa Central.

Zeven and de Wet 1982, 177. South America is the center of gene diversity for this species.

Nadkarni 1914, 235. *Mirabilis jalappa* [*sic*]. Sanskrit: *sandhya-rága*. Eng.: four-o’clock flower. Found in gardens.

Torkelson 1999, 1786. Sanskrit: *krishnakeli*

Chopra *et al.* 1956, 168. Sanskrit: *krishnakeli*. Cultivated in the greater part of India.

Int. Lib. Assoc. 1996, 569. Sanskrit: *krishnakeli.*

Pullaiah 2002, II. *Ttrisandhi, krsnakeli* [*sic*], *sandhya-raga*. Medicinal uses.

Balfour 1871–1873, III, 282. Cultivated as an ornament in gardens. Not directly useful. English name is ‘Marvel of Peru.’ For Sanskrit he gives two names: *bahu-bumi*, and *sundia-ragum*. (So also Watson 1868.)

Mollugo verticillata

Origin: uncertain

Summary: Archaeological specimens provide positive evidence for ancient presence of this weed in both hemispheres.

Transfer: from one hemisphere to the other (uncertain in which direction)

Time of transfer: before Roman times at least

Grade: A

Source: *Mollugo verticillata*—carpetweed

MOBOT 2003. This plant is native to China according to *Flora of China*. Specimens in the herbarium are from North, South, and Middle America.

Chapman *et al.* 1974, 411–12. Archaeological evidence is adduced to show the presence of this weed in the eastern United States on the order of 3000 years BP. They also reprise some of the literature on its millennia-old presence in Europe. They suppose that its presence in the Americas must be connected with the agriculture of the American Indians, for the weed is garden-dependent.

Monstera deliciosa

Origin: Middle America

Summary: Temple sculptures of India establish this climbing vine from Mesoamerica as a significant element in medieval Indian art.

Transfer: India from Mesoamerica

Time of transfer: by the 11th century
Grade: A

Sources: *Monstera deliciosa* Liebm. (syn. *Philodendron pertusum* Kunth.)—ceriman
Zeven and de Wet 1982,187. Mexico and Guatemala are the center of gene diversity.
Lundell 1937, 35. *Monstera* sp. Probably the most conspicuous epiphytes of the humid shaded zone are the giant root-climbing aroids, species of *Monstera philodendron*. They completely surround tree trunks and extend from the tree bases to the crotches. Some of their leaves may reach a length of a meter or more. 54. He lists two different species found at Uaxactun, each given as only "*Monstera* sp."
Burkill 1966, II, 1515. *M. deliciosa*, Liebm. A native of Mexico, where it is wild on the western slopes of the mountains in the southern parts of the country, and is also cultivated for the sake of its delicious fruit. It has the flavor of a pineapple. Brought to Singapore (from the Americas) only in 1877.
Bailey 1935, II, s.v. *Monstera*. From Tropical America. Called ceriman.
Gupta 1996, 108–9. This is a large evergreen climber, native of Central America, but it is cultivated throughout India for its foliage and edible fruit. The artisans had to be familiar with the plant in order to sculpt it. Sculpted on various Hindu and Jain temples in Gujarat and Rajasthan; sculpted mainly behind the heads of various deities dating from the 11th to the 13th century AD. The Mandor statue of Vishnu near Jodhpur has not only the *Monstera* leaves but even the stalks of the leaves sculpted. One of two dwarf-like figures shown with Vishnu is holding a *Monstera* fruit on a plate in his left hand. Other temple sculptures are cited. Plates 136 and 137 show two, while on page 108 is a picture of the living plant.

Morus sp.

Origin: Old World
Summary: A highly important genus in Asian civilizations (for manufacturing paper and bark cloth), two species were known also from Middle America, where they were apparently used in a similar manner. A detailed analysis of parallels in the technological complex of bark-paper/cloth processing has shown that quite certainly that complex passed from Southeast Asia to Mesoamerica, including a particular type of bark-beater found anciently in Mexico.
Case l: **Transfer:** *M. alba*: Asia to Middle America
Time of transfer: first part of the 1st millennium BC, following Tolstoy
Grade: A minus

Case 2: Transfer: *M. rubra*: Middle America (according to Brücher) to Asia
Time of transfer: possibly the 3rd millennium BC
Grade: incomplete (origin needs more definitive determination)

Sources: *Morus* sp.—mulberry tree, moral
Pandey 2000, 281. *M. alba*, white mulberry, was introduced to India from China.
Chopra *et al*. 1956, 170. Sanskrit: *tula*
Pandey 2000, 288. *M. nigra*, from Asia, probably Persia, was introduced to India in 1795.
Watt 1888–1893, V, 280. The antiquity of its culture in China and Japan and the number of varieties (there) led De Candolle to believe the original area extended eastward as far as Japan. Others believe it extended from Northwestern India into Asia Minor and Persia. Watt considers his *M. indica* equivalent to *M. alba*. 283. Bark in China was used for paper from very early times.
Bretschneider 1892, 128. The Chinese mulberry is *Morus Alba*, L. … many varieties are cultivated. 203. The *Lu shi* [Sung Dynasty] relates a tradition according to which the Emperor Shen Nung ["28th century BC," but now known to be much later] first taught the people to cultivate the … mulberry tree, for making … silken cloth." (328–9) This tree is cultivated in all the provinces of China. Silk is raised wherever the tree grows. This pattern can be traced back to the remotest time of Chinese civilization. According to an ancient tradition related in Huai Nan Wang's treatise on the rearing of silk-worms [1st century BC], it was Siling, Empress of Huang Ti ["2697 BC"] who first taught the people the art. She was consequently deified and worshipped. The mulberry trees cultivated in China for the breeding of silk-worms are all varieties of *Morus alba*, L., as also are the trees grown in Western Asia and Southern Europe for the same purposes. The name, *M. alba*, was given to the silk-worm mulberry by C. Bauhin on

account of its white fruit. But in China (at Peking at least, Bretschneider observes), the fruit of *M. alba* is generally of a red color. "I have seldom seen white berries there." [The rearing of silk-worms in Japan, according to the Japanese annals, dates from the 3rd and 4th century.]

Burkill 1966, II, 1522. *M. indica* and *M. alba* are the mulberries grown for feeding the silk-worm. The Malays know it as *tut*, an Arabic name widely used in northern India. 1523. *M. alba* has many varieties and intergrades with *M. indica*, which some have reduced [taxonomically] to it. [See Bretschneider (1892) under *M. alba*.] *M. nigra* is the mulberry cultivated for its fruits in Europe and elsewhere. It is not found in Malaya, but is in the hills of Java.

Balfour 1871–1873, III, 357–9. *M. alba* is from all southern Asia. 359. *M. alba* is cultivated in Europe, and in all south and east Asia the leaves of it are fed to the silkworm. *M. indica*, found in southern India, is cultivated in Bengal to feed silkworms.

Von Hagen 1944, 37. Hernández (arrived 1570) discovered many species of wild fig in use in Mexico. 51. "Primitive paper or bark-cloth, wherever it is found, whether on the African coast, or in Java, the Fiji Islands, or the Tonga Islands, Sumatra, the Celebes, or Hawaii, is always made from the mulberry or its close relative, the Fig." 53. When Maoris migrated to New Zealand they brought their mulberry plant with them, but it did not grow well. 58–9. Kinds of plants used for paper-making by the Otomí (Central Mexico) were the mulberry (Spanish: *moral*) "which has been identified as *Morus celtifolia*, a paper-mulberry similar to the plant used by many Asiatic papermakers." 60. The Aztecs (a living remnant tribe) use almost the same papermaking plants as the Otomís, including the mulberry. 67. After naming nine species of *Ficus* used for paper, he says in a footnote: "Three well-known species of mulberry found in this area may also have been paper-trees: *Morus alba*; *M. nigra*; *M. rubra*.

Brücher 1989, 239. *Morus rubra* L. "This fruit tree deserves a short mention, because it is said to be of American origin, whilst other *Morus* species are Old World species. It extends from the southern States of the USA to Central America."

Tozzer 1941, 195. In Yucatan, "there are two kinds of mulberry plant, very fresh and fine." Note 1040. Lundell notes this was "probably a *Morus*." However, no species of the genus has been collected in this region.

Las Casas 1875–1876, IV, 379–80. Reported abundant mulberries growing in the Antilles.

Bretschneider 1892, 128. *M. nigra* is a native of Western Asia, where it was much cultivated for its excellent dark red fruit, but it is not fit for rearing silk worms.

Torkelson 1999, 1788. Sanskrit: *tula*

MacNeish *et al.* 1967, 85. They excavated a type of stone bark beater in the Tehuacán Valley of Mexico which they consider "remarkably similar" to some in Java and Celebes; they find it "extremely difficult" to believe in the beater's independent invention because the degree of similarity is so great.

Tolstoy 1963. A detailed and systematic analysis of parallels in the bark-cloth manufacturing industries of Southeast Asia and Mesoamerica provides evidence that he considers to be unequivocally indicative of historical relationship between the two areas. He thinks the technology was introduced to Mesoamerica in the early part of the 1st millennium BC.

Mucuna pruriens

Origin: Americas

Summary: Widespread distribution in Asia and unmistakable characteristics combine with multiple Sanskrit names to ensure the presence of this species (or two species, if *pruriens* is distinguished from *prurita*) in both hemispheres. Importation to Polynesia directly from the Americas is more plausible than a tortuous route from Southeast Asia for which there is no evidence.

Case 1: Transfer: Americas to India
Time of transfer: at least as early as the first centuries AD
Grade: A

Case 2: Transfer: Americas to Hawaii
Time of transfer: pre-Columbian.
Grade: B

Sources: *Mucuna pruriens* (syn. *prurita*)—cowhage (Kew. syn. *urens*, Am., Austr.; syn. *Prurita*; syn. *imbricata*) [Synonymies inconsistent]

Burkill (1966, 1528) says *M. urens* is not the same: “The plant [*M. pruriens*, DC, cowitch) was taken to the West Indies some centuries ago and occurs there alongside a very similar species—*M. urens*, DC.” Boiled seeds of *M. pruriens* have been used in India from Sanskritic times as an aphrodisiac and its roots as a tonic.

Cook (1901, 292) says this plant, of American origin, was in Polynesia and the Malay region in prehistoric times.

Webster’s *Ninth New Collegiate Dictionary* says: “cowhage, also cowage. From Hindi: *kavac*. A tropical leguminous woody vine (*Mucuna pruritum*) with crooked pods covered with barbed hairs that cause severe itching; also these hairs sometimes are used as a vermifuge.” The same information and more can be found in the *Oxford English Dictionary* (OED).

Roys 1931, 235. Mayan: “*Chiican*. *Mucuna pruriens* (L.)” *Picapica*. “This is the English cow-itch.”

Watt 1888–1893, V, 286. *Mucuna pruriens*. Cowhage. “It occurs commonly throughout the tropical regions of the Americas, Africa, and India.” Seeds in India are considered a strong aphrodisiac.”

Chopra *et al*. 1958, 515. In the Punjab plains, from the base of the Himalayas to Ceylon and Burma. Many medicinal uses.

Nicolson *et al*. 1988, 1238. Called *nai-corana* in Hortus Malabaricus. Still known throughout Kerala as *naikurana*.

Hillebrand 1888, I, 101-2. “*M. urens*.” Found on Maui, Hawaii. “A native of Tropical America from the West Indies to Brazil and Peru, well known as the Cow-itch plant.” He considers it of pre-Cook age in Hawaii.

Balfour 1871–1873, III, 394–5. Cowage, or cowitch, has medicinal uses. Found in East and West Indies and elsewhere in the American tropics (*M. urens* and *M. pruriens*). Sanskrit: *atmagupta* in general; *M. prurita*, Hook, W. & A.; Sanskrit: *copikachuand atmagapta* (*sic*). “Sir W. Hooker has distinguished the East India plant, *M. prurita* from *M. pruriens*, which is indigenous in the West Indies.” Same, vol. I, 389. The species are found in hedges, thickets, on the banks of rivers, and about watercourses, in the East and West Indies, and in the Americas within the tropics. *Mucuna urens* and *M. pruriens* usually furnish the substance (*i.e*. the hair).

Nadkarni 1914, 242–3. *Mucuna prurians* (*sic*). Sanskrit: *atmaguptä, kapikachchhu*. Eng.: cowhage. An annual climbing shrub wild in Bengal and common in the forests throughout the plains. Cultivated in some parts for its velvety legumes, which are eaten as a vegetable.

Torkelson 1999, 1788. Sanskrit: *atmagupta, kapikachchha*

Chopra *et al.* 1956, 171. Sanskrit: *atmagupta*

Int. Lib. Assoc. 1996, 569. Sanskrit: *atmagupta*

Pullaiah 2002, II, 369–70. Sanskrit: *atmagupta*, *vanari*. Described in the texts in the tradition of Ayurvedic medicine.

Musa x paradisaca

Origin: South Asia

Summary: *Musa* x *paradisiaca* is descended from two genomes which now include ‘banana’ (most varieties) as well as the ‘plantain.’ Historical and linguistic evidence in abundance demonstrates that the traditional view among plant historians that the Spaniards introduced this plant to the New World is in error. Archaeological finds from Peru seem to confirm the occurrence. In any case ethno-historic accounts credit several Mesoamerican peoples with growing this cultivar before Columbus’ arrival, and linguistic and historical documents confirm heavy pre-Columbian use for tropical South American peoples also.

Transfer: Widespread distribution in the American tropics seems to rule out a mere transfer to the hemisphere via Polynesia as too late to account for the Western Hemisphere spread. There must have been (also?) an earlier advent, either via the Pacific or from Africa. We take one transfer as a minimum; two or more as possible.

Time of transfer: Supposing the Peruvian tomb finds were legitimate, then perhaps as early as the first BC centuries, or at least on historical and linguistic evidence in South America, one millennium before the Spanish Conquest.

Grade: A

Sources: *Musa* sp.—banana, plantain

Nicolson *et al*. 1988, 297. *Musa* x *paradisiaca*. In Malabar, *vazha* is still used (*cf*. Rheede ‘*bala*,’ which is the general term for all bananas and plaintains as plants). “Modern nomenclature for cultivated *Musa* is based on genome analysis. Moor “pointed out that *M*. x *paradisiaca* is correctly applied only to cultivars with parental genomes of *M. acuminata* (‘A’) and *M. balbisiana* (‘B’). Thus, the genome of the cultivar *Mysore* is expressed as [AAB], showing it is a triplid with two complements of *M. acuminata* and one of *M. balbisiana*.”

Berry 1925, 531–2. Illustrates and discusses seeds of “*Musa enseteformis* Berry, n. sp.” These fossils were collected from coal beds by “an experienced naturalist“ (Dr. M.A. Rollot, aka Bro. Aristé) of the Instituto de La Salle of Bogotá. Most modern bananas do not bear seeds, but of those which do, the closest to these are those of the African species *Musa ensete* Gmelin which have inedible fruits and very large seeds. 533–4. All *Musaceae* have been considered to be natives of the Old World except the large and exclusively American genus *Heliconia* and one species of the ditypic genus *Ravenala* found in northern South America, the other species of which is confined to Madagascar. The peculiar distribution of *Ravenala* and the disputed occurrence of *Musa* in the New World before the arrival of the Spanish explorers might well have discouraged dogmatism regarding the latter. 534–5. Cook says the banana was originally a root crop, and even at the present time the root and heart are eaten in some countries. Most authors (Cook the most vocal exception) have assumed an Indo-Malayan region origin. Humboldt questioned this view (*Nouvelle Espagne*, first ed., vol. 2, 360, 1911). He quotes a number of early authors who asserted that it was cultivated in the Americas before the Conquest and mentions its cultivation on the Orinoco and Beni rivers in regions far removed from foreign influence. Garcilaso de la Vega says the banana was one of the staple foods in Peru at the time of discovery and accurately describes several cultivated varieties. Montesinos said the same. Of supposed banana leaves from Peruvian graves, “of course leaves of *Musa* (the banana) are not distinguishable from those of the exclusively American genus *Heliconia*, so that no reliance can be placed on the leaves ….” 530. Berry: “The great similarity of the fossils to the seeds of the existing *Musa ensete* of Africa caused me to have some doubt as to their authenticity. They are, however, undoubtedly fossil and not recent ….” “It would seem that the presence of characteristic remains of *Musa* in the Tertiary of northern South America effectually disposes of the Old World origin of the genus, and although it does not prove that the New World was the actual place of origin, it disposes one to a more ready acceptance of the arguments for such an origin. It seems further to visualize the independent cultivation of the banana by the natives of the Americas long before the advent of the Europeans, thus validating the opinion of Humboldt and the statements of Garcilaso and Prescott.”

De Prez 1935, 59, Fig. 15. Bananas are shown at Borobudur (India) *ca*. AD 700–900.

Newcomb 1963, 50–2. “It is time to face up to the Banana.” This genus has three sections which are differentiated on the basis of chromosome characteristics. (The *Musaceae* Family is divided into four genera, *Strelitzia*, *Ravenala*, *Heliconia*, and *Musa*.) Darlington in his *Chromosome Atlas* subdivides the *Musa* into three groups according to haploid numbers, which are 10, 11, and 12. The African *Musa* (Ethiopia) is cultivated not for fruit but for its stem which is boiled or baked for food. The *Abaca* species, *Musa textilis*, has fruit. It might have appeared in the New World “later,” but this is not yet proved (see Miranda, on Chiapas). Also, the Pacific Island *fehi*, or *fe’i*, bananas are distinct. And finally, seed bananas in the New World: where do these fit? (At this seminar, Simmonds had never heard of them until told by C. Sauer.) At Ancón, Peru, investigators turned up some banana seeds. This collection was studied twice, by Wittmack and by a French botanist [Rochebrune?] Some bananas are grown there in that area now. Wittmack thought the seeds in the site could have been contaminants.

Newcomb, cont’d. Cheesman pretty well established that plantains are from Southeast Asia, specifically from the eastern side of the Bay of Bengal; the wild parentage is there. The Berlanga myth (that this Dominican priest brought the first banana rootstock to the West Indies from the Canaries) couldn’t explain the tremendous number of New World forms developed in so short a time. Experience shows that banana rootstock is durable and could survive lengthy sea voyaging. African bananas were imported from Asia, not domesticated locally.

Latcham 1936. For Pacific coastal South America, he reports the practice of planting bananas in moist beds above the water level but below ground level.

Moseley 1969, 485–7. South American *mahames*, or sunken garden plots, were a supplement to canal irrigation along the arid coast because ground water kept the plants moist.

Skottsberg 1920, 13. Easter Island. Describes use of small, cultivated plots dug below ground level and used particularly to grow bananas below the prevailing winds.

Dagodag and Klee, 1973,10–5. A distributional study that maps the widely spread uses of this (*mahamae*s) form of cultivation, in Oceania, Peru, and Chile. [This cultural parallel supports the supposition of a transfer of the plant also from Eastern Polynesia to South America, or vice versa.]

Mellén Blanco 1986. 130–1. Easter Island. "Plátanos guineos" in early explorers' documents has to refer to one of the varieties of *Musa sapientum*, (reported in tradition) brought to the island by the first settlers. Called *maika*. Grown in pits (*manavái*) sometimes to protect from the wind. Hervé reported a banana plantation a fourth of a league long and almost half that wide, in addition to smaller plantings.

Heyerdahl 1964, 123. Stevenson, Wittmack, and Harms had pointed out that plantain [meaning generic *Musa*?] leaves had been frequently identified in aboriginal Peruvian graves and Rochebrune found a fruit of cultivated *Musa paradisiaca* in a prehistoric tomb at Ancón. Chroniclers Garcilaso de la Vega, Acosta, Montesinos, and Guaman Poma unanimously stated that the plantain was grown before the Conquest in Peru. Further, when Orellana descended the east side of the Andes and crossed South America (1540–41, the first European to do so), he found plantains growing all along the reaches of the upper Amazon. [This report is circulated in the literature, but his original account does not say anything of the kind.] In the light of this, Merrill finally granted that "We may reasonably admit that one, or a few of the numerous Polynesian plantain varieties may have" reached the Americas.

Towle 1961, 97. Leaves of the banana are said to have been found in Peruvian graves (Rochebrune, 1879, 348, 352; Pickering 1879, 663). Rochebrune, 352, also speaks of specimens of the seedless, berry-like fruits having been recovered. However, this Old World species was brought to the Americas only after the European discovery [*sic*, Towle]. Since the specimens are not available for study, it is not possible to determine their correct identifications.

Jeffreys 1963a, 196–7. The historical claim circulates (originally from Oviedo) that Fr. Thomas de Berlanga brought the banana and plantain from the Great Canaries in 1516. Jeffreys, formerly a banana planter in Cameroon, observes that the shoots brought by Berlanga to Santo Domingo in 1516 would not have been available for planting out until the end of 1517 or beginning of 1518; yet before 1525 Oviedo published that by then there were huge plantations in the islands and on the mainland. Only those who have had nothing to do with running banana plantations may be able to swallow Oviedo's assertion about the banana's origin via Berlanga. Among these is Professor Merrill (1954). 202. Cites De Candolle (1884, 304) to the effect that Garcilaso de la Vega "says distinctly that at the time of the Incas, maize, quinoa, the potato, and, in the warm temperate regions, bananas, formed the staple food of the natives. He describes the *Musa* of the valleys of the Andes; he even distinguishes the rare species [variety?] with a small fruit and sweet aromatic flavor, the *dominico*, from the common banana, or *arton*."

Cook 1901, 258. "The evidence of the banana in prehistoric America is equal, if not superior, to that presented here for the coconut." American bananas have mistakenly been attributed to importation via the Manila galleons, but Oviedo describes them in the New World 40 years before that route was even discovered, and Philippine varieties of bananas are still not found in Mexico.

Harms 1922, 166. Literature is cited showing their presence in Peruvian graves.

McBryde 1945, 36. Bananas are mentioned in the tradition, *Annals of the Cakchiquels* (in Guatemala), and some varieties seem to have grown in the Americas prior to the Conquest.

Scholes and Warren 1965, 965. Bananas were being grown before the Spanish Conquest in southern Mexico.

Sapper 1934, 119*ff*. Gives names for the banana from many languages, from which he concludes that this plant had to have been present well before the Conquest and probably in the 1st millennium AD.

Smole 1980, 47–50. His ecological and ethnographic studies among the Yanoama Indians in Brazil/Venezuela provide convincing basis that their current heavy dependence on plantain cultivation is an old, conservative feature. Cultivated plantains relate to a variety of wild *Musa* forms in the vicinity. He also considers Berry (1925) as presenting "credible evidence" for Tertiary-age bananas in Colombia. Upon his reexamining the Spanish chroniclers, he finds their statements support the indigenous view rather than that Spaniards exclusively introduced bananas. The evidence overall is not incontrovertible but does support the hypothesis.

Wittmack 1890, 325–49. Lengthy review of chroniclers and archaeology concludes that the banana was pre-Columbian in Peru.

Merrill 1954,165–385. One or more plantain varieties may have been carried by the Polynesians to South America, where they reached the Amazon basin.

Roys 1931, 304. *Musa sapientum*. *Platano blanco*. (No indigenous Mayan name.) The Maya text prescribes a medicinal use for the leaf.

Spores 1965, 971–2. In the hot mountain valleys to the west of Tehuantepec, [pre-Columbian] inhabitants grew bananas among other crops.

Addenda: Too late to enter in detail: Smole 2002; Jett 2002c.

Musa coccinea

Origin: China

Summary: Find of this anomalous species (only?) in such a remote spot in the Amazon basin is impossible to explain as a post-Columbian import. It seems highly probable to have been aboriginal.

Transfer: Asia, apparently, to South America

Time of transfer: pre-Columbian

Grade: C plus

Sources: *Musa coccinea*—Chinese banana (Kew. {China}).

MOBOT 2003. Native to China according to the *Flora of China*.

Newcomb 1963, 50–2. H. Bassler, a U.S. geologist working in the Amazon in the 1920s, wrote a description of seed-bearing bananas in the Upper Amazon (published in the *Journal of the N.Y Botanical Garden*). He compared it to the Chinese *Musa coccinea*. The fruit head in this specimen stands up rather than hangs down. He speculated it might have been an early Chinese introduction, carried on into Amazon country. 52*ff*. “*The Evidence Pro and Con Regarding the Pre-Columbian Occurrence of the Banana in the New World***.**” Tessman found that simple cultures had the seed bananas. Guaraní-related Indians, more advanced, lacked the seeded type. A fairly promising case exists that these seed-bearing bananas were indeed *fehi* bananas, for they had seeds, and the fruit-bearing stems were not pendent but upright. No one has followed this up. (H.J. Bruman, in the C. Sauer seminar that Newcomb reports, reported meeting Tessmann in 1956 to examine the wild Amazon bananas grown in Paraná. Bruman confirmed the characteristics attributed by Tessman. These plants grew at a low elevation and in conjunction with domesticated bananas as associates.)

MOBOT 2003. “Native” to China.

Myrica gale

Origin: probably Old World

Summary: Distribution on both sides of the Atlantic, combined with pollen on intervening Greenland and Iceland dated to the times of Norse sagas, make likely that those voyagers were responsible for the transfer.

Transfer: Northern Europe to Iceland, Greenland, and North America

Time of transfer: AD 1000

Grade: B

Sources: *Myrica gale*—bog myrtle

Thorarinsson 1942, 46. *M. gale* is spread on both sides of the North Atlantic, although it is now absent from Iceland and Greenland. Yet its pollen is found in Icelandic excavation layers from saga times, and possibly also in Greenland as well. The Norse sometimes used this plant instead of hops to brew beer. He finds it tempting to ask the question whether this plant could have been brought to North America by the Norse. His implied answer is that they could and apparently did, since no other scenario for the plant’s distribution in North America recommends itself.

Sauer (1969) raises a question about how it appeared in both hemispheres.

Nelumbo sp.

Origin: Old World

Summary: See the summary for *Nymphaea* sp.
Grade: incomplete

Sources: *Nelumbo* sp.
Pullaiah 2002, II, 377. *Nelumbo nucifera* (syn. *Nymphaea nelumbo*). Four Sanskrit names are given. Trade name: East Indian lotus, sacred lotus.
See also the material under *Nymphaea* sp.

Nicotiana rustica

Origin: Americas
Summary: This 'wild' tobacco is found widely in India. It is unlikely to have been introduced after *N. tabacum* was available, for *tabacum* is far more desirable, but it may have been brought in at the same time (inadvertently?). More information is needed to determine its significance, if any.
Grade: incomplete

Sources: *Nicotiana rustica* (syn. *rusticum*)—Turkish tobacco, wild tobacco
Chopra *et al.* 1956, 176. Hin. and Ben.: *vilayeti tamaku*. Cultivated in West Punjab, Baluchistan, Bengal, and other parts of India.
Gupta 1971, 70–1. "The tobacco plant of commercial importance was introduced into India as late as the 15th century AD by the Portuguese, and that is perhaps why there are no Hindu myths connected with the plant, nor is it considered to be sacred by them. But a large number of tribal myths connected with the plant are current, though very likely they refer to the wild varieties of the plant." (Citing V. Elwyn, *Myths of Middle India*, 324.)
Chopra *et al.* 1958, 679. Cultivated in many parts of India. *N. rustica*, Turkish tobacco, is also cultivated in some parts of northern India. Does not list any Sanskrit name, but gives Arab.: *tanbak*; and Pers.: *tanbaku*.
Watt 1888, V, 352. *N. rusticum*. "Turkish or East Indian tobacco." (Not named in Sanskrit, he says.) Widely cultivated throughout much of India. "The vernacular names given to it would indicate its introduction into Northern India from opposite directions." (354. *Rusticum* was never naturalized.)
See also material under *N. tabacum.*

Nicotiana tabacum

Origin: Americas
Summary: Use of the plant by living Egyptians and others in the Old World has been demonstrated definitively by study of mummies and desiccated corpses dating from at least 1100 BC. Use of the water-cooled hooka smoking device is shown in pre-Columbian art in India, along with medicinal references to tobacco in traditional forms of medical practice. Names point to the pre-Columbian presence of tobacco in Asia and perhaps in Tibet. Sanskrit, Arabic, and Persian names are recorded. Found wild on Easter Island, while tradition says it was introduced by the earliest settlers.
Case 1: Transfer: Americas to Egypt, at least
Time of transfer: no later than 1100 BC
Grade: A

Case 2: Transfer: Americas to Eurasia (Cases 1 and 2 may prove to be combined.)
Time of transfer: Sanskritic times, surely by AD 1000
Grade: A minus

Case 3: Transfer: Americas to Easter Island
Time of transfer: pre-Columbian
Grade: C

Sources: *Nicotiana tabacum*—common tobacco
Zeven and de Wet 1982, 181. It has been shown that tobacco is a natural amphitetraploid of the New World. *N. sylvestri* and *N. tomentosiformis*. The occasional wild plants are escapees of cultivation.
Balfour 1871–1873, IV,104. *N. tabacum*. He gives the names for Sanskrit as *sahastra-patra* and *dhumra-patra*. (But Hindi: *tamakhu* or *tambaku*.) "Mr. Royle mentions on the authority of the Persian

works on *Materia Medica*, that it was introduced into India in AD 1605 … though Royle quotes the authority of Pallas, Loureiro, and Rumphius, who think tobacco was used in China at a period anterior to the discovery of the New World."

Pullaiah 2002, II, 380. Sanskrit: *tamakhu*.

Heyerdahl 1964,126. This (in a wild, or feral, state) was one of a number of plants found when Europeans first recorded the flora of Easter Island. Thomson before 1891 collected traditions that say that this plant was brought by the first ancestral settlers. Its name, *avaava* [*cf*. Rarotonga: *kavakava*, acc. to J. Sorenson, personal knowledge] indicates, he says, that it was chewed, not smoked (another word is applied to the latter, *odmoodmo*). This is another "reasonable suspect" to have been introduced in pre-European times.

Martínez M, 1978, 124–5. Miranda found only *N. tabacum* (growing wild?) in Chiapas. Its preparation requires much care (drying or curing by air or fire). Quotes Thompson (1970, 110) on uses—offering to gods, divination, worn as an amulet, and in burials. It was chewed with lime or smoked. Thompson (p. 118) says in Mesoamerica tobacco was considered almost a panacea for illnesses. They applied the juice on insect bites. 129. Some seeds found by flotation date to the Chiapas Proto-Classic [*ca*. the 1st century AD).

Yarnell 1970, 225. Earliest remains, Northern Mexico, 1600 BP.

Ashraf 1985, 91–101. It is universally accepted that tobacco began in the New World and was carried to India after its introduction into Europe by Europeans, especially the Portuguese. 92. Tobacco in Tibb-e-Unani (Greco-Arab medicine). Hikmat, or Tibb-e-Unani, along with Ayurveda, were the two dominant schools of medicine before the advent of modern medicine. It was practiced all over India. In that system, tobacco was one of the important plants used as a cure for a number of diseases. One of the earliest mentions of *tanbaku*, or tobacco, as a medicinal plant is found in a collection of prescriptions titled *Majmua-e-Ziai*, penned by the court-physician of *Muhannad-bin-Tughlaq* of the Delhi Sultanate. It is dated 737 AH (AD 1329). This ms. mentions use of tobacco as a component of a compound preparation, *nás*, used for a number of diseases. (93) Name: *tanbaku* falls in the category of names identical in Persian and Sanskrit. Hence, we suspect the tobacco tradition goes much further back than the 14th century. That is confirmed by another medieval source, a Persian translation of a Sanskrit classic of Ayurvedic medicine, completed AD 1512. "We find mention of tobacco in traditional Indian medicine of a period almost a millennium before the discovery of the New World and the introduction of tobacco into Europe." Not only Indian but European practitioners of Greco-Arab medicine who were residing in India and were familiar with Indian traditions of both medicine and culture, considered tobacco to be native to India and not an introduction. More details.

Ashraf cont'd. 95–96. The issue rests with identity of the substance labeled by the noun, *e*, then documents continuity of the smoking tradition in India (which used the *huqqa*, or water pipe). It was present almost unchanged since the 14th century and mentioned in texts very possibly earlier. A temple in Himachal Pradesh dated to AD 1422–1424 shows archaeologically the use of the *huqqa* at that time. Photographic documentation of this depiction is also had for other temples through the Archaeological Survey of India. 96–97. Argues that prohibition of tobacco smoking in Sikh religion supports the argument so far, for there would be no prohibition without the practice being common.

Chopra *et al*. 1956, 176. Sanskrit; *tamakhu*. Hin. and Bom.: *tambaku*. Cultivated throughout India.

Torkelson 1999, 1793. Sanskrit: *tamakkhu*. Arabic: *tanbak*. Pers.: *tanbaku*

Marszewski 1975–1978, 255. Pointed out on the basis of plant names a possibility of pre-Columbian cultivation of tobacco in India and Southeast Asia.

Bucaille 1990, 187–8. Fragments of American tobacco and a coleopterous parasite of tobacco were found in the abdominal cavity of the mummy of Ramses II. He reproves any speculation about possible ancient American contact with Egypt on the basis of this tobacco. The abdominal cavity was open for years while the mummy was in various locations over the past century. "This accounts for my surprise upon hearing the Museum of Anthropology [in Cairo] declare that the discovery of morsels of tobacco in the mummy's abdomen was proof that the ancient Egyptians were familiar with the plant."

Christian 1897, 138. He gives Samoan, *sai*, meaning a bundle of tobacco, in possible relationship to Quechuan (Peruvian) *sairi*, tobacco.

Dixon 1921, 19–50. Name study shows tobacco is American only; this follows upon his devastating review of Leo Wiener's book the previous year. [But in the light of additional findings in this paper, some material in Wiener's book needs to be re-examined.]

Feinhandler, Fleming, and Monahon 1979, 213–26. Comprehensive on the diffusion of tobacco. The conventional view of exclusive New World origin followed by diffusion by the Spaniards is probably false and needs to be modified. Maps given of the pre-Columbian distribution in Australia, New Guinea, Melanesia, and Polynesia. Some of what Lewis (see below) claimed appears right. Goodspeed gave the definitive taxonomy of *Nicotiana* and argued that one sub-genus had spread from South America to Australia long before any possible human residence in the Pacific [*sic*].

Balabanova *et al.* 1992a, 358. Nine Egyptian mummies, dated from approximately 1070 BC to AD 395 were examined by radioimmuno-assay and gas chromatography/mass spectrometry. Cocaine and hashish were found in all nine, and nicotine from tobacco in eight mummies in hair, soft tissue, and bones.

Balabanova *et al.* 1992b. Showed hashish along with cocaine and nicotine in Peruvian mummies. Balabanova, Boyuan Wei, and Krámer (1995, 68) say that 1992b demonstrated "the presence of cocaine, nicotine, and hashish in hair and soft tissue of pre-Columbian mummies," so this was not an inadvertent statement.

Balabavanova, Boyuan Wei, and M. Krámer 1995, 74. More than 60 kinds of wild tobacco plant forms are known (in the world). It "seems possible" that in past centuries nicotine was used in medicine. Or nicotine may have entered the picture as a secondary alkaloid in some other plants. Thus, *e.g.*, in *Withania somnifera*, family nightshade, in the levels (*sic*) of *Prunus ceresus*, family *Rosaceae*, in the *Narcisse*, family *amaryllidaceae*, etc. Use of these plants [not demonstrated, of course] "may" be followed by accumulation of nicotine in the body. Also, possibly imported. *E.g.*, *Withania somnifera* is the best-known drug in ancient India. "In conclusion, our results showed the presence of nicotine in ancient population (*sic*) of southern China, and consequently, the presence and use of the alkaloid, as principal or secondary alkaloid in native Chinese or imported plants."

Langdon 1988, 329. Thomson found tobacco growing wild in secluded spots on Easter Island in 1886, a century after Cook's visit. Langdon infers that this probably meant pre-European cultivation of toabcco.

Zeven and De Wet (1982, 181) say the plant does not grow "wild" but only as an escape.

Brücher 1989, 180–1. The species *N. tabacum* does not exist in free nature, nor does *N. rustica*. Both are allo-polyploids with hybrid origin. American wild (predecessor) forms are identified here. They are found on the western slopes of the Andes in Peru, Bolivia, and Argentina.

Laufer 1931, 138–40. He had written about the spread of American tobacco into Asia, Europe, and Africa after European discovery, but Melanesia and Australia are different. He supports Lewis (1931). There are native tobaccos in New Guinea, he is assured, and the method of smoking them there is unique and likely very old.

Lewis 1931, 134–8. He claims pre-European presence of tobacco in New Guinea while others suppose it only came via the Spaniards. He argues for independent domestication and use in New Guinea.

Jeffreys 1976, 9–28. Tobacco is one of the plants he finds present in Africa before the influence of Iberian impacts. Its presence there may be due to the Arabs.

Wiener 1924, 305–314. A summary of his three-volume work (1920–22), which was badly handled by critics. At this point, he claims that forms of the word *tubaq* are found in Semitic and Sanskrit, and the Náhuatl and Tarascan words for tobacco and pipe, he claims, are from Arabic. [Requires more critical examination.]

Watt (1888, V, 352*ff*.). 353. *N. tabacum*. "American or Virginian tobacco." Hindi: *tamáku, tumálk, támbáka, támbáku*." Persian: *tanbaku*. Arabic: *tanbák.* Malayalam: *pokala, puka yila*, etc. Widely naturalized. An abundant weed. 361. The tobacco plant was introduced to India by the Portuguese about 1605.

Burkill 1966, II, 1577. *N. tabacum* often maintains itself in a wild state in the tropics, but not in the sub-tropics, whereas the reverse is the case with *N. rustica*. *N. tabacum* is the tobacco plant of chief interest in the Malay Peninsula.

Nadkarni 1914, 257. *Nicotiana tabacum*. Sanskrit: *támrakúta*. Eng.: tobacco. Hind., Pers., and Mah.: *tambâku*. Arab: *tanbak*.

England 1992, 161. There was a word for tobacco in reconstructed Proto-Mayan, before 1000 BC.

Balabanova, Wei, and Krämer 1995, 68, 70, 73–74. Significant nicotine and cotinine (a metabolized product of nicotine) residues were identified in five of eight naturally preserved cadavers from Guangxi state in Southern China, dating some 3750 BC—thus, significantly earlier than the oldest Egyptian mummies. The cotinine indicated *ante-mortem* use of the source of the alkaloid, not external contamination. *Nicotiana* is known to have been used medicinally in China during the last few centuries.

Balabanova 1994. She surveys comprehensively literature from biologists, historians, archaeologists, *in re*. pipes, etc., to demonstrate that a tobacco plant was cultivated and consumed in Europe long before Columbus. (Compare Benoit 1962, 1963.)

Addendum: too late to enter in detail: Jett 2002a.

Nymphaea spp.

Origin: Old World

Summary: Some observers say that Eurasian and Middle American water lilies (‘lotuses’) differ by very little; botanists may consider such differences of considerable significance. To non-specialists, those pictured in the Americas look essentially ‘the same’ as some flowers in the Old. (Within the Old World, species, and even genera, differences exist also but are overlooked for iconographic purposes.) But the treatment of the motif in art and myth has such notable parallels, that one supposes the natural differences may have been overlooked by the ancient Americans who could have considered the lily they had (*Nymphaea* sp.) the ‘lotus’ in the same manner that horticulturists treat both *Nymphaea* and *Nelumbo* species as ‘lotus.’ It is impossible to know at this time whether there is an exact species equivalence between the Mesoamerican lotus and that of the Old World, where the two genera were considered equivalent for some purposes. It is a subject worth further study.

Transfer: Old World to Middle America

Time of transfer: pre-Columbian

Grade: incomplete

Sources: *Nymphaea* sp.—lotus, white water lily, blue water lily

Aguilar 2003, 80. Maya shamans had within their pharmacopeia the white lotus flower (*Nymphaea ampla*, also known as the white water lily, or *nenúfar*). In Egypt, the *mandragora*, or blue lotus flower (*N. caerulea*), was employed, along with datura and henbane (as psychotropics).

Lundell 1937, 191, 198. *Nymphaea ampla* Salisb. Mayan, *nohoch naab*, *nape*. A very common aquatic plant with large floating leaves and attractive white flowers.

Pullaiah 2002, II, 377. *Nelumbo nucifera* (syn. *Nymphaea nelumbo*). The East Indian lotus. Four Sanskrit names.

Gupta, 1996. 117–120. *Nelumbo nucifera*, lotus. Held sacred by Hindus, Jains, and Buddhists, is the most common floral depiction on temples. “Practically every god or goddess is sitting or standing on a lotus flower. This could be because lotus is a symbol of beauty, fertility, and purity.” In Hindu and Buddhist cosmology, the lotus flower arises and unfolds from the formless, endless Ocean of Creation and represents the Universe. The regents of the eight directions are its eight opened petals. Lakshmi, the goddess of fertility, beauty, and prosperity (basically a goddess of fortune), is associated with the lotus plant and is known as Padma, the lotus Goddess.

Naudou 1962, 340–7. The lotus panels from Chichen Itza are compared in some detail with those of India and Southeast Asia.

Heine-Geldern 1966, 284. A lotus motif was important in the art of India in the period from 2nd century BC to the 2nd century AD. It shows not only the flowers and leaves but the whole plant, including the rhizome. In Maya art, the lotus motif appears in Classic times, but at Chichen Itza of the later Toltec period [post AD 750] motifs correspond most closely to Indian designs, particularly to those of Amaravati in south India (2nd century AD). At Uxmal, a similar motif dates to about the 7th century.

Heine-Geldern and Ekholm 1949, 306–8. Associations of the lotus are discussed, all of which are shared between the two areas.

Rands, 1953, 75–153. He grants that there are “truly remarkable parallels” in representations of the water lily at Chichen Itza and Palenque, and at Amaravati, India. But a naturalistic convergent explanation for the parallels cannot be ruled out.

Fuchs, 1951, 61–2. Motifs shared by Hindu/Buddhist art of southern India (style of Amaravati) and of Southeast Asia, with Mexico and the Maya region are now an established fact. Among the motifs is the lotus.

Díaz 2003, 81. The white water lily plant employed as a hallucinogenic (called *nenúfar*, or white lotus flower), became a symbol of a lineage often depicted in the headdresses of Maya rulers. The white water lily flower was also seen as a link in the chain of fertility: the flowers fed fish, which subsequently fertilized the soil to permit the cultivation of corn. The *nenúfar* also symbolized death. In the Codex Dresden, the god Chac pulls this precious white flower from the water.

Newcomb 1963, 59–60. Carl Sauer observes: Lotuses occur in bayous of the Magdalena River in Colombia as well as in Cuba and possibly Mexico. Only one botanical distinction exists between the New World lotus and those of the Old World, which is a matter of flower coloration. [But see below.] Old World lotus has yellow blossoms, those in the Americas white or pink. Old World distribution is also disjunct, not explainable by reason of birds or transport via drainage systems. This suggests that man is responsible. There are records of lotuses being carried to Europe from the Orient. Lotus roots are starchy; the seeds are nutty like the piñon, and the flowers are edible. Flowers are also an important art motif. And how are lotus and water lily related? The former is genus *Nelumbo*, whose leaves stand well above the surface of the water. Equating *Nelumbo* spp. and the term lotus is the usage of U.S. horticulturists. The water lily is the genus *Nymphaea*, or true water lily, whose leaves float on the surface of the water. These species represent the true African or Egyptian water lilies. However, the common nomenclature for lotus and lily is quite confused.

K.T. Harper, personal communication, 2004. The Old World lotus (*Nelumbo*) has white, pink, or blue flowers. The *Nelumbo* species also has a different leaf (peltate). The *Nuphar*s and *Nymphaea* species have a very different leaf. The flower of *Nelumbo* is elevated three or four feet above the water; the *Nymphaea* flower opens at, or close to, the water surface.

Wilkinson, 1879, II, 407. Plants from Pliny: “*Nymphaea* Lotus. Arab.: *beshnín*. Footnote 2: This *Nymphaea* Lotus grows in ponds and small channels in the Delta during the inundation … but it is not found in the Nile itself. It is nearly the same as our white waterlily. Its Arabic name is *nufár*, or *nilófer*, or *beshnín*; the last being the ancient *pi-sshnn*, or *pi-shneen*, of the hieroglyphics. There are two varieties—the white, and that with a bluish tinge, or the *Nymphaea caerulea*. The Buddhists of Tibet and others call it *nenuphar*. Though the favourite flower of Egypt, there is no evidence of its having been sacred; but the god Nefer-Atum bore it on his head, and the name *nufar* is probably related to *nofar*, ‘good,’ and connected with his title.”

Roys 1931, 267. White water lily, found in shallow ponds near Merida and elsewhere.

Rands 1953, 117. The water lily in both the Maya area (*Nymphaea ampla*) and the Hindu lotus (*Nelumbo* sp.) are members of a single family, the *Nymphaeceae*. The stalks of both rise prominently above the water. This being the case, a certain degree of resemblance in the depictions of the two related plants might well be expected. A number of conventionalizations strikingly similar to Maya floral forms must be admitted to exist in Southeastern Asiatic depictions of the lotus. 118. “The Type C flower which occurs at Chichen Itza, Palenque, and Chinkultic … is closely paralleled in certain representations of the lotus.” He continues with additional, fine details relying on Coomaraswamy (1931) for the India comparisons. 119. “Maya associations of the water lily having correspondences in Indian art appear to be quite numerous.” (Details given.)

Ocimum sp.

Origin: Old World?

Summary: We have data on three species of *Ocimum* but are uncertain of all synonymies. Nevertheless, it is clear that at least one species was shared between India and Mesoamerica.

More study is required on why a plant of a taxon called *americanum* would have two Sanskrit names. Distribution of *O. basilicum* throughout the Americas also needs explanation, since it has a long history in

India, where it is said to be indigenous, bears two Sanskrit names, and probably is also mentioned in a Hindu text no later than AD 400.

The genus (species not certain) was found in an archaeological site in India before 800 BC. Yet at the time of the Spanish Conquest 'sweet basil' was growing in Mesoamerica.

Transfer: Old World to New?

Time of transfer: pre-Columbian.

Grade: B

Ocimum americanum

Source: *Ocimum americanum* (syn. *canum*)—hoary basil

Pullaiah 2002, II, 384. Sanskrit: *vanabarbarika, aranyathullasi*

See also above, *Ocimum* sp.

Ocimum basilicum

Sources: *Ocimum basilicum*—French basil

Chopra *et al.* 1958, 680. Sanskrit: *munjariki*. Herb common throughout India. 517. Medicinal uses. Indigenous to the lower hills of the Punjab. Cultivated throughout the greater part of India.

MOBOT 2003. Distribution: North, Middle, and South America; Africa; China.

Saraswat, Sharma, and Saini 1981, 316. *Ocimum* sp. A carbonized branch (species undetermined) was excavated from the Sanghol site in each of Periods I and II (1300–800 BC and 800–600 BC respectively).

Pullaiah 2002, II, 385. *Ocimum basilicum*. Sanskrit: *barbari, munjarik*. ('Sweet,' or 'common' basil.). Medicinal uses.

Dastur n.d., 172–3. Sweet, or common basil. Indigenous to Sind and the lower hills of the Punjab; cultivated throughout the greater part of India and Pakistan.

See also above, *Ocimum* sp.

Ocimum sanctum

Sources: *Ocimum sanctum* (?syn. *micranthum*; syn. *tenniflorum*, or *tenuiflorum*), sweet basil, holy basil.

Tozzer 1941, 194. Sweet basil was very abundant in Yucatan. Note 1033. *Ocimum micranthum* Willd., *albahaca* in Spanish (in modern Spanish, *alebaca*).

MOBOT 2003. *Alfavaca* is *O. sanctum*, holy basil.

Aiyer 1956, 27. Species not given but "basil" is mentioned in the *Ramayana* and in *Charaka Samhita* text, no later than 400AD.

Pullaiah 2002, II, 385. *Ocimum tenniflorum* (syn. *sanctum*). Sanskrit: *surasa, vrinda* ("sacred basil"). *O. basilicum*, Sanskrit: *barbari, munjarik*. (Sweet or common basil). Medicinal uses.

Dastur n.d., 172–3. Holy, or sacred basil. Distributed throughout India and Pakistan.

Saraswat, Sharma, and Saini 1981, 316. *Ocimum* sp. A carbonized branch (species undetermined) was excavated from the Sanghol site in each of Periods I and II (1300–800 BC; 800–600 BC).

Heywood 1993. This species was regularly grown near temples in southwestern Asia.

Gupta 1996, 131–2. The plant is called *bhutagni* (Sanskrit?) and is planted in the house so that no evil spirits come near it. It is symbolically and ritually associated with marriage. Its use is old, being mentioned in five different *purana*s.

See also above the material under *Ocimum* sp.

Opuntia dillenii

Origin: Americas

Summary: The fact that some cacti were considered indigenous to India, together with the degree of naturalization varieties seem to show, hints that cactus plants may have been there before the Portuguese could have brought them. That notion is bolstered by the fact of Sanskrit names for a cactus considered of New World nativity. In the Near East there are further hints that this species lived in the area much earlier than usually assumed. (Consider also the entry on *Agave* sp.)

Transfer: Americas to India or the Near East
Time of transfer: while Sanskrit was still a living language, *i. e,* before AD 1000, at least.
Grade: B

Sources: *Opuntia dillenii* (syn. *megacantha*; syn. *streptacantha*; syn. *amyclaea*; syn. *ficus-indicus*; syn. *Cactus Indicus*)—prickly pear cactus—(Kew. syn. *ficus-indicus* {Haw., Am. Austr.})

Nadkarni 1914, 266. *O. dillenii* (syn. *Cactus indicus*). English: prickly-pear. Native of the Americas, now naturalized in India, in great tracts.

Pullaiah 2002, II, 389. *Opuntia stricta* (syn. *dillenii*). Sanskrit: *vidara*, *visvasraka*.

Torkelson 1999, 1798. (syn. *Cactus indicus*) Sanskrit: *vidara*

Chopra *et al.* 1956, 178. Sanskrit: *vidara*. "Introduced in India."

Jeffreys 1976, 9–28. Among the plants he suggests that were in Africa before the Portuguese was "the prickly pear."

Patiño 1963, 359. The name *tuna* is from the Taino language, generalized throughout South America. In Mexico, the name is applied only to the fruit, while the plant is called *nopal*.

Towle 1961, 71. Species of *Opuntia* are widely distributed in Peru. Plants of this genus are often reproduced on pottery vessels.

Roys 1931, 273. Mayan: "*Pakam*, or *Pakan*. *Opuntia Dillenii* (Gawler) Haw. *Tuna*, *nopal*. *Pakam* is probably a general name for the prickly-pear." Motul gives "*Pakam*. *Tunas* on whose leaves the cochineal is bred."

Dressler 1953, 139. This species is the plant on which the early Mexicans cultivated the cochineal insect. The present[-day] cultivation of cochineal in Oaxaca is said to utilize varieties of *O. ficus-indica*.

Forbes 1956, 102. "We also have hints in later Jewish documents that the cactus *cochenillefera* was grown near Nablus, and the insect producing the red dye was fed on it." Abrahams and Edelstein reported that analysis of Bar Kokhba-period textiles (*ca*. AD 135) from Judea revealed the dye chemical characteristic of cochineal. [But see Robinson 1969, below.] The raising of cactus in the Near East remains unproved, although today at least two *Opuntia* species are naturalized in the Mediterranean Basin, according to Groves and di Castri (1991, 68).

Jett 1998, 143–4. True (Mexican) cochineal is generally considered post-Columbian in the Eastern Hemisphere, although, according to Wulff (1966, 189), true cochineal [probably not so?; see Robinson 1969] was mentioned as early as the time of Sargon II of Assyria, in 714 BC as coming from Armenia and northern Persia.

Robinson (1969, 25) states that "Cochineal made from … *Coccus cacti* … came to Europe from the New World [after Columbus' discovery], but recent discoveries in the Ararat Valley and adjacent areas suggest it was known and used by the Assyrians before the 7th century BC, being produced in the Armenian mountains." Others say that what was referred to was a native grass-parasite, an Armenian coccid, *Porphyrrophora hamel*.

Dhamija (1990, 841) reports that this Armenian red "is chemically similar to New World cochineal," that is, it contains carminic acid, the key colorant in cochineal. An early medieval textile from Gujarat, India, has been found in Egypt, that perhaps utilizes cochineal dye (Rosenberg *et al.* 1993, 93).

Townsend 1925. "'*Opuntia*' and all *Cactaceae* are of American origin, but various species of *Opuntia* have been known in Asia and Africa from remote times." [Caution: Townsend exhibits an unsophisticated knowledge of botany and entomology at some points.]

Watt (1892, VI, Part I, 109) lists *Opuntia dillenii*, Haw. Prickly pear. "Originally brought from America but now quite naturalized." No Sanskrit name is known. A separate entry is in Watt, 1892, V, 490–2. Roxburgh, who described this under the name *Cactus indicas*, believed it to be a native of India. However, no references are made by Greek or Roman writers. First mention is by Spanish and Portuguese sources. "Most probable that it was introduced by the Portuguese." The cochineal insect was brought to India in 1795. Then, this (plant) species was so prevalent in India that writers spoke of this cactus as indigenous. Insects thrived on it as much as on *Opuntia* species specifically brought with the insect.

Pandey 2000, 272. *O. dillenii*, from South America, is a species "naturalized throughout India," while (273) *Opuntia vulgaris* is listed as naturalized in some parts of India.

MOBOT 2003. Distribution of *O. dillenii* is given as North, Middle, and South America, the Caribbean, Europe, Asia, and Africa. "Indigenous in Mexico."

Desmond 1992, 209–10. In the late 1700s, "as opuntias were widely distributed in India and especially in Bengal, it was assumed by Anderson and other naturalists that they were native to the country. They did not know that this invasive genus had been introduced from the New World, probably by the Portuguese, although for what purpose is a matter for speculation."

Osteomeles anthyllidifolia

Origin: Americas

Summary: Distributed widely in Pacific islands and perhaps in the Far East, this positively suggests human transport from the Americas.

Transfer: Americas into Pacific islands (as far as China?)

Time of transfer: pre-Columbian

Grade: B

Sources: *Osteomeles anthyllidifolia* Ldl. (Kew. {Ins. Pacif., China})

Safford 1905, 233. In a footnote under *Cocos nucifera*: "Another interesting example of the wide dissemination of a plant belonging to an American genus is that of *Osteomeles anthyllidifolia*, all save one of whose congeners are indigenous to the Andes, but which occurs in the Hawaiian Islands, Pitcairn, Rarotonga, the Bonin Islands, and the Liu-kiu [Ryukyu] group, near Formosa."

Bailey 1935, II, 2414. There are three species of the genus in East Asia and Polynesia. The South American genus *Hesperomeles*, with about 10 species, of which none seems to be in cultivation, is sometimes united with *Osteomeles*. *O. anthyllidifolia*, Lindl. is spread from Hawaii to Pitcairn Island. In the Hawaiian Islands, it is known as *uhi-uhi*. (Two East Asian species are also mentioned, from China and Japan.)

Bretschneider 1892, 429. A Japanese source (date uncertain) gives (Chinese) characters for the name of this plant or *Osteomeles subrotunda*, Koch (syn. *O. anthyllidifolia*, Ldl.)

Pachyrhizus erosus

Origin: Americas

Summary: The species is long naturalized in India, so much so that it has been considered indigenous and bears a Sanskrit name.

Transfer: Americas to India

Time of transfer: at least before AD 1000 and probably much earlier

Grade: A

Sources: *Pachyrhizus erosus*—jicama, yam bean, xicama

Towle 1961, 51–2. Widely cultivated and naturalized in the tropical regions of both New and Old Worlds for its edible tuberous roots. It is disputed whether this or *P. tuberosus* was grown in Peru.

Newcomb 1963, 61. A legume whose beans contain strychnine and therefore are poisonous. The large, white tuber of the Mexican plant tastes like a young turnip. The same plant occurs in Southeast Asia and a similar plant grows in Andean Valleys. The last is much more starchy and is commonly cooked in stews.

Roys 1931, 235. "*Chicam*. *Pachyrrhizus erosus* (L.)" Jicama. Maya: *chicam*; the xicama (equated in the Motul dictionary). 264. *Mehen-chicam*, jicama dulce.

Watt 1892, VI, Part I, 3. Gives *Pachyrhizus angulatus*. Cultivated throughout India for its large edible root, but it does not occur in a wild state. Sanskrit: *sankhálu*.

MOBOT 2003. (syn. *angulatus*)

MacNeish 1992, 260. Lists this plant as a Southeast Asian domesticate [indicating a long period of naturalization in Asia, since it is actually of American origin (see Brücher)].

Brücher 1989, 84–5. It is cultivated in the Philippine Islands and in China to such a great extent that it was claimed to be of Asiatic origin (Sorenson 1985, unpubl.). Real origin is undoubtedly Central America, where several biotypes still occur wild.

Pachyrhizus tuberosus

Origin: South America
Summary: Another Amazonian plant, old in Peru, that grew also in Western Polynesia as well as in China.
Transfer: China from Americas, possibly by way of Polynesia
Time of transfer: pre-Columbian
Grade: B

Sources *Pachyrhizus tuberosus*—yam bean, jicama, potato bean
Zeven and de Wet 1982, 174. Maximum gene diversity center, headwaters of the Amazon.
Shady 1997, 18. Remains of *P. tuberosus* have been excavated from five sites of the Late Archaic (3000–1500 BC) in Peru.
Yacovleff and Herrera 1934–1935, 281–2. *P. tuberosus*, jicama. Fig. 14 shows the *jiquima* in Nazca art. According to Standley and Vavilov, it grows spontaneously in southern Mexico and Yucatan, where it is also cultivated. Fossil remains have come from tombs at Paracas.
Heyerdahl 1964, 120–33, 128. Clausen showed *P. tuberosus* is native to the headwaters of the Amazon and tributaries in Brazil, Peru, etc. It possesses insecticidal properties, which aid in cultivating the yam. This plant has almost disappeared from modern Peruvian agriculture, although it was described by early chroniclers, and Yacovleff and Herrera (1934–1935) demonstrated its presence in the form of roots in tombs at Paracas (BC times). The plant also formed a decorative motif in Nazca art. Cook reported that the plant occurs in Tonga. While no longer cultivated for food, farmers there believe that planting it makes the soil the sooner capable to yield larger crops of yams. In Fiji, the stem is used for fish lines. Steward (1949, 413) and C. Sauer (1950, 513) both considered this bi-hemispheric distribution as due to trans-Pacific voyaging.
Johannessen and Wang Siming 1998, 9–36, 26–27. *Pachyrhizus tuberosus* is called *dou shu*, or *tu gua*, in China. It is the same plant as Mexican *jicama*. Citations to several Chinese plant records are given, one dated 1736, describing the ‘earth squash,’ or ‘soil squash, characterized as having “its root … quite big, greenish-white in color,” and for which a particular Chinese character was used in writing. The same character today stands for the yam bean. It was in use during the Song Dynasty (*i.e.*, by AD 1182), when the plant represented was said to grow in mountainous areas where barbarians dug it up for food. Also, “It tastes sweet and fragile or soft crunchy to eat.” Several Chinese crop specialists now accept it as present in pre-Columbian China.
Brücher 1989, 44–5. *Pachyrrhizus tuberosus* Lam. Spreng., potato bean, jicama. Origin in Upper Amazonas.
Chang 1970, 177. He accepts the yam bean as one of the early crops of China.

Paullinia sp.

Origin: Americas
Summary: Distributed on either side of the South Atlantic, although propagated by cuttings, there seems a possibility that its African presence is to be accounted for as a result of voyaging. Requires more research, along with *Tephrosia*.
Grade: incomplete

Sources: *Paullinia* sp., piscicidal tree (Kew. syn. *P. pinnata*)
Bailey, 1935, III, 2487. Tropical America, and sparingly in Africa; species number about 140. Propagated by cuttings.
Quigley 1956. More directly of concern are plants found on opposite shores of the South Atlantic. One is *Paullinia pinnata*, L. This is used as a piscicide in South America but not in Africa, possibly because replaced by more toxic species. Chevalier’s conclusion is that human groups use similar plants for similar purposes on both sides of the Atlantic due to “a truly marvelous genius of intuition.” “But it would require much more than that to produce the same species of plant on both sides of the ocean.” Must be by floating or by human agency. And the human agency cannot be Portuguese or Negro slaves. 521. (Fish poisoning had been outlawed by the Spanish king by 1453 and for the Portuguese in 1565.)

Pharbitis hederacea

Origin: Americas
Summary: In India as a widely spread plant that yields a medicinal substance and has a Sanskrit name. It also was probably known in China.
Transfer: Americas to Asia
Time of transfer: before AD 1000
Grade: A

Sources: *Pharbitis hederacea*—ivy-leaf, morning glory, (MOBOT and Kew. syn. *Ipomoea hederacea*)

Safford 1905, 349. A twining plant. “The seeds are strongly purgative and in India are used as a drug under the name of *kaladana* (citing Trimen, *Handbook: Flora of Ceylon*, III, 212–3, 1885). The plant is probably of American origin.”

MOBOT 2003. Distribution (of herbarium specimens) (as *Ipomoea hederacea*) given as Bolivia, Brazil, Mexico, and the Bahamas.

Chopra *et al.* 1956, 142. *Ipomoea hederacea*. Hin., Ben., and Bom.: *kaladana*. Sanskrit: *krishnabija*. Cultivated throughout India and also wild, up to 6,000 ft.

Bretschneider 1892, 349. Gives two Chinese characters as a name for *Pharbitis* which is referred to by Li Shizhen (16th century) and is probably from a classic Chinese reference. The fruit includes a capsule containing seeds built like those of an elm tree, which the wind disperses (a short distance).

Phaseolus adenanthus

Origin: Americas
Summary: Distribution in Hawaii and other Polynesian islands argues for an early voyage.
Transfer: Americas to Hawaii and beyond
Time of transfer: centuries ago in order to explain pan-Polynesian spread
Grade: C

Source: *Phaseolus adenanthus* (syn. *truxillensis*)—a bean

Hillebrand 1888, 104. A twining herb found on the islands of Oahu and Hawaii. A native probably of South America but collected also in most Polynesian islands, on the east coast of Australia, and in other tropical countries. [The preferred mode of transfer to the islands should be taken as human voyaging, unless good evidence for a natural transfer is produced.]

Phaseolus lunatus

Origin: Americas
Summary: This fundamental American crop has been found in India (before 1600 BC) and also in China.
Transfer: Americas to Asia
Time of transfer: before 1600 BC
Grade: A

Sources: *Phaseolus lunatus*—lima bean, sieva bean, butter bean

Zeven and de Wet 1982, 174. Center of gene diversity: Central America and the Andes from Peru to Argentina. The large lima was first domesticated in the Andean highlands and then the small lima (sieva) may have arisen in the Pacific coastal foothills of Mexico. The small-seeded subspecies (ssp. *microsperma*, Sieva, or Small Lima) originated by natural selection.

Sauer 1993, 77. “The archaeological record strongly suggests independent domestication in Central America and northwestern South America.”

Pokharia and Saraswat 1999, 99. *Phaseolus*. “… beans of American origin have been encountered from proto-historic sites in peninsular India.” *P. vulgaris* has been recorded from pre-Prabhas and Prabhas cultures at Prabhas Patan, Junagadh Dist., Gujarat, dated from 1800 BC to AD 600 (endnote 153). Also from Chalcolithic Inamgaon (about 1600 BC), and Pune Dist., Maharashtra (endnote 154), and from Neolithic Tekkalkota (C14: 1620±108 BC), Bellary Dist., Karnataka (endnote 155). *P. vulgaris*, *P. lunatus*, and the phasey bean have been recorded by Vishnu-Mittre, Sharma, and Chanchala (endnote 156) from deposits of Malwa and Jorwe cultures (1600–1000 BC) at Damabad in Ahmednagar Dist., Maharashtra.

Vishnu-Mittre, Sharma, and Chanchala 1986. *P. lunatus* found at the Diamabad site (1600–1000 BC).

Brücher 1989, 91. *P. lunatus* L. has two agrotypes: var. *microcarpus* = sieva bean; var. *macrocarpus* = lima bean.

Pickersgill and Heiser 1978, 811. Includes large limas of South America and small sieva beans of Mesoamerica. Sievas found at Tamaulipas, Tehuacán Valley and Dzibilchaltun, Yucatan, between 1850–1150 BP.

Chen Wenhua 1994, 59. He reports a find of lima beans in an archaeological site in Zhejiang, China.

Chopra, *et al.* 1956, 189–90. Pun.: *lobiya*. Cultivated throughout India. Native of Brazil.

Pullaiah 2002, I, 400. No Sanskrit names.

Yarnell 1970, 225. Earliest remains, Peru: 5300 BP; Southern Mexico: 1400 BP; Northern Mexico: 1800 BP.

Towle 1961, 52–3. She considers *P. lunatus* the same as *P. pallar* (sieva). 45. Discussing specimens found in Peru, Towle notes that Kaplan reported that *Canavalia* sp. was present with *Phaseolus lunatus* from the early pre-ceramic levels through those of the ceramic-bearing Cupisnique Period at Huaca Priéta. 54. Lima-shaped ideograms appear from Nazca, Paracas, and Tiahuanaco.

Newcomb 1963, 38. *P. lunatus* raises a distribution question. Lima beans contain prussic acid. Old World types contain this acid, but few New World ones do except in the varieties found in the West Indies. Prussic acid content was evidently bred out under cultivation in the Americas. But around the Indian Ocean (Mauritius, Madagascar, Malaysia) dangerous types occur. Where did they come from and when?

Heyerdahl 1964. In 1950, Sauer pointed to certain very early genetic peculiarities of a race of lima beans of primitive characteristics long under cultivation in Indonesia and Indo-China. He says: "If, then, Southeastern Asia should prove to be a reservoir of the more primitive lima beans, long since extinct in Peru and Mexico, a further problem of the time and manner of trans-Pacific connection is raised."

See also material under *P. vulgaris*, below.

Phaseolus vulgaris

Origin: Americas

Summary: Archaeologically attested in early Indian sites and, on the basis of names, it was present in the Near East all the way back to Sumerian times and in India to a time when Sanskrit was active.

Transfer: Americas to the Near East or India

Time of transfer: before 1600 BC

Grade: A

Sources: *Phaseolus vulgaris*—kidney bean

Sauer 1993, 73. Vernacular names—common, kidney, navy, string, wax bean.

Yen 1963, 112. Notes that at Huaca Priéta, Peru, Bird (1948) found seeds of *Phaseolus*, dated *ca*. 2578 to 2470 BC (calibrated, 3348–3057 BC).

Roys 1931, 218. Mayan: "*Buul*. *Phaseolus vulgaris*, L. Frijol amarillo." *Buul* is a general term in Mayan for the kidney bean. (*Cf*. 'bean' {*Vicia faba*}, Heb.: *pôl*; Arabic: *ful*.)

Pickersgill and Heiser 1978, 810–11. Earliest *P. vulgaris* in Tamaulipas and Tehuacán, Mexico, domesticated from *ca*. 6000 BP.

Shady *et al.* 2001, 725. The phenomenal site of Caral in the Supe Valley of Peru, dated between 2627 and 2020 Cal BC, yielded remains of *Phaseolus vulgaris*, among other domesticated plants.

Martínez M. 1978, 113–5. This was possibly the most important crop at this (Chiapas) site (around the 1st century BC). Two (possibly three) specimens were recovered here, but both were burned sufficiently that species could not be established. Four beans are cultivated in Chiapas nowadays, plus numerous others wild. His specimen *Phaseolus l.* could be *P. vulgaris*, he suggests.

Chopra *et al.* 1956, 190. Hin.: *bakla*; Pun.: *babr*. "Universally cultivated but not anywhere clearly known as a wild plant."

Kramisch 1928, 50. Reads the kidney bean as present in an Indian text of the 5th century AD.

Thompson 1949, I, 416–436. Gives among Mesopotamian food-plants, "*F*(aba) *vulgaris* Mill. (Arab.: *ful*), as well as *Phaseolus vulgaris* L. (*lubiya ifranjiyah*), *fasulia*.

Pokharia and Saraswat 1999, 99. *Phaseolus* "… beans of American origin have been encountered from proto-historic sites in peninsular India." *P. vulgaris* was recorded from pre-Prabhas and Prabhas cultures at Prabhas Patan, Junagadh Dist., Gujarat, dated from 1800 BC to AD 600 (see endnote 153). Also from Chalcolithic Inamgaon (about 1600 BC), and Pune Dist., Maharashtra (see endnote 54), and from Neolithic Tekkalkota (C14 1620±108 BC), Bellary Dist., Karnataka (see endnote 155).

Vishnu-Mittre, Sharma, and Chanchala 1986, 600–3, 589. *P. vulgaris* specimens were identified from archaeological remains at the site of Diamabad, India, to phases dated 1400–1000 BC.

Balfour 1871–1873, IV, 546. *P. vulgaris*, Linn., called in Eng., 'French bean,' 'kidney bean,' or 'haricot bean.' In Hindi: *lobiya* and *bakla*. "Native of Cabul and Kashmir, said to be a native of India."

Bretschneider 1892, 168. Gives a two-character Chinese name for *P. vulgaris* from a Japanese list (Matsumura). The name may or may not be of classic Chinese age.

Heyerdahl 1964, 130. In the last (19th) century, Körnicke, in a paper on the home of the garden bean, pointed out that this crop was formerly generally accepted as having been cultivated in Europe by the ancient Greeks and Romans under the name of *Dolickos*, *Phaseolos*, etc. It was supposed that the New World bean owed its introduction to post-Columbian early Spaniards. So opinion remained until in 1880 the common bean was found in excavations at Ancón, Peru. … But at that point in time pre-Columbian beans from Europe were no longer available for examination. So then it was supposed that Spaniards had taken the bean back to Europe from the Americas. More recently, Hutchison, Silow, and Stephens [1947] pointed out, with corroborative botanical evidence, that "*Phaseolus* beans indicate inter-hemispheric contact before Columbus." The same problem exists with *P. lunatus*, lima bean. They are in the earliest Chimu and Nazca graves. In 1950, Sauer pointed to certain very early genetic peculiarities of a race of lima beans of primitive characteristics long under cultivation in Indonesia and Indo-China and said: "If, then, Southeastern Asia should prove to be a reservoir of the more primitive lima beans, long since extinct in Peru and Mexico, a further problem of the time and manner of trans-Pacific connection is raised."

Yarnell 1970, 225. Earliest remains: Peru, 2500 BP; Southern Mexico, 1400 BP; Northern Mexico, 1800 BP.

Watt 1888–1893, VI, Part I, 194–5. Kidney bean. Botanists held for a long time that this was of Indian or Kashmir origin, but De Candolle proved this erroneous. He concluded that it had not been long cultivated in India, Southwestern Asia, or Egypt; it is not certain that it was known in Europe before the discovery of the Americas.

Levey 1973, 55 (see also Levey 1966, 16). "The medieval Arabic term for kidney bean [*i.e.*, *P. vulgaris*,] is *lubiya*. It is *lubbu* in Akkadian and *LU.ÚB* in Sumerian. … In Sanskrit and Hindustani, however, it is *simbi* and *sim* respectively …."

Physalis lanceifolia

Origin: Americas

Summary: The historical sources show this species' presence in India anciently where it received a Sanskrit name. It was also taken to the Marquesas from the Americas by voyagers before modern discovery.

Case 1: Transfer: to Eastern Polynesia
Time of transfer: pre-Columbian
Grade: B minus

Case 2: Transfer: Americas to India
Time of transfer: one or two thousand years ago to account for multiple Sanskrit names
Grade: B plus

Sources: *Physalis lanceifolia* Nees—ground cherry, winter cherry (Kew. syn. *lanceolata*; MOBOT syn. *angulata*)

Chopra *et al.* 1956, 191. Sanskrit: *rajaputrika*. Considered a native in the area of Southeast Europe to Japan (it was not an Asian native; naturalized in many parts of the world.)

Torkelson 1999, 1808. Sanskrit: *rajaputrik*a.

Chopra *et al.* 1956, 192. Sanskrit: *lakshmipriya*. Grown in Indian gardens. [From]“Tropical America.”

Nadkarni 1914, 298. *Physalis indica* (no syn.). Eng.: winter cherry.

Brown 1935, 257-8. Approximately 45 species of *Physali*s show a distribution centered in the Americas. Marquesan: *konini*. This species is a “Native of Tropical America; of early introduction in the Marquesas where the fragrant fruits are valued.” [“Early introduction” sometimes means, in Brown’s usage, aboriginal, although the meaning is not entirely clear here.] Used both cooked and uncooked as food.

Bretschneider 1882, 32. Shen Nung, was traditionally an emperor of the 28th century BC who authored a famous classic of *Materia Medica* [although surely the author was not of that remote an age]. In the document attributed to him (31–2), as Bretschneider gives it, Shen Nung lists plants (for which European nomenclature is supplied by Chinese physicians who relate ancient plants with the names). One is *Physalis alkekengi*. From a description elsewhere in this Appendix, this is clearly the ground cherry (syn. *lanceifolia*?), commonly used for food (although *P. alkekengi* is not considered by modern botanists synonymous with *P. lanceifolia*.). 57–61. Li Shizhen authored a great 16th-century synthetic work on medicine, including much compiled older material, wherein he mentions several cultivars of American origin including *Solanum nigrum*, maize, *Portulacca* (*sic*) *oleracea*, and“Pumpkins,” along with “*Physalis alkekengi*,” giving ground for supposing them pre-European in China. He calls *P. alkekengi* (64) “the winter-cherry, *hung ku uiang,* ‘red girl,’” on account of the red leafy bladder which encloses the ripe fruit.

Bretschneider 1892, 45. Two names are given; one applies to a red fruit enclosed in a five-angled bladder resembling a lantern; this is the winter cherry, *P. alkekengi*, a common plant in North China, called also ‘lantern plant’ and ‘red girl.’ Another name is also given—for a common plant that grows near dwelling places. “The fruit is a capsule (bladder) within which is a berry of a yellowish red colour.”

Balfour 1871–1873, IV, 562. In India, *P. peruviana*, the winter-cherry, is commonly called Cape gooseberry or Brazil cherry [and is considered imported.]

Brücher 1989, 276. *Physalis philadelphica* Lam., husk tomato, tomatillo, miltomate. Indians of present Guatemala/Honduras used the wild-growing species *P. philadelphica* Lam., which has relatively large fruits, and have transformed it into a garden crop. Similar importance was given to *P. pubescens* L. (called ‘tomatillo’), which after the Spanish invasion was spread over the whole pantropic belt. *Physalis* species spread also to Asia and Africa.

Hernandez 1942–1946 [before 1580], I, 283. His “tomatl de cascabel,” or *ayacachtomatl*, the editors (who prepared the Hernandez 1942 edition) read as a species of *Solanum* or *Physalis*. Hernandez (III, 699–715) identifies a dozen of the plants pictured under one or another *tomatl*. They include *miltomatl*, *P. philadelphica*; *xitomame* is what is now known as *jitomates*, that is, *Lycopersicon esculentum* Mill. “With the name of ‘*tomame’* are known several species of *Physalis*:” *P. peruviana*, *P. pubescens*. The commentaters note that *P. pubescens* is found in both India and Tropical America. According to Sturtevant, *miltomatl*, the species figured by Hernandez would be *P. philadelphica*. [Because of uncertainties in taxonomy we cannot be certain from Hernandez himself which species of *Physalis* should be compared with which species found in Asia, but regardless of the obscurities of the formal taxonomy, the same fruit seems to be present in both hemispheres.]

Roys 1931, 272. *Physalis pubescens* L. (Standl.). Ground-cherry. *P. angula* L, *farolitos*. Ground-cherry. Mayan, *ppac-can*, according to the Pío Perez dictionary: “A sort of wild tomato … its calyx almost covers the oval fruit, so that the latter rests, as it were, in a capsule.”

Gunther 1934, 468–71. He reads a plant described by Dioscorides (1st century AD) as *Physalis minima* (‘husk tomato’).

See also the material under *Physalis peruviana*.

[This section shows that while early references to species of *Physalis* in Asia are confused, quite surely this one—*P. lanceifolia*—or a closely-related American species, was shared by India and the Americas, and likely more than one species.]

Physalis peruviana

Origin: Americas

Summary: This species was present at least in Hawaii, the Marquesas, and Easter Island, that is, throughout eastern Polynesia, as well as, apparently, India, and perhaps in more of Asia. The occurrence of a Sanskrit name clearly establishes the age of the ‘ground cherry’ on the western side of the Pacific. Furthermore, this species typically grows only in areas disturbed by human cultivation, reassuring us that it did not spread by purely natural forces.

Case 1: Transfer: Americas to India
Time of transfer: 1000 to 2000 years ago, while Sanskrit was a living language
Grade: B plus

Case 2: Transfer: Americas to eastern Polynesia
Time of transfer: pre-Columbian
Grade: B

Sources: *Physalis peruviana*—husk tomato

Chopra *et al.* 1956, 191. Sanskrit: *rajaputrika*. Said to be native to the area from Southeast Europe to Japan; naturalized in many parts of the world. [Actually, this *Physalis* was not an Old World native; see Brücher. The old notion of a Eurasian origin that Chopra *et al*. still reflect suggests the degree of the species’ naturalization in Asia.]

Torkelson 1999, 1808. Sanskrit: *rajaputrika*.

Zeven and de Wet 1982, 181. Known as Cape gooseberry. The Andes is the center of genetic diversity. Often observed as a weed or semi-wild.

Brücher 1989, 275–7. Most *Physalis* species (probably there are 90 taxa in all) are American, with a principal center in Mexico and a dozen taxa in South America. Only a few representatives are found in the Old World.

Heyerdahl 1964, 126. When first recorded by Europeans, the plants of Easter I. included a small husk-tomato. It was formerly widespread in eastern Polynesia. On Easter I. and in the Marquesas, it is nearly extinct, although occasionally found growing wild in old abandoned habitation sites. Also in Hawaii, where Hillebrand in 1888 considered it part of “the important American element of the Andean regions which is apparent in the Hawaiian flora.”

Heyerdahl 1996. “Shiny red husk-tomatoes, the size of big berries,” were identified in the Marquesas by Brown (1935) and considered to have come from the Americas in aboriginal times. Heyerdahl and his bride in 1939 discovered the same plant feral on old habitation sites on Fatu Hiva. It was found also on Easter Island and Hawaii. He found the same husk-tomatoes growing on the site of the Tucumé pyramids in Peru.

Hillebrand 1888, 310. Considers it of pre-Cook age in Hawaii. Native of the Americas, but common in Hawaii in the mountains.

Dressler 1953, 144. The cultivated *Physalis* of the Guatemalan highlands is usually referred to as *P. pubescens*, but may be *P. ixocarpa* (syn. *philadelphica*) or some other species.

Bailey 1935, III, 2608-09. Husk tomato. Ground cherry. Genus contains probably 75 species, mostly American, only a few of which are in Europe and Asia. Species are variable and confusing to the systemist. 2609. *P. ixocarpa*. In Mexico, fruits used for chili sauce, “usually under the name of ‘tomatoes.’” “The Mexican forms are [taxonomically] confused.” *P. peruviana*, Linn. Cape Gooseberry.

Balfour 1871-1873, IV, 561. Calls *P. alkekengi*, winter cherry, “a native of Europe,” and Japan. 562. *P. peruviana* is in India; the winter-cherry plant, commonly called Cape gooseberry or Brazil cherry.

Polygonum acuminatum

Origin: South America

Summary: The technical work by Skottsberg and later by Dumont *et al.* establish a firm basis for interpreting the co-occurrence on Easter Island as due to voyagers.

Transfer: to Easter Island
Time of transfer: 13th century
Grade: A

Sources: *Polygonum acuminatum*—Easter Island: *tavari*

Heyerdahl 1961, 26. Mixed with *totora*, this aquatic plant on Easter I. forms a thick floating bog covering crater lakes Rano Kao and Rano Aroi. *P. acuminatum* is used for medical purposes here as it is in the Titicaca basin. It is an American plant. Skottsberg (1957, 3) considered that human introduction of both *totora* and *tavari* was likely. Neither species occurs elsewhere in Polynesia.

Heyerdahl 1964, 126. Pollen from borings analyzed by Selling showed that *Polygonum* pollen “suddenly” began to be deposited in the crater lakes during the earliest human settlement period. (*Cf*. now Dumont *et al.* 1998 for later data.)

Skottsberg 1920, I, 412. Because of distances to adjacent Polynesian groups and to South America, “The presence of a neo-tropical element (on Juan Fernandez and Easter Island) is surprising.” *Scirpus riparius* and *Polygonum acuminatum* are American. Their mode of occurrence and ecology oblige us to regard them as truly indigenous, “unless they have been intentionally introduced in prehistoric time during one of the mythical cruises which, according to Heyerdahl, put Easter Island in contact with Peru. A direct transport of seeds across the ocean without man’s assistance is difficult to imagine ….” 425. Contrarily, for the Marquesas “there is no neo-tropical element in spite of the prevailing direction of winds and currents,” as far as he notes.

Dumont *et al.* 1998. They report analysis of a core from Rano Raraku crater lake on Easter Island. Five (vertical) zones are identified. The last three of these are separated by waves of immigration. They argue that a first, or South American, wave, dated to the second half of the 14th century by radioactive dating, may represent a visit by South American Indians. 410. They found the top 85 cm. of sediment to include *Schoenoplectus californicus* and *Polygonum acuminatum*. Because of the synchronous appearance of multiple floral taxa, they rule out passive introduction. (418. “… the island is so remote, and such a small target, that mechanisms of passive dispersal were ineffective for populating it” [botanically]). Besides, there are no freshwater birds on the island. “We therefore propose that humans introduced these neo-tropical biota, in one single event …. The most parsimonious explanation for the South American wave, which clearly predates the arrival of the Europeans, might be an introduction by seafaring people from Peru or Chile.” Polynesians presumably [also] reached Easter Island during the 5th century AD.

Portulaca oleracea

Origin: Americas
Summary: Presence widely in the Old World in a naturalized condition combined with Sanskrit names establishes the antiquity of the species in Asia and Europe.
Transfer: Americas to East Asia
Time of transfer: while Sanskrit was an active language.
Grade: A

Sources: *Portulaca oleracea*—purslane (Kew. {Africa, India, southern China, West. U.S., Mexico, Guat., Peru, Brazil, Marquesas, Belize, Nicaragua}).

Watt 1892, VI, Part I, 329–30. A number of Sanskrit names are given. De Candolle [mistakenly] thought it indigenous to the region from the Western Himalaya to the south of Russia and Greece.

Chopra *et al.* 1956, 202. Sanskrit: *lonika*. Grows “all over India.”

Chopra *et al.* 1958, 521–3. Sanskrit: *mansala*. Cultivated and naturalized all over India.

Pullaiah 2002, II, 426. Sanskrit: *ghotika*, *lonika*. Medicinal uses.

Torkelson 1999, 1818. Sanskrit: *lonika*

Hillebrand 1888, 39. Pigweed. Genus of 16 species, chiefly belonging to Tropical America.

Burkill 1966, II, 1832–3. Purslane is found throughout warmer parts of the world; [the genus is] chiefly in the Americas. A vegetable from time immemorial. Appears mentioned in Egyptian texts of Pharaonic times.

Bailey 1935, III, 766. Purslane, pusley. About 40 species in the genus in the tropical and temperate regions, mostly American. *P. oleracea* is probably native to the southwestern parts of the U.S. Gray and Trumbull (1883) argued for the nativity of purslane in North America.

Bretschneider 1882, 49–53. From a treatise, *Kiu Huang Pen Ts’ao*, by Chou Ting wang, an imperial prince under the first Ming Emperor (prince died in 1425). He had seen the following plant in Honan province: *Portulacca* (*sic*) *oleracea*. 57–61. Author of the famous Chinese volume of *Materia Medica*, Pen Ts'ao Kang Mu, first published 1590, mentions *Portulacca* (*sic*) *oleracea*, from which it can be inferred that the plant was present in pre-European times.

Bretschneider 1892, 67. A (Chinese) source shows two figures, one representing an amaranth and the other *Portulacca* (*sic*) *oleracea*.

Balfour 1871–1873, IV, 660. For this he gives English: common, or small, purslane; Sanskrit: *lonika*, or *loonia*. Common in India and eaten by the Hindus. A common weed but cultivated by the market gardeners. Used as spinach and in curries.

Roys 1931, 220. Span.: *verdolaga*; Mayan: *cabal-chum*. The plant is usually called *xucul* in Mayan. 296. *Xucul*, or *H-xucal*, is the name for *P. oleracea*.

Psidium guajava

Origin: Tropical America

Summary: A number of Sanskrit names (as well as obviously cognate Arabic and Persian names) join with widespread naturalization of the plant and use of the fruit in South Asia to assure us that it was not a modern introduction.

Transfer Asia from Americas

Time of transfer: at least 2000 years ago

Grade: A

Sources: *Psidium guajava*—guava

Shady *et al.* 2001, 725. The phenomenal site of Caral in the Supe Valley of Peru, dated between 2627 and 2020 Cal BC, has yielded remains of guava (*Psidium guajava*), among other domesticated plants.

Towle 1961, 73. An oblong, compressed fruit of *P. guajava* was recovered from Ancón cemetery (BC date). Whole, globular fruits were found in Gallinazo and Mochica levels. Depicted on Early Nazca embroidery.

Tozzer 1941, 199. "There is a fruit which the Spaniards have brought [to Yucatan], good to eat and healthy, which they call *guayabas*." Footnote 1088: "*Psidium Guajava* L." [However, the plant is native to the Americas.]

Roys, 1931, 231. Mayan:"*Chac-pichi*. Probably *Psidium guajava* L. Guava." 276. "Pichi. *Psidium guajava* L. Guayabo, Guava."

Brown 1935, 200. More than 100 species of this genus are natives of Tropical America. Two horticultural varieties of the guava are present in the Marquesas. One is probably of aboriginal introduction. The other is of recent introduction.

Watt (1892, VI, Part I, 351–3) gives Sanskrit, Arabic, and Persian names, all closely related (*amrud*). Native to the Americas, now naturalized and largely cultivated throughout India.

Bailey 1935, 2847. Genus entirely native to the Americas. Has become naturalized in many parts of Asia and Africa. The genus is somewhat confused and in need of further study. A large number of species doubtless exist in South and Central America that have not as yet been described.

Balfour 1871–1873, IV, 694–5. *P. pomiferum*, Linn. Eng.: red guava. No Sanskrit name listed by him. "The guava tree of the W. Indies, Mexico, and America, is cultivated throughout the E. Indies." *P. pyriferum*, Linn., Roxb. syn. *Guava pyriformis*, Gaertn. Eng.: white guava. Grows all over British India and all southern Asia. Probably came through the Portuguese.

Chopra *et al.* 1956, 205–6. Sanskrit: *mansala*. "Cultivated and naturalized throughout India."

Int. Lib. Assoc. 1996, 571. Sanskrit: *mansala*.

Nadkarni 1914, 320. *Psidium guayava*. Sanskrit: *péràlà*. Hin.: *amrút*

Chopra *et al.* 1958, 683. Sanskrit: *amruta-phalam*; Hind.: *Amrut*;. Arab.: *amrud.* Found throughout India for its fruit.

Pullaiah 2002, II, 433. Sanskrit: *perukah, mansala*. Medicinal uses.

Aiyer 1956, 36. Mentioned in the *Charaka Samhita*, no later than the 4th century AD, and it probably was present considerably earlier. This despite the belief common among scientists that the plant was introduced to India by the Portuguese.

Sharma and Dash 1983, 518. The paravata fruit of the *Caraka Samhita* text is the guava, *Psidium guajava*.

Saccharum officinarum

Origin: Old World

Summary: Some sources from the period of exploration and colonization of South America identified sugarcane as present and later the cane in South America hybridized with imported sugar cane. Most botanists who deny that sugarcane was present assume that another plant, perhaps an unusual variety of maize, was what was seen. But maize was so well known to Spanish explorers that mistaking corn for cane does not seem possible.

Transfer: Old World across either ocean

Time of transfer: pre-Columbian.

Grade: B minus

Sources: *Saccharum officinarum*—sugarcane

Cook 1904. Sugarcane, he claims, was cultivated in the islands of the Pacific, coastal Asia, and America. No specific data.

Newcomb 1963, 62–3. Pigafetta (Magellan expedition) reported *caña dolce* at Guam, in the Philippines and in Brazil. [Having seen it and apparently identified it correctly in the Pacific islands it cannot be imagined that they were mistaken as to what they had seen in Brazil.] (This Pigafetta eye-witness evidence is explained away by disbelievers as due to reference to a form of sweet maize in the Rio Loa area.) Early Portuguese accounts exist telling of sugarcane which was true cane and which they themselves had not introduced. Labat around 1700 in Martinique spoke of what was grown there as Carib cane, not brought from Europe. In the 17th century, the English on Barbados and St. Kitts found wild sugarcane growing. *Uba* cane, from the Tupi-Guaraní word for the wild cane, proved resistant to a troublesome mosaic disease that attacked the *S. officinarum* that had been brought by the Europeans. The latter was hybridized with *uba* from Brazil and Paraguay to produce a variety that overcame the disease.

Lunde 1992, 50–55. Two plants that definitely were shared between the hemispheres were the coconut and sugarcane (found by the Portuguese on coastal Brazil).

Sagittaria sagittifolia

Origin: Asia

Summary: Carl Sauer considered this Asian plant to have been present in theAmericas, as in China. Further information is needed.

Grade: incomplete

Sources: *Sagittaria sagittifolia*—wapatoo

Sauer 1969, 56. One of a group of Asiatic plants found in theAmericas associated with man. Found also in China. Its possible transmission should be examined further.

Balfour 1871–1873, V, 46. Extensively cultivated among the Chinese, not for its beauty but for the sake of its edible rhizome, which fixes itself in the solid earth below the mud and constitutes an article of food.

Salvia coccinea

Origin: Americas

Summary: Its ancient presence in India is shown by the presence of a Sanskrit name. Brown apparently also considered the plant in the Marquesas to be pre-Columbian; if so, it might have arrived there from the west rather than from its native America.

Case 1: Transfer: to India

Time of transfer: no later than *ca*. AD 1000

Grade: C

Case 2: Transfer: Americas to Marquesas Islands

Time of transfer: pre-Columbian

Grade: B–C

Sources: *Salvia coccinea*—scarlet salvia, cardinal sage

Brown 1935, 252. Native of the West Indies and Tropical America; probably of early introduction in the Marquesas, where it has become thoroughly naturalized at middle and low altitudes.

Bailey 1935, III, 3064. In the West Indies and Tropical America and occasionally escaped in India and Australia.

Roys 1931, 232. Mayan: *chac-tzitz* = "*Salvia coccinea* Juss." "Cultivated under the names of scarlet sage and salvia." Prescribed for decayed tooth.

Watson 1868, 489, 201. Sanskrit: *rosea*.

Schoenhals 1988, 159. Eng.: cardinal sage.

Salvia occidentalis

Origin: Americas

Summary: Brown's description of the extent of its naturalization and spread in the Marquesas Islands suggests its pre-Columbian presence.

Grade: C

Sources: *Salvia occidentalis* Swartz—a salvia

Brown 1935, 253. Native of the West Indies and Tropical America; probably of early introduction in the Marquesas, where it has become established at altitudes from 200–600 m.

Burkill 1979, II. *S. occidentalis* Swartz is another American plant which is established in Java, where it has been tried as a cover crop.

MOBOT 2003. Distribution: Middle and South America.

Sapindus saponaria

Origin: Americas

Summary: The berries serve as a soap as well as fish poison and also medicine for some ailments. Two regional variants have long been utilized for some of the same purposes in India; they are synonymous with *S. saponaria*. The species is present in the Marquesas and on Easter Island, and perhaps elsewhere in the Pacific (which we take to have come across from Asia, where it is old). Sanskrit names for each of the differentiated varieties that characterize south and north India indicate the age of the tree on the subcontinent. (MOBOT does not make the Indian soapberry trees synonymous with *S. saponaria,* but their functions are identical; Index Kewensis does make them synonymous.)

Case 1: Transfer: Americas to Asia
Time of transfer: over 2000 years ago
Grade: B

Case 2: Transfer: Americas to Eastern Polynesia
Time of transfer: pre-Columbian
Grade: B plus

Sources: *Sapindus saponaria*—soapberry (Kew. syn. *S. mukorossi* {Asia trop.}; and *S. trifoliatus*)

Zeven and de Wet 1982, 178. Tropical America is center of maximum gene diversity.

Nadkarni 1914, 350. *Sapinda* (*sic*) *trifoliatus* (syn. *S. emarginatus*). Sanskrit: *phenila*. Eng.: soap-nut tree. Common in Southern India and cultivated in Bengal. *S. Mukorossi* (syn. *S. detergens*) is the soap-nut tree of North India.

Pullaiah 2002, II, 456. *Sapindus emarginatus* (syn. *trifoliatus*). Sanskrit: *arishta*. 457. *Sapindus mukorossi*. Sanskrit: *urista, phenile*, the soap-nut tree of Northern India.

Watt 1889, VI, Part II, 468. He lists *Sapindus Mukorossi*, Gaertn., the soap-nut tree of North India. Distributed also in China and Japan. Original home not clear. Separately, he gives *S. trifoliatus*, Linn. The soap-nut tree of South India. Cultivated in Bengal, South India, and Ceylon. Used medicinally by Hindus "from a very early period."

Int. Lib. Assoc. 1996, 572. *Sapindus trifoliatus* L. var. *emarginatu*s (syn. *Sapindus emarginatus*), Sanskrit: *arishta*. *S. mukorosi,* Sanskrit: *urista*.

Brown 1935, 160–1. The Marquesas plant compares closely with the Society Islands version. Marquesan name: *kokuu*. Juice from leaves and fruit treats skin diseases. Endemic in the Marquesas.

Langdon and Tryon 1983, 43. Rapanui: *mari, kuru*, soapberry. Marquesas: *ko/ku?u*, soapberry. The 60 or so species of *Sapindus* are widely distributed in the tropics, but are best represented in the Americas, citing Macmillan Brown (1935). A variety of *Sapindus saponaria* occurs in Hawaii, where it is called *a?e*. That variety is not found elsewhere in Polynesia. This information in Langdon and Tryon is in a section entitled "Words confined to RAP[anui] and the Marquesic languages, that is, words that occur in extreme eastern Polynesia where the plant may have arrived from the Americas." In the Casma Valley of northern Peru, it has been found in middens with *Capsicum*, cotton, and the gourd, the middens dating to 1785 BC (see Ugent *et al.* 1986). "Well-represented in the Americas" (Langdon 1988, 334).

Quigley 1956, 513. "The evidence seems clearly to show that the fish poisoning trait did not come to the New World by way of Bering Strait." 520. Beyond the *Tephrosia* species pantropical plants of other genera which are recorded as piscicides in at least part of their range [include] … *Sapindus saponaria* L.

McBryde 1945, 152. Much used in Guatemala for soap.

Tozzer 1941, 197. Landa reports a "small fruit … and with the rind they wash their clothes as with soap, and thus it lathers like it." Footnote 1060. "*Sapindus saponaria* L."

Hernandez 1943 [by 1580], II, 529–30. His *charapu* is identified as *S. saponaria*, from Veracruz, Oaxaca, Durango, and Tamaulipas, Mexico.

Roys 1931, 309. "*Zihom*, or *Zihum*. Probably *Sapindus saponaria*, L., soap berry." A tree standing sometimes 50 feet high, bearing a berry acting like soap.

Heyerdahl 1963, 31. Easter Island has this plant which served as a constringent medicine and as soap. Knoche (1925, 102–23) lists it as being at home in the American tropics.

Towle 1961, 62–3. A small tree, four to ten meters in height. Berries contain the glucoside saponin, which yields a soapy lather in water and forms an emulsion with fats and oils. Specimens quite widely known archaeologically.

Schoenoplectus californicus

Origin: Americas

Summary: Totora (a sedge) has many uses that are similar on the coasts, in Andean lakes, and at least on Easter Island and Hawaii.

Grade: A

Sources: *Schoenoplectus californicus*—bulrush, sedge, totora (Kew. *Scirpus californicus*; syn. *riparius*; syn. *validus*; syn. *lacustris*; syn. *totora*)

Langdon 1988, 330, 334. While unknown in western Polynesia, it is found on Easter I. and in Hawaii with a related name in the two places (suggesting a single transfer to one or the other island group followed by diffusion to the other).

Langdon and Tryon 1983, 43. Called in Rapanui: *nga?atu*. Found in the Americas from California to Tierra del Fuego. Used on Easter Island (Rapanui) to cover huts and to make sleeping mats, baskets, floats, and boats. *Cf.* Hawaiian *nanaku* (long dash over first 'a') for the same plant.

Skottsberg 1920, 412. Because of distances to adjacent Polynesian groups and to South America, "The presence of a [*i.e.,* this] neo-tropical element [in the flora] is surprising." *Scirpus riparius* and *Polygonum acuminatum* remain American. Their mode of occurrence and ecology oblige us to regard them as truly indigenous, "unless they have been intentionally introduced in prehistoric time during one of the mythical cruises which, according to Heyerdahl, put Easter Island in contact with Peru. A direct transport of seeds across the ocean without man's assistance is difficult to imagine …."

Mellén B.1986, 135. *S. riparius*, the totora, was called *ngaátu*, and abounds in the craters. It is very old if not indigenous, and was widely used in building, etc.

Heyerdahl 1961, 23–5. Skottsberg studied the wild plants of Easter Island in 1917 and 1956. He said there were only 31 wild flowering plants, and some ferns and mosses, reported from Easter I. Of those, 11 were pantropical and could be seaborne by natural means from either direction. The remaining 20 species are in part dependent on human aid for their spread to this area. The presence of American plants among the 20 was surprising to him. The most unexpected were the two aquatic phanerogams growing in the fresh water of the three Easter Island crater lakes: *Scirpus riparius* and *Polygonum acuminatum*. They are at home in Andean lakes and in irrigated swamps on the desert coast of Peru and Chile. *Scirpus riparius*, the totora reed, was the most important wild plant in the economy of Easter I. culture. The 1770

Gonzalez expedition from Peru identified the totora as the same species as the reed grown in Callao, Peru, and used by native Peruvians to make mats. According to native tradition (on Rapanui), this reed was brought by early ancestors of the Easter Islanders and planted in the deep cauldron of Rano Kao. 26. The pre-European presence of the plant is verified by a specimen found in a datable tomb in Ahu Tepeu. Initially described as a distinct variety, Skottsberg (1956, 407) concluded that it does not deserve to be distinguished as a separate variety since it is identifiable with the American species.

Towle 1961, 26–27. She gives the species as *S. tatora*, not *totora*. The rhyzomes are used for food in Peru, in addition to use for cordage, baskets, etc. Closely related to *S. californicus* [now considered synonymous], it is widely distributed. Some botanists consider the two synonymous. The totora of Lake Titicaca is used to construct the famous reed boats ,or ‘balsas,’ made and used by Aymara Indians on the Lake. Yacovleff and Herrera say that root-stocks of *S. riparius* are used for food, and the canes and leaves are also used in various ways. Archaeological specimens in Peru have been found as early as the Gallinazo period (early centuries AD) as well as at Paracas Cavernas (Formative, perhaps first half of 1st millennium BC).

Gorner 1980,19–22. A lengthy quotation from Heiser claims that he has demonstrated that the totora reed has seeds and that birds carry the seed (the plant is known to grow on uninhabited Pacific islands). [According to Dumont *et al*., there are no (migrating) freshwater birds on Easter Island, hence his claim is impossible to accept in regard to that island.]

Heiser (1985, Chapter 2) reports his extensive pursuit of the origin of the totora reed, proposed by Heyerdahl to have been transported from South America to Easter Island. After reporting a great deal of information from his field and lab studies of the plant, he concludes that nothing rules out Heyerdahl’s proposal, although Heiser prefers a hypothesis of introduction to Easter Island by birds, without explaining his reasons.

Dumont *et al*. 1998. They report analysis of a core from Rano Raraku crater lake on Easter Island. Five (vertical) zones are identified. The last three of these are separated by waves of immigration. They argue that a first, or South American, wave, dated to the second half of the 14th century by radioactive dating, may represent a visit by South American Indians. 410. They found the top 85 cm. of sediment to include *Schoenoplectus californicus* and *Polygonum acuminatum*. Because of the synchronous appearance of multiple floral taxa, they rule out passive introduction. (418. “… the island is so remote, and such a small target, that mechanisms of passive dispersal were ineffective for populating it” [botanically]). Besides, there are no freshwater birds on the island. “We therefore propose that humans introduced these neo-tropical biota, in one single event. … The most parsimonious explanation for the South American wave, which clearly predates the arrival of the Europeans, might be an introduction by seafaring people from Peru or Chile.” Polynesians [also] presumably reached Easter Island during the 5th century AD.

Sesamum orientale

Origin: Old World

Summary: Roys’ Mayan name for this Old World species implies that the species was present and cultivated at the time of the Spanish Conquest. There is a puzzle here that needs to be elucidated by more research.

Grade: incomplete

Sources: *Sesamum orientale*—sesame

Roys 1931, 309. *S. orientale*, *zicil-puuz.*

Miranda 1952–53, 2a parte, 183. The plant was found in Chiapas in field survey. *Sesamum orientale* L. *ajonjolí*. (That name, possibly from Arabic, could have come from Spain via the Spaniards.)

Sisyrhynchium acre

Origin: Americas

Summary: It could not have drifted by sea when it grew so far above sea level. Native use hints at a pre-Columbian age. Further study is necessary.

Transfer: Hawaii from Americas

Time of transfer: pre-Columbian

Grade: incomplete

Source: *Sisyrhynchium acre* Mann**.—**called **'**a grass' in English, although it is not so botanically (Kew. *Sisyrinchium*, with an 'i' not a 'y' in third syllable; {Hawaii}).

Hillebrand 1888, 436–7. This genus includes about 50 species, all except the present one natives of temperate and Tropical America. Found on high mountains of Hawaii and Maui from 3,500 ft. upward. Natives use the juice to give a blue stain to their tattoo-marks. [At such altitudes, ocean drift would be an impossible mechanism for transfer.]

Sisyrhynchium angustifolium

Origin: North America
Summary: This plant has been found in Greenland at former Norse sites; Iverson believes that no other explanation for its presence will do than Norse transfer.
Transfer: Newfoundland to Greenland
Time of transfer: *ca.* AD 1000
Grade: B

Sources: *Sisyrhynchium angustifolium*—blue-eyed 'grass' (but not of the grass family)

Faeggri 1964, 344–51. This plant was found on the site of the Old Norse settlement of Vestribygd in southwestern Greenland. Although considered by some biologists to have survived the glacial period in Greenland, it is more likely to have been transplanted from Vinland by visiting Norsemen.

Polunin 1960, 181. In 1936 in southwestern Greenland, he noted living descendants of this plant that had evidently been introduced from North America by Norsemen. (The author apparently never published further on this topic.)

Thorarinsson 1942, 45–6. Of the 6 plant species that can fairly surely be assumed to have been transported to Greenland by the Norse, there are 5 on North America's Atlantic coast, and the idea can't be excluded that some of these species were even brought there by the Norse. One has, as well, to reckon with the possibility that the plants were transported from North America to Greenland in the same way. In 1932, the Danish botanist J. Iversen found, in a now inaccessible place by Godthaab's fjord in West Greenland and near to the remains of an old Norse settlement, a North American plant, *S. angustifolium*, whose nearest place of discovery lies on Newfoundland's west coast and west of St. Lawrence Bay. In 1937, Iversen and Troels-Smith found this species in three new locales in the West District, all close to the remains of old Norse settlements. Iversen rejects the idea that this species could be an interglacial relic on Greenland ,or that it could have been brought there by modern people. He finds no plausible explanation for this appearance other than that it was transported there from North America by Norsemen.

[Note that these sources fail to give the names of the other 4 species of plants Iverson refers to. Potentially, those four would further support the case for a voyaging transfer of *S. angustifolium* as part of a complex of transported plants.]

Smilax sp.

Origin: Central America
Summary: The sources show a cacophony of species, one or more of which were recognized by the early Spaniards as common to Central America and the Old World, although precise species identification in older sources poses some problem.
Transfer: Central America to Eurasia
Time of transfer: by the time of Dioscorides and the active use of Sanskrit
Grade: B

Sources: *Smilax* sp.—sarsparilla

Torkelson 1999, 1843. Gives the Sanskrit name *chobachini* for *Smilax glabra*, although we do not know that that specific species occurred in the Americas.

Hawkes 1998, 157. Sarsparilla, *Smilax ornata*. This is a medicinal plant from the lowland forests of Central America. According to Woodward (1971), it had arrived in Europe by the 1690s. By habit, it is a climber in tropical forests.

Tozzer 1941, 195. "In the region of Bacalar there is sarsaparilla." Note 1042. "This is a *Smilax*, in Maya, *am-ak*." "If Landa means here that this is the Bacalar sarsaparilla, we would find the Maya equivalent, *x-co-ceh*, or *x-co-ceh-ak*. Standley identifies this as *Smilax mexicana* Geseb., probably *Smilax aristolochaefolia* Mill.

Roys 1931, 215. Mayan, *amak*, is a *Smilax* sp. that resembles *S. mexicana*. Dondé, the Yucatecan botanist, has been quoted as stating that the *am-ak* is a variety of sarsparilla. 225–6. Mayan: *x-co-ceh*, or *x-co-ceh-ak*. 226.

Chopra *et al*. 1958, 187–8. Sarsparilla is obtained from *Smilax ornata*, a climbing plant indigenous to Costa Rica, and from other similar species found in Central America. It is commonly known as Jamaica sarsparilla because it was formerly exported from Jamaica to various countries. *S. officinalis* comes from Honduras, but *S. ornata* is considered to be the best commercially.

The important varieties of sarsparilla and their sources as given in the U.S. Pharm. XIV (1950) are as follows (as reported by Chopra): Mexican source: *Smilax aristolochiaefolia*; Honduras source: *Smilax regelii*; Ecuadorian source: *Smilax febrifuga*; Central American source (the Costa Rican or Jamaican variety): from undetermined spp.

Hernandez 1946, III, 758–69. A number of species, or varieties, of *Smilax*, 'sarsparilla,' are discussed based on H.'s drawings and descriptions. One is *chiquimecatl*, or *pahuatlanense*. This is a species of *Smilax* that Spaniards commonly call *zarzararrilla*. Roots are medically efficacious. Under *mecapatli* o *zarzaparrilla*, the commentaters (editors of the Hernandez edition) observed: "Thus, the Mexicans call that famous medicine that our compatriots call *zarzaparrilla*, and of which are found in New Spain quite a few varieties." Hernandez wrote,"I first want to describe that species that in Spain and principally in Andalucia is found in valleys and mountains, classified by the pharmaceuticalists and botanical specialists as the *Smilax ásper* described by Dioscorides, and (which is) found by me not far from the city of Mexico …." "That this is a species of *zarzaparrilla* (although the Spaniards who haven't come to these lands can hardly believe it), no one can doubt …." Commentaters/editors who prepared this edition of Hernandez say on 760: "The species found by Hernandez in the pueblo of Santa Fe is probably *Smilax moranensis* Mart. *et* Gal., since this is precisely the species that abounds in the cold and mountainous places of the Valley of Mexico. It is very similar to *Smilax aspera* of the Mediterranean region." *Smilax aristolochiaefolia* Mill (syn. *S. medica* Schlecht. *et* Cham.) is the principal source of *mecapatli*, or commercial *zarzaparrilla*. It is distributed in all regions on the slope down to the Gulf (of Mexico), from Tamaulipas to Honduras, and to this species Hernandez alludes at the end of the chapter. (A discussion follows under the name *quauhmecapatli*.) 761. Several species have the same qualities. 764–6. Further discussion. *Cozolmecatl* is *Smilax mexicana* Griseb., found in Guerrero, Yucatan, and Tamaulipas. The dry roots are made into a beverage to treat rheumatism and skin infirmities. 766–8. Still another species of *Smilax* (possibly), *olcacatzan*. 768. There is a species of (in) China, called *mechoacanense*. "The root is called 'root of China' or simply 'China,' a species of *zarzaparrilla* that is imported to Europe from the Orient, above all from China, and has been since ancient times." The Tarascan Indian name for [this] *Smilax bona-nox* (syn. *S. corifolia* H. *et* B.) is *pacas*, or *phacas*, or *phacao*.

Standley 1920–26, 101–4. *Smilax medica*. Veracruz and San Luis Potosi. "The species of *Smilax* which furnish the sarsaparilla of commerce are very imperfectly known, but this species is believed to be one of the chief sources of the drug. According to the U.S. Pharmacopoeia, *S. medica* is one of the official sources of sarsparilla. However, the species are poorly known. Sarsparilla was introduced into Spain about 1540 and was widely used as a remedy for venereal diseases. *Smilax bona-nox* is a second species known as *zarzaparrilla*. He does not include any reference to *zarzaparailla* in discussing *S. mexicana.*

***Solanum* spp. (sources on multiple species)**

Sources: *Solanum* spp.—naranjillo and others (Kew. *candidum* {Mexic.}; syn. *ferox*; syn. *repandum* {Ins. Pac.}; syn. *variabile*; syn. *sessiliflorum* {Brazil}; syn. *georgicum*)

Hutchinson 1974, 158. "Whether or not there is a genetic basis to the taxonomist's concept of a species has been debated long and inconclusively. It must be accepted that a species can only be defined in terms of the available information, and the taxonomist's task is to devise a classification on what is available …." 159. Recent work has shown in many crop plants a closer relationship between cultivars and wild and weedy types. With the knowledge now available of the brief period over which man has been practicing agriculture, it is not surprising that so many crop species can now be seen to be conspecific … with their nearest wild relatives."

Heiser (1985, 76–7) compares the naranjillo of northwestern South America with *S. lasiocarpum* of Southeast Asia. The two are so close that they may be the same species. Fruits are used for food in both areas. He assumes *S. candidum* is American, although no wild ancestor is known. Its wide dispersal in Asia needs explanation. Iberian voyagers in the 16th/17th centuries may have been involved, he thinks. A second species, *S. repandum*, is found only on Polynesian islands and Fiji and again is so similar to *S. candidum* of the upper Amazon area that the question remains of how to explain the high degree of similarity. Again, early Spanish explorers are a possible explanation. So are birds, but if that should be so, it "would not explain why the fruits are used in similar ways in South America and on the Pacific islands."

Whistler 1991, 41–66. This cultivated plant in Polynesia appears to be a South American introduction. *S. repandum* is distributed from the Marquesas to Fiji, but nowadays is rare or has disappeared over most of this range. The closest relative to *S. repandum* is a South American species, *S. sessiliflorum*, according to Whalen *et al*. (1981), and the two are so similar that these authors suggested they may be conspecific. Their section of the genus is predominantly South American, which suggests the origin of *S. repandum* there. In Polynesia, the plant is always associated with human activities, and is rarely, if ever, found in undisturbed habitats, which also suggests the plant is an introduction. Its wide distribution in Polynesia suggests a much earlier, Polynesian, introduction as against a Spanish introduction. "Its Polynesian names, such as *koko'u* in the Marquesas, may be cognates of its South American name, *cocona* (Whalen *et al*. 1981), who [meaning Whalen?] spelled the Marquesan name *kokoua*."

Whalen *et al*. 1981, 41–129. Spread from Sonora and Chihuahua widely into Guatemala and El Salvador, some in Central America, and in the Chocó area of Colombia and lowlands of Ecuador and northern Peru. 105. *S. lasiocarpum* is closely related to the neo-tropical *S. candidum*. The species are so similar that we are not completely at ease retaining them as separate. Differences are all quantitative and in every case there is some overlap. *S. lasiocrpum* must be of ultimate American origin and its present distribution presents a puzzling historical problem, as does that of *S. repandum*. The great variability of *S. lasiocarpum* and its morphological divergence from its American counterpart make recent human introduction an unsatisfactory explanation. If dispersal was by birds or early man, it is surprising that the species is not found on intervening islands of Oceania. 109. Heiser (1972) pointed out the close relationship of *S. quitoense* to *S. candidum*, a wide-ranging species extending form Mexico to Peru. The morphological similarity between these taxa is great, and the differences between them are primarily in characters that would likely have been influenced by human selection during the process of domestication. 83. *Solanum repandum* is very closely related to *S. sessiliflorum* of the western Amazon Basin in South America, and only with some hesitation do we retain it as a species. The two are essentially identical in habit, stellate vestiture, floral morphology, and fruit morphology. Most of the differences are quantitative and there is some degree of overlap. *S. repandum* has not been recorded from primary plant associations in Polynesia. Like *S. sessiliflorum* in South America, it is found only in association with human disturbances and is often cultivated for its edible fruits. Even the uses of the two species are similar in both regions. The berries are cooked in soups and stews and in fish and meat dishes, as well as being used fresh and for juice. Apparently, these are the only two species of section *Lasiocarpa* that are used extensively in cooked dishes.

Whalen *et al*. cont'd. The presence of *S. repandum* as an endemic cultivated plant of the South Pacific presents enigmatic problems concerning its origin and dispersal. All that seems certain is that the species was derived from *S. sessiliflorum* or an ancestor closely resembling that species. When first discovered by Europeans, the South American and Polynesian plants were already as distinct morphologically as they are today. Therefore, dispersal to the Pacific must have occurred much earlier (than European discovery). Either dispersal by human agency or by natural means might have been involved. Certain circumstantial evidence can be marshaled suggesting humans as the dispersal agent. (1) Pre-Columbian Ecuadorians are known to have had sailing vessels capable of long ocean voyages

(Doran 1971), and the Spanish were known to have made voyages to the Pacific in early post-Columbian times. In 1595, the Mendaña-Quiros expedition sailing from Piata, Peru, landed in the Marquesas Islands, the station for *S. repandum* nearest South America. (2) The indigenous name, *cocona,* used for *S. sessiliflorum* in Ecuador and Peru is rather similar to the name, *kokou*, used for *S. repandum* in the Marquesas Islands. (3) As noted earlier, uses of the two species in the two regions are similar. (4) The apparent absence of *S. repandum* from undisturbed vegetation in Polynesia suggests a human role in its survival. Successful establishment perhaps would have been much more likely following human dispersal than after natural dispersal. 84. The objection might be raised that if the Spanish had introduced *Solanum sessiliflorum* there would not be enough time for speciation to occur. 85. However, if one assumes that one or a few seedlings became established on a Pacific island, conditions would be ideal for rapid evolution. As pointed out above, *S. repandum* is only doubtfully a distinct species, and the differences between it and *S. sessiliflorum* are hardly profound. It is probably not necessary to insist on a great length of time to bring about the necessary changes. (Also talks about how the fruits arrived from the Andes to the Pacific coast of South America. Natural means?) “This offers no fewer difficulties than does the former hypothesis—humans. Neither the fruits nor the seeds of *S. sessiliflorum* seem suited for transoceanic flotation. Birds? However, most birds that make long flights in the South Pacific are shore birds and would have been unlikely to have picked up seeds of an upper Amazon plant.

Solanum candidum or *S. lasiocarpum*

Origin: Americas?
Summary: Studies have revealed a complex set of interrelationships among closely related and perhaps conspecific plants in South America, the Pacific islands, and Southeast Asia. Similar uses in different cultures as well as parallels in vernacular native names suggest human carriage into or from the islands of one or the other of these species.
Transfer: South America to Pacific islands and Asia, or vice versa
Time of transfer: pre-Columbian
Grade: B plus

Sources: See combined sources on *Solanum* spp.

Solanum nigrum

Origin: Old World?
Summary: Regardless of its place of origin, this plant was clearly present in both hemispheres before the Columbian era of discovery. Because the seed’s narcotic properties are so widely known, we suppose that its spread was due to cultural selection and voyaging. It has not been suggested to have spread naturally.
Case 1: Transfer: one hemisphere to the other, probably Old World to the Americas
Time of transfer: pre-Columbian
Grade: A minus

Case 2: Transfer: American mainland to the Marquesas Islands
Time of transfer: pre-Columbian
Grade: C

Sources: *Solanum nigrum*—nightshade, black nightshade
Thompson 1949, 142–3. *Solanum nigrum* (see Post 1932, ii, 379) Use in India, China, is mentioned. 143. “ … it is obvious that the *S. Nigrum* is a very popular drug in the East.” The Assyrians used it.
Nadkarni 1914, 373. *Solanum nigrum*. Sanskrit: *kákamàchai*. Ben.: *kákmáchi*. Common throughout India.
Chopra *et al*. 1958, 525. Sanskrit: *kakamach*. Many medicinal uses. Grown throughout India up to 9,000 ft in the western Himalayas.
Chopra *et al*. 1956. Sanskrit: *kakamachi*
Torkelson 1999, 1845. Sanskrit: *kakamachi*
Int. Lib. Assoc. 1996, 573. Sanskrit: *kakamachi*
Pullaiah 2002, II, 473. Sanskrit: *kakamaci*

Nicolson *et al*. 1988, 249–50. A sheet in *Hortus Malabaricus* they say has been identified generally as showing *S. nigrum*; however, now "modern workers are restricting *S. nigrum* to a hexaploid (2n=72) that may not be in India. Syumon (l.c.) commented that works on Indian botany persist in misusing *S. nigrum* for what is *S. americanum*, a diploid species with 2n=24. A key is given here to distinguish the two. "Pending firm evidence to the contrary, Rheede's (*i.e*., the *H. Mal*.) element is perhaps best treated as *S. americanum.* Names: *nilamchunda*, still used in Kerala; also called *manithakkali*.

Roys 1931, 248. Mayan: *Ich*-('ch' plosive)*can*. *Solanum nigrum*, L. "A synonym for *pahal-can*." 2723. *Pahal-can*. *Solanum nigrum*, L. Black nightshade. Yerba mora.

Yacovleff and Herrera 1934-1935, 281. *S. nigrum*, L. called *hierba mora* in Peru. An herbaceous plant with light blue flowers. Has narcotic properties.

Brown 1935, 255. Marquesas: *koporo*. Juice of the leaves is used as a toothache remedy. A widely distributed weed in tropical and temperate parts of the globe; possibly of aboriginal introduction in the Marquesas. Also from eastern Polynesia in general.

Watt 1888, VI, Part III, 263–4. Found throughout India and Ceylon. Distributed to all temperate and tropical regions of the world. Berries were described in Sanskrit works of medicine.

Bretschneider 1882, 57–61. The famous Chinese volume of *Materia Medica*, Pen Ts'ao Kang Mu, which was compiled in part from older materials, mentions *Solanum nigrum.*

Maimonides 1974. *Solanum nigrum* mentioned.

Mayerhof and Sobhy 1932. *S. nigrum* mentioned, from Maimonides.

Balfour 1871–1873, V, 461–2. English nightshade, or common nightshade. Sanskrit: *kaka machie*; Persian: *ruba tarbuc*; Hindi: *mako, mackoe, pilkak, kaknachi*. Although considered by Europeans to be poisonous, natives of India eat the fruit with impunity. Used medicinally.

Hernandez 1942–1946 [before 1580], III, 710. Discussing *Toonchichi*, this is a strange (foreign? *extranjera*) species of *Solanum.* Identified as *Solanum*? Under the name, *tonchichi*, it is known today in Oaxaca, according to M. Martínez ('*Catalogo*,' p. 475) as *Solanum nigrum*. "Nevertheless, this species of *Solanum*, so well-known in Spain with the name of *hierba mora*, did not seem 'strange' to Hernandez.

Standley 1920–1926, 1296–7. Widely distributed in tropical and temperate regions of both hemispheres. Black nightshade. A common weed in Mexico and the U.S. Berries commonly believed to be poisonous, yet some forms of the plant have been cultivated under the names 'wonderberry' and 'garden huckleberry.' A somewhat variable plant, and many of the forms, including several from Mexico, have been described as distinct species.

Solanum repandum or *S. sessiliflorum*

Origin: Americas?

Summary: Such closely-related species distributed in linkable areas invites seeing one species derived from the other, in whichever direction. The similar uses suggest human carriage rather than natural passive transmission.

Time of transfer: pre-Columbian

Grade: B plus

Sources: See combined sources on *Solanum* spp.

Solanum tuberosum

Origin: South America

Summary: Early visitors to Easter Island were shown/given tubers that appear to have been *S. tuberosum*.

Transfer: South America to Easter Island

Time of transfer: pre-Columbian

Grade: A minus

Sources: *Solanum tuberosum*—potato

McBryde 1945, 139–40. There are thirty species in Mexico and Guatemala, double those of Peru or Chile. Small red ones were probably in Guatemala as a pre-Columbian introduction (from the south). McBryde had seen ceramic models in Peru of a large, well-developed potato similar to the 'Irish' potato.

Jeffreys 1963a, 11–23. Quotes from Roggeveen, the first European to visit Easter Island (1721), who said in the original log of the expedition that the natives presented them with “a good lot of potatoes” (193, citing the translation in Corney 1908, 135.) 19. In 1825, the ship Blossom visited the island and Peard’s journal mentions receiving “small baskets of potatoes.” (Jeffreys distinguishes these from *batatas,* sweet potatoes.)

Yarnell 1970, 225. Earliest remains: Peru, 2700 BP.

Mellén B. 1986, 133. A report from Olaondo, who investigated part of the interior of the island the same day as Hervé and others in the first Spanish expedition to Easter Island stopped elsewhere, noted that the natives had “some maize and potatoes.” He is the only chronicler to note the potato. Mention of these two plants augments the evidence for an introduction of plants from the New World by South American navigators. The current Easter Island word for the *patata* (the term used by Olaondo) nowadays is *kumara putéte* (formed from the word for sweet potato, *kumara*, plus a second term derived from the English word ‘potato’).

Stubbs 1996, 24**.** Two examples, amidst a large set of lexical correspondences forming a systematic pattern that relates Semitic to Uto-Aztecan languages, show Hebrew *tirmania*, ‘truffle,’ and Hopi *tïmna*/*tïmon*, potato. The sound transformations are witnessed in many other cases presented. Also, he compares Aramaic *kam*’, ‘truffle,’ with Náhuatl *kamo’-tli*, sweet potato; and notes also Ugaritic *kama’atu(m*), ‘truffle,’ and Cora *kamwah*, ‘sweet potato.’ [The possible lexical relationships might be evidence that at least some tuber may have been known among or exchanged between both these languages/cultures, or maybe just the idea of tuber.]

Sonchus oleraceus

Origin: Old World

Summary: In addition to a long history and wide distribution in Eurasia, the sources identify the same plant in pre-Columbian America. This species is often confused with *C. intybus*. Either is called ‘chicory’ in various sources.

Transfer: Old World to the tropics of the New World

Time of transfer: pre-Columbian

Grade: B plus

Sources: *Sonchus oleraceus*—sow thistle

Tozzer 1941, 196. Landa in 16th-century Yucatan says: “There are very fresh chicories and they grow them in the cultivated lands, although they do not know how to eat them.” [Probably meaning that they did not know how to process the roots to make the coffee flavorer, or coffee substitute, known as chicory.] Footnote 1058, p. 196: “Roys (268) and Lundell identify this as *Sonchus oleraceus*, L., a native of the Old World. Roys gives the Mayan name as *nabukak* and notes that while this name does not appear in any of the Yucatecan sources, “the plant is probably the one described here by Landa.”

Watt 1988–1893, II, 285. He lists *Cichorium intybus*, Linn. The wild, or Indian, endive, chicory, or succory, is cultivated from the Atlantic to Punjab and Kashmir and Morocco to Lake Baikal, wild in many places. 287. The young plant is used as a vegetable. The roots are roasted, ground, and mixed with coffee to flavor it. Sometimes it serves as a substitute for coffee.

Bailey 1935, III, 3189. Of the genus of 40 or more species in the Old World, some of them were introduced in North America as weeds. In the Canaries it is considered a salad.

Balfour 1871–1873, V, 482–3. *Sonchus ciliatus,* Lam. syn *S. oleraceus*, Roxb.. W.: *Ic*. Eng.: sow thistle. A native of Europe, of the Punjab plains and up to 8,500 ft., and of Peninsular India. Used in the Nilgherries as a potherb by natives. In Kashmir, people use it as a vegetable.

Watson 1868, 259. Persian: *Cichorium endivia*, *kasnee*. The seeds in Hindi and Tamil are called *kassini-verei*. 274. ditto, *kesni. Cichorium intybus,* Linn. The wild, or Indian, endive, Chicory.

Bretschneider 1892, 179. *Sonchus oleraceus,* sow thistle. Chinese terms given.

Roys 1931, 268. Mayan: “*Nabukak*. *Sonchus oleraceus*, L. Achicoria, lechuga silvestre [wild lettuce]. What Landa called ‘chicories.’”

Yacovleff and Herrera 1933–1934, 299. Peru. Discussion of “Cerraja; Chicoria. *Hypothoeris sonchoides*, Kth. Used in popular medicine as an antibilious and antifever remedy. *Hypochoeris stenocephola* var. *subcaposa* Hieron. is rather similar to the preceding species. Used for food and medicine. Quotes Contreras: "It is an herb used by the Indians in health and sickness; they eat it raw. Has the same properties as chicory."

Sophora toromiro

Origin: South America
Summary: The many uses to which this valuable tree is put, the tradition that says it was introduced by a voyaging ancestor, and the highly restricted distribution argue for arrival of the tree by voyaging immigrants.
Transfer: South America to Easter Island
Time of transfer: pre-Columbian
Grade: A

Sources: *Sophora toromiro*—toromiro tree (Kew. syn. *tetraptera* {N.Z., Chile})

Heyerdahl 1963, 26–7. The only wild tree in the flora of Easter Island, now essentially extinct except for some bushes. Formerly the principal material for wood-carving, used for house frames, tiny canoes, for ceremonial and practical paddles and clubs, wooden images, etc. Traditions recorded by the first missionaries said that the toromiro tree was imported by the original immigrant ancestors.

Knoche (1919) considered it a cultivated plant. Apart from a distant relative in New Zealand, related species are absent from Polynesia. Skottsberg found that its closest relative is *Sophora masafuerana* from Juan Fernández Island. The time and mode of introduction to the island is obscure, possibly having come from some South American area where it is now lost.

Skottsberg 1920, 421. Forster (who was with Capt. Cook in 1774) mentioned 'Mimosa' (*Sophora toromiro*). On page 373, he says: "*Sophora* (called *tetraptera*) was recognized and recorded only from Chile, Juan Fernandez, Easter Island, and New Zealand."

Mellén B. 1986, 135. Pascuan [Easter Island] traditions relate that ancestral settler Hotu Matu'a brought to the island different species of trees and plants, such as the *totomíro* (*sic*), (*i.e.*) *Sophora toromiro*. The indigenous name derives from *totó-miro*, literally translated as 'blood of wood.'

Guppy 1906, II, 64. At Easter Island he suspects South American immigration due to the presence of *Sophora tetraptera* (assumes it equals *S. toromiro*.)

Spondias lutyea

Origin: uncertain
Summary: Known only from Standley's comment.
Grade: incomplete

Source: *Spondias lutyea*

Standley 1920–1926, 658. The species is widely distributed "in the tropics of both hemispheres." This species is rather rare in Mexico but sometimes [is] in cultivation. "It may be that it is not native there." Its fruit is similar to the *mombin* but of inferior quality. "This species has doubtless been confused in Mexico with *S. mombin*."

Spondias purpurea

Origin: Americas
Summary: The 'mirabolanos' of the Mediterranean, and *S. mombin*, or *S. purpurea*, of Middle America appear to be the same (the early Spaniards considered them the same plant).
Transfer: Middle America to Eurasia
Grade: incomplete

Sources: *Spondias purpurea* (syn. *mombin*; syn. *pinnata*; syn. *acuminata*)—hog plum, golden mombin, ciruela

Tozzer 1941,198. *Spondias purpurea* L. 'plum,' Yucatan

Aiyer 1956, 19. *Spondias mangifera* is the Indian hog-plum; Sanskrit: *amrataka*, mentioned in the *Birhat Samhita* and *Mahabharatha*, dated previous to AD 400.

Patiño 1963, 254–5. Also called *hobos*, or *jobos*, *mirabolanos*, and other names listed. In the Antilles, the Spaniards believed that the *Spondias mombim*, or *hobo* (a 'plum'), was the same as the Asiatic *mirabolanos*. In the beginning in the Antilles, they fed them to hogs, hence 'hog plum.'

Yacovleff and Herrera 1933–1934, 304. *Spondias purpurea* L. ciruelo, jobo. The fruit is an oval drupe, purple or yellow color, pleasant acidic taste, with a single seed. According to Vavilov, it grows spontaneously and is cultivated in southern Mexico. It was seen by Cabezas in Peru.

Roys 1931, 235. "*Chi-abal*. *Spondias mombin*, L." *Ciruela morada*. 245. Syn. *Ciruela colorada.* 213: *abal-ac*. *S. purpurea*. Motul: "The wild ciruela and its fruit." English: 'hog plum.' Maya medicinal use. 312. Also *zuli-abal* ("probably *S. mombin*.")

Bretschneider 1882, 38. In the document, *Nan fang Ts'ao Mu Chan* (China), the author, Ki Han, AD 290–307, lists 80 species including *Spondias*.

García-Bárcena 2000, 14. *Spondias mombin*, ciruela, was grown in Mexico from 5000 BC.

Brücher 1989, 217–8. Red *mombin, jocote*. Probably of Central American origin, native also in the Antilles. Distributed from Mexico to Paraguay. During fruiting thousands of yellow fruits cover the soil under the trees, avidly devoured by wild animals and hogs. Fruit similar to European plums.

Standley 1920–1926, 656–8. He equates *S. mombin* with *S. purpurea*. Called *jobo*, or *hobo*, in some areas, *ciruela*, etc. English name is 'hog plum.' Common in many parts of Mexico. The tree is treated by most of the early writers on the Americas. Oviedo names it *xocot*, *ciruelo* (*sic*), and *hobo*. *S. purpurea* is illustrated by Hernandez [by 1580] but without description, under the name *mazaxochotli*. It has fruit similar to *mombin* but of inferior quality. "This species has doubtless been confused in Mexico with *S. mombin*." [One of the reasons for the many varieties is that the tree can be easily reproduced; any time a new taste or shape of fruit is observed, it can be reproduced by simply placing a branch in the ground.]

Addendum: Too late to enter in detail: Carter 2002, 253.

Synedrella nodiflora

Origin: American tropics

Summary: Its distribution in at least India and the Americas raises a question about possible transfer by ancient voyagers. In the absence of better information we consider it a reasonable possibility that it spread to India at the same time as other plants demonstrated (above) to have so traveled.

Grade: incomplete

Sources: *Synedrella nodiflora* (L.) Gaertn. (Kew: Am. Trop.)

Brown 1935, 349. Two species of this genus are natives of the American Tropics. This one is now worldwide in the Tropics. "A pantropic weed of American origin; probably of aboriginal introduction in southeastern Polynesia."

Pandey 2000, 274. *S. nodiflora*, from Tropical America, "naturalized in some parts of India".

Pope 1968, 253. Listed by Hooker (*Flora of British India*, Vol. 3, 308, 1879) as distributed in the tropics of the Americas and Asia. It was recently reported growing on Christmas Island in the eastern Pacific; that island has had no modern settlers likely to have introduced the plant. [There are indications of some transient ancient visitors, although Pope supposes that the plant was introduced by floating on the ocean.]

Tagetes erecta

Origin: Mexico

Summary: Substantial evidence from several lines shows that the plant has long been in India and is used in essentially the same ways in Mexico.

Transfer: Mexico to India

Time of transfer: in time to receive two Sanskrit names and to become firmly ensconced in the ceremonial calendar on a wide scale.

Grade: A

Sources: *Tagetes erecta*—large marigold

Zeven and de Wet 1982, 188. South-central Mexico is the place of maximum gene diversity. Probably a parent of *T. patula*.

Nadkarni 1914, 389. In India, *Tagetes erecta*. Eng.: French marigold

Pandey 2000, 287. India. *T. erecta* is a native of Africa or Mexico.

Chopra *et al*. 1956, 239. Sanskrit: *zanduga*

Torkelson 1999, 1853. Sanskrit: *zanduga*

Int. Lib. Assoc. 1996, 574. Sanskrit: *sthulapushpa*

Pullaiah 2002, II, 492. Sanskrit: *sandu, sthulapushpa, ganduga*. Medicinal uses.

Hernandez 1942–1946, II, 644–52. Ten varieties of *Tagetes* are illustrated by Hernandez, including *T. erecta* (*cempoalxochitl*, or 'flor de muerto'). Also, *macuilxochitl*, possibly a variety of *T. erecta*, or of *T. patula*, while *T. patula* may be his *tepecenpoalxochitl*. 'Flor de muerto' means flower of death.

Neher 1968. Gives a long list of uses for each species of marigold, with country listed. 321. In India, it is an anti-nematode. Used as general coloring, same as *Bixa orellana*. *Tagetes patula* and *T. erecta* are revered for their beauty and are the species most commonly associated with observance of All Saints Day, Nov. 1, and All Souls Day, Nov. 2, in Latin America. Called 'flor del muerto.' In Mexico, the most abundant flowering of the marigolds corresponds with the time of these religious ceremonies. Flowers are used to decorate household altars and are strewn on the graves of relatives and on paths to guide the souls of dead children to food and offerings placed on the altars. Marigolds commonly found growing in profusion along pathways and cemeteries. 322. Both species are also used in Hindu religious ceremonies. Used as altar decoration. Eyewitness account by Harlan is quoted of a village harvest festival when village gods were decorated with garlands of marigolds. Flowers were everywhere. The orange/yellow shade of the flowers is exactly the same as maize and peppers (grown in that village). Harlan says it seems evident that the marigold provided the model (color) for the other crops to mimic. The marigold is a sacred flower in the Kulu valley, Himachel Pradesh, and varieties of maize and peppers have been bred to match its color.

Johannessen, personal observation. There is heavy production of *Tagetes* plants and flowers of several sizes in Bhutan and Nepal for use in celebrations in adjacent regions of India, where each year rickshas and taxis are strung with marigold flowers in a riot of color from Oct. 30–Nov. 3.

Newcomb 1963, 164. The marigold, genus *Tagetes*, is a ritual flower in Mexico and Central America that was carried early into Europe along with its same usage. It is used to deck out the icons, and in South Germany it is known as the flower of the dead. It is a domesticated plant in Mexico, where double marigolds were found.

Tagetes patula

Origin: Mexico

Summary: The uses in India are nearly identical to those in Mexico for both this species and for *T. erecta*. Evidently they were transmitted as a pair.

Transfer: Mexico to India. There is insufficient data to determine whether the German use/transfer was post- or pre-Columbian.

Time of transfer: pre-Columbian; probably transferred with *T. erecta*

Grade: B

Sources: *Tagetes patula*—dwarf marigold, French marigold

Roys 1931, 279. Mayan, *x-puhuk*, or *maceual-puhuk*. Very abundant in old fields near Izamal. See also Hernandez 1942–1944 (before 1580), III, 652. *T. patula*.

Pandey 2000, 271. *T. minuta* (referring to dwarf?) is one species "naturalized in some parts of India." 287. *T. patula* a native of Mexico.

Zeven and de Wet 1982, 188. South-central Mexico is the place of maximum gene diversity. Probably *T. patula* has *T. erecta* as an evolutionary parent.

Pullaiah 2002, II, 493. Sanskrit: *taugla*.

See also the information under the Neher entry on *T. erecta*.

Tamarindus indicus

Origin: Asia

Summary: Wide distribution and naturalization in Tropical America leads to the possibility of a pre-Columbian transfer for which there is no direct evidence except a native Mayan name.

Grade: incomplete

Sources: *Tamarindus indicus*—tamarind tree

McBryde 1945, 147. Says of its Mesoamerican presence, “presumably from India.”

Castelló Yturbide 1987, 61. The tamarind, an Asiatic tree, must have arrived very early on the Manila galleon, for it is found everywhere in *tierra caliente* (in Mexico).

MacNeish 1992, Table 9.1. Native of Southeast Asia.

Pandey 2000, 271. *T. indica*, a native of tropical Africa, was imported to India.

Roys 1931, 273. “*Pah-chuhuc* (‘ch’ plosive). *Tamarindus indica*, L.” “Although a native of the East Indies, it appears to be thoroughly naturalized in the Maya area.”

Johannessen, personal observation. Tamarind fruit is produced abundantly in Central America in the regions of hot climate where the juice, mixed with water, is used as a refreshing drink.

Tephrosia sp.

Origin: uncertain

Summary: Quigley raises questions about the reason for this tree’s presence on either side of the South Atlantic. Further study is needed.

Grade: incomplete

Source: *Tephrosia* sp.

Quigley 1956, 510. After discussing botanical nomenclature, which includes many synonyms for the species, he concludes, intermediately, that “In general, the wide distribution of a few plants used in the same way over an area which is known to have been in culture contact from a remote period of prehistory (*sic*) seems to strengthen the view that the whole Old World forms a single diffusion area.” Furthermore (513), “The evidence seems clearly to show that the fish poisoning trait did not come to the New World by way of Bering Strait.” On subsequent pages he presents a highly detailed treatment of the intergrading and overlapping of the species of fish-stupefying plants which has resulted in labeling what are effectively the same species, or at least the same genera, on different continents as multiples. For example (517), the worldwide range of some species of *Tephrosia*, their weed-like qualities (such as prevalence around old human habitats, showing travel as hitch-hikers with humans), their great variability, their occurrence as cultivated plants on very primitive levels, all serve to make *Tephrosia* an important plant in the study of early agriculture, prehistoric migrations, and cultural diffusion. There are about 150 species, of which 22 are used as fish poisons. However, the list of 22, because of taxonomic overlap, is actually fewer. 519. … “It would seem that the widespread American fish-poison *Tephrosia toxicaria* and the widespread African fish-poison *Tephrosia vogelii* could, botanically speaking, have been derived by long cultivation from a common ancestor, and have passed across the Atlantic from Africa to jungle South America in the pre-Columbian period.” “This view is supported by a great mass of evidence, no single piece of which is entirely convincing but whose cumulative effect is rather persuasive.” 520. Beyond the *Tephrosia* species, pantropical plants of other genera, that are recorded as piscicides in at least part of their range, are *Cissampelos pareirs* [sp.?] L., *Sapindus saponaria* L. [*q.v.* in this study], and *Entada phaseoloides* L. (all the above with many references).

Trapa natans

Origin: Eurasia

Summary: Occurrence and use in China as well as, reportedly, in North America, this distribution has raised the question of how and when transfer took place between the hemispheres. That needs further study.

Grade: incomplete

Sources: *Trapa natans*—water chestnut

Sauer 1969. Raises a question about the plant’s occurrence in both hemispheres.

Bretschneider 1892, 220. In his *Index Florae Sin*., on page 311, all the Chinese species of *Trapa* are referred to as varieties of *Tr. natans*, L.

Balfour 1871–73, V, T–186. The European species is said to be grown also in China. The seed is good to eat, somewhat like a chestnut. It was known to the Romans. Pliny said it was used on the Nile for food.

Watson 1969, 400. “At the site of Chiien Shan Yang in Chekiang, in addition to rice, the following were identified,” *Arachis hypogaea* (obviously a very early American crop import), and *Trapa natans*. (Citing, in endnote 17, “*Chekiang Province Cultural Properties Control Report* {1960} on the first and second seasons of excavation at the site of Ch’ien-shan-Yang in Wu-hsing hsien, Chekiang, K’ao ku hsüeh pao, 2 pp. 84.7.”)

Triumfetta semitriloba

Origin: Americas
Summary: The use of this neo-tropical species on the island makes quite certain its transfer from the mainland, along with at least a dozen other plants (above).
Transfer: South America to Easter Island
Time of transfer: pre-Columbian?
Grade: C

Sources: *Triumfetta semitriloba*
Heyerdahl, 1963. 31. The bark of this Easter Island plant provided material for rope.
Knoche (1925, 102, 123) lists the plant as being at home in the American tropics.
Roys 1931, 267. A shrub 10 feet high found in brush lands near Izamal, Yucatan. The small fruit is covered with spines and sticks to clothing.

Verbesina encelioides

Origin: Americas
Summary: Hillebrand’s expert judgment should be respected unless it is impeached by pertinent facts. The significance of the fact that the plant is also naturalized in India needs further investigation.
Transfer: North or Middle America to Hawaii
Time of transfer: pre-Columbian
Grade: C

Sources: *Verbesina encelioides* (Cav.) Benth. & Hook, f. ex A. Gray #3 VEEN Crownbeard (from biosis) (Kew. Am. No. and Austr.)
Hillebrand 1888, 204. A note under the genus statement says: “A large genus, diffused over the warmer parts of the American Continent.” The note following the species description says: “A native of Mexico, Arizona, and Texas.” On page XCIII, the volume editor, W.F. Hillebrand, notes that his father, the author, changed his mind about some plants which he first assumed to be introduced since Capt. Cook’s voyage of discovery; those plants “may in reality have been of earlier introduction,” but he failed to go back and remove the symbols indicating the fact. He says, “Of 9 non-endemic species which existed before the discovery … one, *Verbesina* [is] American ….”
Pandey 2000, 241. *V. encelioides*, from Tropical America, is one species “naturalized in some parts of India.”

Vigna sinensis

Origin: Africa
Summary: The American distribution deserves further research in light of other transfers from the Old World evidenced above.
Grade: incomplete

Sources: *Vigna sinensis*—cowpea
Newcomb 1963, 40. This is African, although it was considered to be from the New World until De Candolle. It is a possible Negro African introduction before Columbus, although it was missing from Arab Africa.
Sauer 1950, 500–3. *Vigna* sp. occurred in both hemispheres before Columbus.

Vitis vinifera

Origin: Old World
Summary: Martinez’ discovery of apparently *V. vinifera* seeds in archaeological remains from southern Mexico is basis enough for more careful scrutiny of other sources.
Transfer: Old World to Mesoamerica
Time of transfer: by the turn of our era
Grade: B minus

Sources: *Vitis vinifera*—grape
Bretschneider 1892, 316. The true vine, *Vitis vinifera*, L., now extensively cultivated in the northern part of China, was introduced into China from Western Asia, in about 125 BC, and is known since that time under the name of *p’u t’ao.*
Sauer 1993, 167. *Vitis* includes about 60 species native mainly to North and Central America and to East and Southeast Asia. *Vitis vinifera* is the Eurasian grape. It is considered by experts to have been derived from a single, fairly homogeneous wild progenitor, *V. sylvestris.* 169. In Asia, the earliest evidence of cultivation of *V. vinifera* and of wine making is from Iran and Baluchistan, dated before 2000 BC. Cultivation spread very slowly into India and China.
Scholes and Warren 1965, 784. A ‘grape’ was in use in the Olmec area, Gulf Coast of Mexico, at Conquest (species not identified).
Martínez M. 1978, 14, 21. The site of his study is a few miles upstream from Santa Rosa, near Laguna Francesa, on the south bank of the Grijalva River, southern Mexico. He worked primarily on the contents of two bottle-shaped cavities (*chultuns*) filled with trash. Dated to the Proto-Classic period (200 BC to AD 200), *i.e*., the second half of Chiapas V through VII (ceramic periods). He used flotation to extract seed from excavated material. On 105*ff* is Cuadro No. 13, classification of vegetal remains. “Vitis, wild, called *bejuco de agua* (*vid*).” Under “Estimulantes” he gives: “*Vitis*. *silvestre* (wild), *vino*, *fruto*, *fermentado* ({assumed} fermented).” 121. Cites Miranda 1975–1976, I, 175–6, as reporting from field survey in Chiapas three species: *V. bouraeana*, or watervine; *V. tiliifolia*, also called watervine; and *V. vinifera*, or ‘vid europea.’ He also mentions *V. labrusca*, or ‘vid americana,’ leaving it unclear if he considered this a fourth species of grape. A rather good quality wine can be made from the juice (no species pinpointed). *Vitis* is wild and only slightly represented in our materials. 125. As indicated previously, utilizing the juice of the grape, pressed and fermented, he says that it is possible to produce a good quality wine. 176. Furthermore, the sap from the stem of the grape plant is fermented (today) to make a drink called ‘taberna.’

Zea mays

Origin: Mesoamerica
Summary: Archaeological evidence demonstrates unquestionably that this species was known in pre-Columbian Asia. Of particular interest is the discovery in an archaeological site on the island of Timor of remains of maize dating to the 3rd millennium BC. There probably were separate introductions of ‘primitive’ *Z. mays.* Strikingly similar plants have been found growing in the Himalaya and interior East Asia and a more developed variety of later date. Names, including Sanskrit names, as well as art representations, confirm that maize was growing in India before, as well as after, the turn of our era. A historical record also places the crop in the Middle East by AD 800. Maize may also have reached Eastern Europe, as well as Africa, in pre-Columbian times, although its immediate source may have been India/Middle East.
Case 1: Transfer: America to Southeast Asia
Time of transfer: by the 3rd millennium BC
Grade: A

Case 2: Transfer: America to India and perhaps then to China and the Middle East
Time of transfer: by the 1st century BC to India
Grade: A

Case 3: Transfer: America to Eastern Europe

Time of transfer: pre-Columbian (may be due to an extension of Case 2)
Grade: C.

Sources: *Zea mays*—corn, maize

Zeven and de Wet 1982, 75. Secondary center of gene diversity (after Central America) is “S. Himalayas” where flint maize is common (citing Brandolini 1970).

Pokharia and Saraswat, 1999, 99. Maize. Also they note sculptures of maize-ears in 12th–13th centuries and earlier in Hoysala temples in Karnataka. Sureness of details means they had models of actual ears (see endnote 165). “… Some ancient maizes have likely existed in Asia for a long time.” References to maize in the 13th century AD literature in China (endnote 170) and in 5th century AD literature in India (endnote 171) suggest much earlier introduction in Asia. 101. A series of caves in Timor, Indonesia, have a continuous sequence of occupation from 12,000 BC to the time of Christ [*sic*. That date is in error, according to the referenced source, Glover 1977] (endnote 175). In the top layers (according to Glover) dated to the “middle of the 3rd millennium BC”, several introduced New World crops occur (Glover supposes “from the northwest”), such as peanuts (*Arachis*), custard-apple/soursop (*Annona*) and maize (*Zea mays*) together with Southeast Asian, or generally Asian, natives (for complete information, see Glover 1977).

Balfour 1871–73, V. “*Zea*.” Bengali: *mokka*; Panjab: *mak, makki, makkei*; Persian: *bajri*; Sanskrit: *yavanala*; Tamil.: *makka-cholum*; Telugu: *makka-jonna*. “*Zea* is entirely American.”

Monier Williams’ standard Sanskrit dictionary lacks a word for maize, yet Watt (1888–1893, VI, Pt IV, 327) reported that in his day a certain (unspecified) publication by Williams himself “furnishes three [Sanskrit] words as denoting ‘maize’: *sasyam, stamba-kari*, and *sasyavisesha*—the last meaning, appropriately, ‘remarkable grain.’”

Chopra *et al*. 1956, 260. Sanskrit: *yavanala*

Torkelson 1999, 1874. Sanskrit: *yavanala*

Bretschneider 1892, 149–150. Another *graminea* identified by the Japanese (from Matsumura) is *Zea mays*, with a three-character identifier. [It is not clear whether the names recorded in Japan were or were not from the era before European influence reached the Far East.]

Johannessen and Wang Siming 1998, 10–12. Well over 100 Hindu, Jain, and Buddhist temples bear sculpted depictions of maize being held in the hand of a voluptuous female figure. The images of the ears include over 40 anatomical features unique to maize (*e.g*., the shapes of ears or cobs, the representations of corn silk, arrangement of rows in relation to each other, arrangement of kernels, unpollinated small kernels, etc.) all of which indicate that actual maize ears had to have been models for the sculptures. Opponents of this view have suggested other objects being held rather than corn. Those explanations are not credible. Various investigators have also found ancient maize varieties in the hill country of Southeast Asia and the northern India subcontinent. Johannessen found in Bhutan and in Yunnan province, China, maize with tiny grains, four-row ears, and multiple ears per stalk.

Johannessen and Wang cont’d. 12–13. The sculptured ears studied are from numerous temples of the 11th to 13th centuries, built during the Hoysala Dynasty located in what is now Karnataka state, India, whose rulers and buildings are well-documented historically. Artists generally signed their work and their biographies are known. Architectural study has shown that the sculpted sections are not additions of later date. In other statuary, of the 6th through 10th centuries, maize ears are held by males, such as a carving of Vishnu, who is shown holding a maize ear carved in a living sandstone wall of a cave near Badami. And Kubera, god of wealth and abundance, shown as a corpulent figure holding an ear of maize, is depicted in a statue dated to the 8th century.

13–14. Some art historians have questioned whether these are ears of corn or of some other plant or object. Corn experts of the U.S. Department of Agriculture who have been shown full photographic documentation of these sculptures concur fully that maize is what is represented by all the specimens displayed on the Indian temple art. In fact, some observers have recognized particular New World ecological source regions for the ears used as models by some of the Indian artists, as Johannessen had suggested. Moreover, studies of names for maize in India and other parts of Asia find notable similarities with certain American names, particularly a connection of names in Amazonian South America with South Asian names for maize.

18–19. Maize is recorded in a Chinese medical encyclopedia of *ca*. AD 1448 which gives detailed guidance on the curative use of corn silk and seeds. This would not have been true of a recently-acquired plant. According to Burkill (1966), the reported treatment with maize products is still used in Southeast Asia for renal problems. Actual maize ears were reported taken from a tomb excavated in Sichuan Province, said to date to about 2000 BP (Han Dynasty). The only documentation was in a newspaper, but the find was known to a number of archaeologists. Because of the prevailing assumption by established scientists of a late date for maize, administrators did not allow the ears to be submitted for C14 dating as requested by the field archaeologists, and the specimens were discarded.

Johannessen 1998a, 122. The sculpted figures holding maize ears make specific Hindu mudra signs (symbolic hand positions). A set of temples earlier than those of Karnataka state is now reported from west-central India that date to the 5th to 8th centuries. They bear sculpted figures of male Hindu gods holding maize in their hands.

Johannessen and Parker 1987, 9–10. They point out the possibility that maize was related to elements of Hindu philosophy. Yellow maize appears 'golden.' Vishnu, the major Hindu god, his consorts, and various forms of the goddess Lakshmi are associated with golden offerings. Corn would fit in nicely with this emphasis on gold. Other temples that have possible maize effigies include: Sravana Belagola, a Jain Temple complex of the 8th century AD; Boodgaya Temple, 1st century BC; and a Kubera Temple in Rajasthan of the 8th century AD. 16. *Zea mays* also is mentioned in 13th-century literature in China (see Kia Ming, cited in Marzeweski 1966) and in 5th century literature in India (see Tagare 1982, 448, 486–7, 498).

Johannessen (1992, 313–33) compares and relates several expressions for maize (*tar*, *hobba* or *hab*, *ang*, *mak* or *maka*, *jonar*, *kana*, and *Bhutta*) that appear and reappear variously in the Andes, Southeast Asia, Indonesia, China, India, Brazil, and Africa. 317. The Hindu goddess, Lakshmi, and god, Vishnu, needed to be worshipped with gold; and they are apparently associated the temples in India where yellow maize is displayed in art. Other colors of maize seed—red, blue, black, white, spotted, and striped—also fit variously into the religious complex of India.

Jeffreys 1955, 427–432. He recapitulates documentary evidence for maize being in Asia and Africa before Columbus. For example, he quotes Idrisi, *ca*. 1150, about people from Senegal to Tchad using "large-grained millet" which, he shows, can only be maize. He also quotes Bonafous (1836) who reported that maize had been brought by Arabs into Spain in the 13th century. Also, Bertagnoli (1881) writes of a grain, "grano Turco," that some people think came from Asia and that first appeared in Italy during the Crusades. According to this "Carta donationis verae Crucis et primii seminis meligae," maize was introduced in 1204 by two captains on their return from the siege of Constantinople. Naysayers have considered this a forged document, yet Bertagnoli says he has "read all the medieval chronicles available on this matter and has found mention at least a hundred times" of 'grano Turco' (maize) before the New World was even dreamed of."

Towle 1961, 21–5. Two major types of corn are found in Peruvian archaeological sites, which she calls Group A and Group B. The former is a weak pod-corn, or primitive popcorn. Found in earlier levels, starting in the Cupisnique period, *ca*. 750 BC, these cobs tend to be as wide as they are long. Group B resembles more elongated forms of corn typically grown in Peru today. The cylindrical ears are larger than those of Group A and bear larger kernels. Group B cobs are reported from Ancón (*ca*. the middle of 1st millennium BC) and at Paracas a little later in the Formative.

Marszewski 1975, 237–60, and 1978, 128–63. He gives a complete review of the literature in regard to the question of maize in Southeast Asia and China. 241. His map plots vernacular names of maize in Vietnam with apparent similarities in Colombia and Peru. 239. One set of maize forms is distinguished by (1) many small ears on a stalk; (2) small spherical kernels having sometimes waxy endosperm; (3) many prop-roots (p. 243); shortness of almost all organs, etc. Most of these range among the popcorn subvarieties (*Zea mays* L. var. *everta*) labelled as a 'Persian' race and considered the most 'primitive' (Anderson), or 'pure' (Suto and Yoshida), type of maize in the Old World. These varieties are cultivated mainly by the conservative hill peoples in Asia but not in coastal zones; they have been identified from the Pontian Mountains eastwards to the Himalaya and on southward through the western part of the Indochina, maybe all the way to Java. 240. The close counterparts of the Asiatic popcorns, particularly North Anatolian, Assamese, and Siamese forms of the 'Persian' race, show traits like short cobs with spherical kernels as known from prehistoric graves and trash-heaps on the shores of Peru, Chile, and even in Argentina (Towle's Race A). 242–3. Other characteristics of the Asiatic popcorns are linked to those growing in isolated places in Argentina, Chile, Bolivia, and Colombia.

Marszewski, cont'd., 243–5. Waxy maize. Collins (1909, 1920) collected this in Southeast China, upper Burma, and Mindanao, and considered it "of a respectable age." Kuleshov (1928) reported the varieties from a far wider area inside Asia and thought a relatively long time had to have elapsed for them to evolve. Anderson (1945) even thought this maize evidence that *Zea mays* might have originated in Asia (247). He notes the overlap in part of area growing amaranth with Asiatic maize and the peanut. (On 255, he adds a discussion of possible presence of tobacco in India and Southeast Asia.) 250–1. Maszewski also gives maize names used by Tibeto/Burman peoples of the Himalaya in comparison to names among the Chibchan language family of Panama and Colombia. "The degree of similitude between the above-mentioned Asiatic and American vernacular names of maize is so great, that, if the peoples under consideration were living on the adjacent territories, their maize appellations could be easily suspected to derive from a common root …." 127. Marszewski hypothesizes that 'primitive' forms of maize "could have been picked up in one or another sector of the Pacific coast of the northern part of South America or southern part of Central America at an indefinite as yet time of the pre-Columbian era." Also, that this "could have been done by some aboriginal sailors coming from the shores of the northern part of South Vietnam and belonging perhaps to the Cham or other akin people." 132–134. Marszewski also discusses "The enigmatic maize forms (Sikkim Primitive 1 and 2) cultivated in some isolated pockets of Sikkim." (*Cf*. Dhawan 1964, and Gupta and Jain 1973). These have "strikingly primitive features." Results of experiments with those maizes and detailed study of their characteristics reveals that "these two Sikkimese races (especially SP 1) resemble astonishingly the progenitor of maize reconstructed by Mangelsdorf, and are much closer to it than any of the Mexican (Nal-Tel {Yucatan 7}, Palomero-Toluqueño, Chapalote) or Colombian (Pollo Segregaciones) races considered previously to be the most primitive known" (see Marszewski 1978, 163).

Marszewski, cont'd.,137. "… Among the agriculturalists and botanists who have studied them in detail in respect to their morphology, genetics, physiology, and distribution, almost all are inclined to admit their pre-Columbian occurrence in some at least of the above-mentioned region" (South China, Himalaya, East and South Asia). The author then reprises this viewpoint for Collins, Kuleshov, Anderson, Suto and Yoshida, Gupta and Jain, Vishnu-Mittre, and Gupta, all of whom either favor or allow for pre-Columbian presence of maize. 139–162. Review of indications from written records about pre-Columbian maize. Considers Chiba (1969) on the pharmacopoeia document of Lan Mao (AD 1397–1476) to be the best evidence, while noting potential problems with identifying the name of the apparent maize plant there mentioned. Other indications of similar nature are noted, mainly from the 16th century. 149–158. A long discussion follows on some Tibetan sources. Pre-Columbian reference to a plant that might be maize cannot be ruled out.

Marszewski, cont'd., 162. "In the light of all botanical data accumulated here, but especially those concerning the 'primitive' maizes from Sikkim (SP 1 and SP 2), the pre-Columbian transfer of such and akin forms into the more or less isolated regions inside the Himalayan zone by some aboriginal peoples, is more plausible than its post-Columbian introduction there by the Europeans." Moreover, the Chinese written sources indicate that in the border land involving certain parts of North China, Southeast Tibet, Arunachal, Bhutan, and Sikkim, maize, most probably belonging to the 'Persian' type, had already been cultivated before the 16th century.

Marszewski, cont'd., Final Addendum, dated 1966, says on p. 30 that one of the Sikkim primitive races bears "the closest resemblance to the wild maize of which an actual specimen in fossil was uncovered (1960) in the lower levels of San Marcos Cave in Mexico." Further, "ancient Tibetan literature" may refer to maize, and he gives an example in a text which dates before Columbus.

Suto and Yoshida 1952–1953, volume 2, 375–530. They compare Asiatic maizes, including 20 races from North China, which reveal that 'Caribbean' types, which prevail on the coasts of China and presumably were introduced by Europeans in the 16th century, were crossed with 'Aegean' types, which now predominate in China, particularly far inland. This is suggestive that the inland maize was present in pre-Columbian times.

Marszewski 1963, 250. Humlum (*Zur Geographie*, 24, 29, 74) pointed to some evidences of maize's probable presence in Angola around the year 1500.

Jeffreys (1953, 965–6) pointed out the discovery by archaeologists of potsherds decorated by rolling a maize cob over wet clay, at Ife, Nigeria. Regarding the questioned date: Ife is traditionally supposed to have been founded by a wave of immigrants from the East between AD 600 and 1000.

Marszewski 1987, 203. From the English summary: concerns an early transfer of maize across the Pacific, from the Americas to Asia or the opposite way. Supportive information includes the facts that among Mizo tribes and in Bhutan, cultivation of maize precedes in time rice cultivation, and maize plays an important role in local religious rituals and ceremonies.

Johannessen reports (personal communication, 2003) that the Tibetan lamaist oral tradition, as told to Johannessen and Parker by high ranking priests in Darjeeling, holds that maize was the first agricultural crop given to the Tibetans by god. Although the altitude is too high for the production of maize near Lhasa, maize is involved in worship there in the largest temple. This consists of the placement, erect in a large basin of rice in front of the largest figure of Buddha, of the largest ear of maize that can be found in northern India (collected fresh each year).

The Wealth of India 1974. 26–9. Long list of names for maize—Hindi: *makai, makka, bhutta, junri, kukri, barajowar*. Bengali: *janar, bhutta, jonar*. Mar.: *maka, makai, buta*. Gujerat: *makkari, makkai*. Telegu: *modda-janna, makka jonnalu.* Tamil: *makka-cholam*. Kan.: *mekkejola, musukojola, goinjol.* Mal.: *cholam*. Oriya: *Maka buta*. Assam: *gomdhan, makoi*. Manipur: *chujak, nahom*. 27: Fig. 2 is a photo of prolific primitive type maize from Sikkim. Evidence from Mexico and a possible secondary center of origin in the Andean region is summarized. “Asiatic origin of maize, or at least its occurrence in the continent in the pre-Columbian times has also been proposed. Outstanding variability in maize cultivars is noted, particularly from Assam, Maghalaya, Manipur, and Arunachal Pradesh in the east and the Chamba valley of Himachal Pradesh in the northwest is outstanding. Five theories of the origin of maize are summarized. *Re*. Africa: Portuguese introduction on the west coast early in the 16th century is mentioned, “though there is said to be some evidence of a prior introduction.” Some maize-cob decorated potsherds have been found in West Africa, which are believed to date several centuries before Columbus landed in the New World in 1492. This and certain other evidences point to the introduction of maize into Africa through Arab/African contacts with the Americas in the beginning of AD 900. *Re*. Asia: mention is made primarily of Portuguese introduction. “A specimen of it (maize) was collected along the Euphrates River in Iraq in 1574.” “The precise date and route of the introduction of maize into India still remains a mystery.” The idea that it was the Portuguese is mentioned. But “lack of subsequent spread of maize cultivation, until very recently, in peninsular India, and the use of Muslim terminology (Makka, ‘Mecca’) in its vernacular names, suggest the arrival of maize first in northern India through Arab/African sources … long before the Portuguese came to India.” “Further, … the identification of some very peculiar types of maize, considered to be the most primitive, from the northeastern Himalayan region, would also suggest the probable existence of maize in India in the pre-Columbian period. Pre-Columbian contacts between India and New World, particularly Mexico, have also been postulated from varied evidences.” (Citing Leonard and Martin; Stonor and Anderson; Thapa; Weatherwax.)

Hatt 1951, 853–914. Myths and rituals in Asia associated with the cultivation of cereals, including maize, and of the origin of the yam (*Dioscorea*), agree with similar complex myths in the Americas about maize and yam. *Re.* Laufer’s notion of the Spanish introduction of maize, which he says reached western China by 1540, Hatt cannot believe that a spread from Spain to India and across the Himalaya could have taken place in the less than 50 years that Laufer assumes; hence, maize very probably was in Asia in pre-Columbian times.

Gupta 1996,176. Mexican origin of maize is noted. “Asiatic origin of maize points to Assam, Meghalaya, Manipur, Arunachal Pradesh, and Chamba in Himachal Pradesh. This hypothesis is based on extensive studies done and recorded in various collections made from the northeastern and northwestern part of India. (Citation to *The Wealth of India* and Hutchinson.) “Different varieties of the corncob are extensively sculpted but only [or rather, chiefly] on the Hindu and Jain temples of Karnataka.” Deities are shown carrying an ear of corn in their hands**.** The straight rows of the corn grains can be easily identified. The Chenna Kesava temple, Belur, and the Lakshmi Narasimha temple, Nuggehalli, are additional sites. At the latter the eight-armed dancing Vishnu in his female form of Mohini is holding a corn ear in one of her left hands and the other hands hold the usual emblems of Vishnu. Two male figures at the base are playing the mridanga (musical instrument). In the Trikuta basti, Muchamandapa, Sravana

Belagola, Karnataka, a 12th century AD sculpture of Ambika Kushmandini sitting on a lotus seat under a canopy of mangoes holds in her left hand a corncob. Plate 223 depicting a Nayika holding a corncob in her left hand is from Nuggehalli, Karnataka. Temples where the sculptures of corncobs are found are dated [to the] 12th–13th centuries AD. The common belief [apparently meaning among Indian crop scientists] is that maize originated in Mexico and came to India by the 11th–12th century. By the time these temples were constructed, maize would have been fairly common in India."

Hutchinson 1974. " … The characteristics and distribution of some forms [are] such as to lend support to the view that they reached India in pre-Columbian times."

Vishnu-Mittre 1974, 6. "A spikelet of rice and pollen of maize appear after AD 1500," in the Kashmir Neolithic. 22. Impressions on a potsherd from Kaundinyapur, M. Pradesh, and dated archaeologically to about AD 1435, have created a difference of opinion among the experts. That the impression could be of a piece of basketry or, of course, textile or fabric has been disproved by experiments. This discovery tends to support a pre-Columbian introduction. [However, Johannessen reports, on the basis of careful personal observation of the actual specimen, courtesy of Vishnu-Mittre, that the marks were not made by maize but by a disc with protrusions on it that had been rolled on the clay, making impressions somewhat like kernels but showing drag marks, *en echelon*, in the curved clay.] Jeffreys gives names as supporting evidence for Arab introduction. Apart from the problem of its introduction, the enigmatic living fossil maize in Sikkim suggests reconsideration of the occurrence of maize there. Several different varieties are grown by aborigines in Siam, Burma, Assam, Sikkim, China, Tibet, etc. It seems to have been grown there for a long time. It could hardly have been introduced by Arabs. [Johannessen has found small-seeded four-rowed ears of corn growing in southern Yunnan and Laos, which are clearly unrelated to modern maizes.]

Mattingly 2000, 31–7. At an oasis zone 100 miles long and 2 to 3 miles wide [located] 700 miles south of Tripoli, Libya, the Garamantes people mentioned by Herodotus and Tacitus constituted such a threat to the Roman Empire that Rome sent an army against them. (Their heyday was the 1st to 4th centuries AD.) The area flourished agriculturally by tapping an aquifer with a system of underground channels (the *foghara*, or chain-well, system, which also was used in the Americas) and traded with both the Roman sphere and sub-Saharan Africa. Tombs shaped like the Egyptian stepped mastaba structures, as well as pyramid tombs, were also built. Recent archaeological work has identified "a series of significant botanical horizons—including a late medieval 'maize horizon,' which represents the arrival of plant species from the Americas, as well as a 'sorghum horizon,' which represents the arrival of sorghum grain from sub-Saharan Africa, probably during the Garamantian period." The Garamantes also wrote in a Libyan script; a version of this script (called Tifinag writing) has persisted among the nomadic Tuareg people of the Sahara.

Sauer 1993, 232. "The possibility of pre-Columbian presence of maize in various regions of the Old World was actively debated during the 1960s and 1970s. Historical evidence was drawn from early reports now generally interpreted as references to grain sorghum." "New evidence has been drawn from stone carvings in 12th- and 13th-century temples in southern India that depict objects resembling maize ears. The resemblances are intriguing, but other possible models have been suggested, including Pandanus fruits. Moreover, the carvings may not be as old as the temples." [Various publications by Johannessen and his colleagues have demonstrated that these speculations of Sauer are inadequately informed.]

Hatt, 1951, 853–914. Myths and rituals in Asia associated with the cultivation of cereals, including maize, and of the origin of the yam (*Dioscorea*) agree with those in America. *Re*. Laufer's notion of the Spanish introduction of maize, which he says reached western China by 1540, Hatt cannot believe that a spread from Spain to India and across the Himalaya could have taken place in the less than 50 years that Laufer assumes; hence, maize very probably was in Asia in pre-Columbian times.

Mellén Blanco 1986, 133. Maize was reported from the interior of the (Easter) island by Olaondo, part of the earliest Spanish party of exploration. On the island, maize is now called *taráke*.

Newcomb 1963,168. C. Sauer provides here a rich source of reviewed and new information in the section entitled "Maize into the Old World." Particularly valuable is the detailed treatment of information in the European herbals on maize, including names of the plant, comprehending the data of Finans, and much more, as well as Jeffreys. Highlights: 20. The term 'turkish corn' (*grano turko, sorgho turko*) is still used in Northern Italy today. Sauer questions the conventional answers to the following issues: (1)

there were no New World/Old World contacts prior to Columbus; (2) maize was introduced into the Old World via Iberia; (3) maize was not known in the Old World prior to the Columbian voyages. He holds, rather (1) that the German herbalists who cataloged maize were competent men; (2) that the South German towns were intermediaries between Venice and the Rhine areas; (3) trade was most active over the pack routes leading between Central Europe and Genoa and Venice; (4) the Levantine trade channel was via Venice, especially during the 15th century, when there were the maximum developments of Venetian ties via the Adriatic to the Black Sea and Asia Minor; (5) Venice was in active commercial contact with the Ottoman Empire; (6) things Turkish were nowhere as well known as in Venice, and nowhere north of Venice was such information better known than in the towns of South Germany; (7) the name 'turkish corn' was affixed after the Turks had gained control of the Levant; (8) note the conspicuous and old usage of maize in the cuisine of the Po Valley even today, and this kitchen usage is not found elsewhere in Europe west of the Adriatic; (9) yet, maize is important as a food only east of the Adriatic in the Balkans and Hungary, both of which were under Turkish control for centuries; and (10) finally, maize cultivation and usage for food are seen clear into Turkish Asia Minor. 21. In South Austria and Vienna, maize is known as *kukuruz,* which is a widely used name also in Slavic areas, including Russia. W. Eberhard did not believe it a Turkish word. There is the suggestion that it is a transfer from the Po Valley, into South Germany, and thence as *kukuruz* into Eastern Europe. 21. Little evidence exists to support Laufer's theory of maize dispersal eastward from Spain. The same is true for the pumpkin, paprika, and tobacco. The Spanish colonists did not care much to eat maize, but were accustomed to wheat. 22. Hernandez in 1570 wrote about maize (*tlaolli* in Náhuatl), noting what a good grain it was and expressing curiosity as to why it had not been taken back to Spain for cultivation. Well, observes Sauer, maize was all right for the mixed (*mestizo*) and native people to eat, but wheat was the grain for white folks. Columbus indeed brought maize back, but it was adopted for cultivation sparsely in Iberia and then meant for animal feed. 22–25 give much detail about names of maize in Europe, especially *re*. Martyr and possible confusions with names for sorghum and pearl millet. 25–7 reprise Jeffreys on names in Africa. 27. "Conclusions on the question of maize introduction into the Old World:" (1) The documents belie the possibility of a Columbian introduction of the first maize into the Old World, and they refute Laufer's idea of a rapid spread of maize through the Mediterranean into Asia. Sauer is of the opinion that maize occurred in pre-Columbian times in Syria, North Italy, and Turkey; and, during post-Columbian times, the Portuguese introduced from West Africa the *milho/zaburro* crop. Jeffreys refers to a town of medieval date in West Africa that is notable for the prints of corncobs on tiles. This settlement was abandoned in the Middle Ages. He claims the existence of hundreds of tiles so marked. How firm is this evidence?, asks Sauer. [*Cf*. now Mattingly 2000.]

Johannessen and Parker 1987, 15. (1) In remote valleys in the Himalaya, such as Tashigang in Bhutan and Ilam in eastern Nepal, farmers grow primitive popcorns with seven to nine ears per stalk, all concentrated in the upper 20% of the stalk. Similar 'Sikkim Primitive' popcorn was recorded in Sikkim by Thapa (1966), Sachan *et al*. (1982), and Sachan *et al*. (1986a and 1986b), the latter in both Sikkim and elsewhere in northeastern India. These stalks have distinctive arrangements of leaves and their tassels droop in a form atypical for American maize. (2) At Pemagatshel, eastern Bhutan, there is a winter flint maize with short, conical ears with a somewhat fattish, or pregnant, shape as in the temple carvings in Karnataka Pradesh. A high conical shape used to be considered a trait of ancient specialization in Central America and Mexico, and in highland Peru. (3) Waxy (sticky) starch maize is widespread in Asia, from Manchuria and Korea to Burma, but it is rare to non-existent in ancient America. Professor You Xiu-ling of Hangzhou (personal communication to Johannessen) has stated that waxy starched maize in China has a significantly distinctive isozyme distribution that is very different from New World maize's isozymes. How far these isozyme patterns extend has not yet been thoroughly explored, but Sachan *et al*. (1982, 1986a, and 1986b) have found that the multi-eared Sikkim primitive popcorn exhibits a similarly distinct constitutive hetero-chromatic phenomenon to that found in South American maizes. So, some ancient maizes have likely existed in Asia for a long time. It is unclear how the characteristics noted relate to the complex of strange maize traits, including primitive popcorns and sticky starch maize of the Naga Hills and Assam reported by Stoner and Anderson (1949, 355–96).

Anderson and Brown 1953. These peculiar maizes stretch from the Aegean to the Asiatic Pacific, including Nepal, Sikkim, and North Assam. Nearest counterparts are in South America before the Incas. They consider it plausible that this corn was transferred across the Pacific, in whichever direction.

Stonor and Anderson 1949, 387. The Russians, under Vavilov, comprehensively surveyed Oriental (Asian) maize. See Kuleshov 1928. They demonstrated that primitive maize like that in Naga country (of India) was widespread in central Asia from Persia and Turkestan to Tibet and Siberia.

Bretschneider 1882, 57–61. Author of the famous Chinese volume of *Materia Medica*, Pen Ts’ao Kang Mu, was Li Shi chen (Shizhen), who first published it in 1590; but the information is mainly *re*. medicines and is chiefly a compilation of traditional materials from classic Chinese texts. He mentions maize among other plants of American origin.

Sarkar *et al*. 1974, 121. “No clearly established reference to maize is found in the Indian scriptures and epics, nor is the plant known to be associated with any religious or domestic rituals. There is not even an authentic Sanskrit name for the plant. [Of course, these statements have proved inaccurate.] The Sanskrit name, *Yaba-nala* (*Yaba* = barley, *nala* = reed-like), sometimes attributed to maize, is also used for Sorghum (Watt 1892).” The most commonly occurring name, *makkai*, or *makka*, which could mean ‘from Mecca,’ (*sic*) suggests introduction from outside India. The other common name for maize in Indian languages is *bhutta*, or *bhuta*. [See above for information via Watt, citing Monier Williams on the use of three Sanskrit words for maize.] The origin of this word is obscure. The idea that maize might have been present in Asia in pre-Columbian times gained some credence with the discovery of ‘waxy’ maize in northeastern China as far as Korea and its description by Collins (1909). But no firm evidence is known of pre-Columbian occurrence. The issue of the antiquity of maize in India is reopened by the recent survey of primitive germ plasm as reported by Dhawan 1964 (and others). These characters (discussed) of the Himalayan primitives, together with the emergence of ears from upper joints of the stalks, reduced internode length, and the occurrence of male and female flowers in the same inflorescence, show that these varieties are closer to the progenitor corn plant reconstructed by Mangelsdorf than such American races as Chapalote, etc. These observations on the two Himalayan primitive varieties clearly establish them as distinct entities different from the advanced types as well as the American primitive types. They don’t want to speculate,“ Nevertheless, they open up an entirely new angle on the origin, evolution, and distribution of maize.” “It must be admitted that the presence of primitive races in Sikkim, Nepal, Bhutan, or Assam hills is extremely puzzling and cannot be explained on the assumption of introduction and spread of maize in the post-Columbian era.” Further research is obviously needed on these primitive forms of maize in south-central Asia and their possible relationships.

MICROFAUNA

Ancylostoma duodenale

Origin: Asia

Summary: Distribution requires explanation of how a parasite in humans could be common to both the pre-Columbian Old World (Asia and the Pacific islands) and the New World (mainly South America). The answer is unequivocal: human carriers of the hookworm had to have carried the worm between the hemispheres by means of voyaging, and at a very early time (at least the 6th millennium BC).

Grade: A

Brief history: This hookworm is present in the digestive tracts of millions of people. Its origin was apparently in Asia, and it was long thought to have been introduced to the New World only by slaves brought from Africa in recent centuries. Early in the 20th century, Fonseca (1970) discovered this parasite in an isolated Amerindian population in the Amazon basin. Shortly afterward, microbiologist Samuel Darling (1920) surmised that the hookworm probably had infested tropical forest natives since before Columbus arrived. If a date before European discovery could be proven, he observed, the only explanation for the parasite’s presence in the New World would be that it arrived anciently via infected humans who had crossed the ocean—“storm-tossed fishermen,” he ventured.

His reasoning sprang from facts about the life cycle of this worm. In one stage it must inhabit warm, moist soil (in a climate no colder than that of North Carolina today). At a later stage, worms in the soil are ingested into a host human’s digestive tract. Settlers who came to the New World in slow stages via the Bering Strait would have arrived hookworm-free, because the cold ambient conditions would have killed the parasite in the soil (Soper 1927; Ferreira *et al.* 1988).

The hookworm's pre-Columbian presence in the Americas was established by Allison *et al.* (1973) who found traces of the worm in a Peruvian mummy dated about AD 900. Evidence from other mummies and human coprolites has since confirmed the initial find (Araújo 1988; Reinhard 1992). In 1988, Brazilian scientists identified this parasite from a dig in eastern Brazil. A series of radiocarbon dates fixed the age at about 5300 years BC (given the inland remoteness of the site, the parasite's arrival on a coast of the continent had to have been centuries earlier). Prevalence of the hookworm in East and Southeast Asia makes that area the source from which the organism probably reached the Americas. (Note that a Brazilian anthropologist has characterized one of the earliest Lagoa Santa skulls from his country as having Negroid characteristics, which he speculates arrived from Melanesia as early as 7000 BC via voyagers who came around the north rim of the Pacific; Wallace, in Bishop 1993; Holden 1999b.)

Modern microbiologists continue to assure us that Darling's assessment was correct: there is but one scenario for the hookworm's reaching the Americas—human carriage by sea. Ferreira, Araújo, and Confalonieri (1982) say, "Transpacific migrants from Asia by sea <u>must be</u> one component of the ancient American population." Fonseca (1970) asserts, the "shared species of parasites … <u>make it inescapable</u> that voyagers reached South America directly from Oceania or Southeast Asia." Ferreira *et al.* (1988) agree: "<u>we must suppose</u> that [the parasite carriers] arrived by sea." Araújo (1988) confirms, "The evidence points <u>only</u> to maritime contacts" (emphases added).

Sources: *Ancylostoma duodenale*—hookworm

Allison *et al.* 1973. A Tiahuanaco mummy dating *ca*. AD 900 has *A. duodenale* remains in the intestine.

Cockburn 1980. Controversy over the pre-Columbian presence or absence of hookworms (*A. duodenale*) is now settled from a Tiahuanaco mummy. "The parasites were probably carried by the original migrants from Asia, who brought them over the Bering land bridge." [This statement shows that he is unfamiliar with South American parasitology studies.]

Darling 1920. Surveys the distribution of the two genera of hookworms, *Ancylostoma* and *Necator*. 221. It is possible that either or both reached the Americas in pre-Columbian times from Asia, Indonesia, or Polynesia via voyagers. Cold on the Bering Strait route would have prevented the continuance of infection, so that migrants would arrive free from hookworm (unless the average temperature at the Strait during migration was equal to that of North Carolina today). 323–3. "If certain tribes in America are found to be infected with *A. duodenale* as well as *Necator* this will suggest their having come to this continent by way of the sea from those countries in Asia where *A. duodenale* and *Necator* are [both] found to be infecting the natives, *i.e*., Japan and China."

Ferreira *et al* 1982. Hookworm eggs are found in pre-European mummified bodies and coprolites. Such eggs develop in one phase of their development in warm soil: thus, not all ancestors of American natives could have crossed by Bering Strait. Transpacific migrants from Asia by sea must be one component of the ancient American population.

Fonseca 1970. A number of shared species of parasites, which are discussed with supporting data, makes inescapable that voyagers reached South America directly from Oceania or Southeast Asia. 305–31. Discusses the question of the distribution of *A. duodenale* and *Necator americanus* and what might be inferred from that regarding the date of arrival.

Verano 1991. Coprolites from coastal Peru show intestinal parasites: tapeworm 2700 BC, pinworm approximately 2300 BC, whipworm by 2700 BC, and roundworm. Also, hookworm (*Ancylostoma duodenale*) from a mummy.

Soper 1927. Distribution suggests that *A. duodenale* was introduced to South America by ancient migrations from Indonesia or Polynesia. Cold climate in the Arctic would have interrupted the life cycle of the parasitic organism and thus precludes the possibility that the introduction to theAmericas came by way of Bering Strait.

Reinhard 1992. He reprises South American incidence of the human parasites, hookworm (*Ancylostomidae*) and whipworm (*Trichuris trichiura*). Since both hookworms and whipworms require warm, moist conditions for the completion of their life cycles, finding human-specific parasites in the Americas is circumstantial evidence for transpacific contact and against a Bering-Strait-only entry of humans to the hemisphere.

Laming-Emperaire 1980. Fonseca has convincingly demonstrated that *Ancylostoma duodenale* and other parasite-caused diseases were shared between Old World and pre-Columbian South American Indians.

Adauto J.G. de Araújo 1980. Coprolites from four archaeological sites in Minas Gerais were examined for parasites. Ancylostomids are established that date by C14 between 3490 and 430 BP. Incompatibility of this organism with cold climate supports a hypothesis of transoceanic migration.

Manter 1967. Hookworm might have been brought with Jomon (Japan)/Valdivia (Ecuador) voyagers, if the Meggers'/Evans' material is sound.

Stodder and Martin 1992. At least eight species of helminthic parasites appear in coprolites.

Ferreira *et al.*1988. The same parasites found at Unai, Minas Gerais, Brazil (*i.e., Trichuris trichiura* and *Necator americanus*) have now been identified in human coprolites from Boqueirão do Sitio da Pedra Furada in a stratum dated to 7320±80 BP. These parasites could not have reached the Americas via Bering Strait because the larvae, which must enter the soil before being taken up again into a human body, could not exist in Arctic cold. So we must suppose that they arrived by sea.

Confalonieri 1983. Examines closely the entire subject of the limits of cold climate on the transmission of this parasite to the Americas, including Bering Strait, transglacial North Atlantic, and Antarctic routes. Could parasites have been preserved in migrating humans on vessels? Yes. Such voyages alone provide a reasonable means of transmission to the Americas.

Araújo 1988. The evidence points only to maritime contacts. A map displays areas of infestation in the Old World of *N. americanus* and of *A. duodenale*. Possible maritime routes across the Pacific and Atlantic oceans are marked on the map.

Crawford 1998, 58. Summarizes the findings of Ferreira and Araujo *et al.*, who assert that South American hookworm infection can only be explained by transpacific contact. Crawford suggests an alternative explanation, that the hookworm could have been a disease of animals since before separation of the New and Old World land masses. [But hookworms parasitic on humans are specific to their hosts. They would not be the same as those in, say, pigs.]

Ascaris lumbricoides

Origin: Old World

Summary: The intestinal parasite could only have crossed the ocean inside a human body. The presence of the parasite in both hemispheres thus required human voyaging.

Grade: A

Sources: *Ascaris lumbicoides*—roundworm

Cockburn, Barraco, *et al.* 1998, 79–80. Mummy PUM II, dating to about 170 BC, had in its intestinal tissue an ovum agreed by specialists probably to be *Ascaris* and some stated definitely that it was *A. lumbricoides*. That species has already been reported from many Old World locations in antiquity, as, *e.g*., at Winchester, England.

Kuhnke 1993, 457. Ascariasis, infection of the small intestine caused by *Ascaris lumbricoides*, the large intestinal roundworm. Pictorial evidence exists for ancient Mesopotamia and in prescriptions in ancient Egypt.

Patterson 1993, 603. This nematode was known to ancient writers in China, India, Mesopotamia, and Europe, and was present in pre-Columbian America.

Verano 1998, 221. One of the parasites previously thought to have been post-Columbian introductions from the Old World, *Ascaris lumbricoides*, roundworm, in fact plagued pre-Columbian New World populations.

Bordetella pertussis

Origin: As with practically all disease organisms, origin was the Old World.

Summary: The agent of infection had to reside in a human organism during transoceanic travel, and the only rational way for a human to make the crossing is a voyage.

Grade: A

Sources: *Bordetella pertussis*—the bacterium that causes whooping cough

Chin 2000, 375–6. Humans are believed to be the only host. Transmitted primarily by direct contact with discharges from an infected person probably by airborne droplets.

Stodder and Martin 1992, 62. Pertussis may have been present in the Southwest U.S. before arrival of the Spaniards.

Hare 1967, 119, 122. He classes whooping cough with measles, smallpox, and other "acute infections in which the organisms disappear when recovery or death occurs." 120. "It is highly improbable that any of these organisms would have become established in a scattered community with a Palaeolithic culture (and thus to have crossed to the Americas via Beringia)." [But pertussis was apparently present in the New World. Thus, if the source was not due to a parallel mutation in the New World, a logical near-impossibility, it must have involved transmission from the Old World, and that would probably have been after urban life developed there—*i.e*., 2500 BC?.]

Van Blerkom 1985, 46–7. There are other *Bordetell*a species that cause respiratory illness in man and other primates, and they are found everywhere in the world.

Antibodies for pertussis bacilli occur in the blood of relatively isolated, unacculturated Brazilian Indians. "If not pertussis, then some close relative of it probably occurred in the New World as well as the Old." Sahagun's Aztec informant knew it (the disease), although this does not prove it pre-Columbian [it virtually proves it]. "Perhaps different strains existed in the two hemispheres …." *B*. is probably an ancient agent which can persist in small populations because of its long period of infectivity (three weeks or more) and its capacity to reinfect ….

Borrelia recurrentis

Origin: Old World

Summary: Again, the only answer to how there could be bi-hemispheric occurrence is a transmission by humans accompanied by lice. Those lice were known.

Grade: In the absence of any alternative scenario for the American incidence, A.

Sources: *Borrelia recurrentis*—the spirochete that causes relapsing fever

Chin 2000, 421–2. Cause of a systemic spirochetal disease. Epidemic, if louse-borne; endemic, if tick-borne. Vector-borne, not transmitted from person to person. Louse-borne infection is acquired by crushing an infective louse, *Pediculus humanus*, so that it contaminates the bite wound or an abrasion of the skin. In tick-borne disease, people are infected by the bite of an argasid tick, principally *Ornithodoros hermsi* and *O. turicata* in the U.S. (or by others of the same genus in Central and South America, Africa, or the Middle East). The actual infectious agent is a spirochete, *Borrelia recurrentis*. (303. The causative spirochete of North American Lyme disease is another Borrelia, *B. Burgdorferi*.). 372. The body louse (*Pediculosis humanus corporis*) is involved in outbreaks of epidemic typhus caused by *Rickettsia prowazeki,* and epidemic relapsing fever is caused by *Borrelia recurrentis*.

See also material under *Pediculosis humanus corporis*.

Alchon 1991, 19–55. 22, 25. Relapsing fever, both the endemic type, transmitted by ticks, and the epidemic type, carried by lice, were present in pre-Spanish coastal Ecuador.

Hare 1967, 118. This spirochete may have first become parasitic in ticks, probably in the eastern Mediterranean. Carried north into Europe, it ultimately underwent mutation into *B. recurrentis* and became parasitic in lice. We do not know when this happened, but cases closely resembling relapsing fever were described (first) by Hippocrates, *ca*. 400 BC.

Van Blerkom 1985, 62–65. The zoonotic form has most likely plagued hunter-gatherers since the advent of man. Louse-borne relapsing fever may date to the rise of urban centers. Relapsing fever in the New World may have been present before the Conquest in its zoonotic, or tick-borne, form. [Alchon eliminates the "may have been" in favor of "definitely was"]. Unlike the direction its evolution took in the Old World, the spirochete never adapted itself to reproduction in human lice, so no specifically human form of relapsing fever evolved in the New World, probably due to relative lack of commensal rodents to carry it into urban areas.

Entamoeba hystolytica

Origin: Old World

Summary: The only credible way for the amoeba to reach a New World population in Ecuador or elsewhere, is by a human being who personally brought the organism to the Americas, although, granted, there is the marginal chance that that might have been via Bering Strait.

Grade: B

Sources: *Entamoeba hystolytica*—the organism that causes amoebic dysentery

Chin 2000, 11–13. Human reservoir. Transmission mainly by ingestion of fecally contaminated food or water.

Stodder and Martin 1992, 62. Amoebic dysentery was probably present before European contact (citing Van Blerkom 1985).

Saunders *et al.* 1992, 118. Newman (1976) suggests pre-European contact diseases including bacillary and amoebic dysentery.

Alchon 1991, 20. Amebiasis was in coastal Ecuador before the Spaniards arrived.

Newman 1976, 669. Among diseases that were part of man's primate ancestry and that either crossed the Bering Strait cold-screen or were acquired in the Americas: "amoebic dysentery." *In re*. 'cold-screen,' *cf*. Innes 1993, 521. Thought on the 'cold screen' is reprised. Given the general scenario of small parties crossing Beringia "the numbers would be far too small to sustain a human-to-human mode of infection. At least one scholar (Klepinger 1987) denies that there is any evidence of the disease being carried over by the Beringia transmigrants."

Van Blerkom 1985, 17. This is problematical. An unidentified *Entamoeba* cyst was found in a Peruvian mummy dating to about AD 1500 (Pike 1967, 185). This cannot be construed as definitive evidence for the presence of amoebiasis in the New World for several reasons. First, the date of this putative pre-Columbian mummy is uncertain, especially when so close to the date of contact. Secondly, there are many species of *Entamoeba* which are nonpathogenic, while amoebiasis is caused by the specific strain, *E. histolytica*. Additionally, it is now known that the amoeba alone is incapable of inducing the disease state, but requires the concomitant presence of a bacterium (citing Schwabe). It is likely that the amoeba but not the bacterium was present in the New World …. The absence of the additional agent can be inferred from the much greater severity of the infection in New World monkeys than in Old World monkeys (citing Bourned). 18. "… one can reasonably conclude with Ashburn that amoebic dysentery was probably introduced into the Americas from the Old World. … and was brought over on the slave ships …." Fig. 2, map on p. 19, shows amoebic dysentery reaching Persia from India by 480 BC, thence to Africa. [But regardless of whether the instrumental bacterium was present to trigger the disease, the fact still remains that the amoeba had entered the Americas and there is no question that it was in a human body. How? Either via Bering Strait or by voyaging, and the concept of a cold-screen makes the latter very unlikely.]

Pike 1967, 185. The body of an eight- or nine-year-old Inca child from a tomb in the Andes yielded cysts of the protozoan *Entamoeba* in the rectum (species unidentifiable). The approximate age of the body was 450 years. [Van Blerkom in citing this find emphasized the date as probably after Spanish influence, but in the light of Alchon's identification of amebiasis in Ecuador before Spanish arrival, there is no reason not to accept the Inca child as pre-Columbian.]

Verano 1998, 221. "Probably present" in a mummy (in Peru).

Flavivirus spp.

Origin: Old World

Summary: The majority of experts say this was not present in the Americas, but a few competent epidemiologists insist otherwise. In deference to the latter we keep the option open that further evidence may be brought forward.

Grade: incomplete

Sources: *Flavivirus* spp.—causal organism for yellow fever

Chin 2000, 553–4. Yellow fever exists in nature in two transmission cycles: a sylvatic, or jungle, cycle that involves mosquitoes and non-human primates; and an urban cycle involving *Aedes aegypti* mosquitoes and humans. Sylvatic transmission is restricted to tropical regions of Africa and Latin America, where a few hundred cases occur annually, most frequently among young adult males who are occupationally exposed in forested or transitional areas of Bolivia, Brazil, Colombia, Ecuador, and Peru.

With the exception of a few cases in Trinidad in 1954, no outbreak of urban yellow fever had been transmitted by *Ae. aegypti* in the Americas since 1942. Reservoir: in urban areas, humans and *Ae. aegypti* mosquitoes. In forest areas, vertebrates other than humans, mainly monkeys and possibly marsupials, and forest mosquitoes. Transmission (sylvatic) in forests of South America by the bite of several species of forest mosquitoes of the genus *Haemagogus*.

Kiple 1992. Arguments for the presence of yellow fever in the Americas have faltered in the face of immunological and entomological evidence. African animals and humans show immunity, but not in the New World. Entomological evidence strongly suggests that the most efficient vector, *Aedes aegypti*, was not present in the New World. Thus, the strong probability is that both virus and vector had to be imported. A warm climate and closely-packed humans are required for yellow fever to have effect. It is supposed that huge numbers of *Aedes aegypti* arrived in the West Indies in the holds of early slave ships, but not until 1647 was the critical mass of humans and mosquitoes reached and Barbados saw yellow fever succeed in getting its first beachhead.

Guerra 1966, 330–2. The two most important aboriginal Aztec disease entities were *matlazahuatl* and *cocolitztli*. Caused major epidemics. Translation of the terms remains unclear. His analysis of the symptoms indicates that the former was exanthematic typhus, with a faint possibility that it was typhoid fever. *Cocolitztli* was a more generic term which some feel might have been yellow fever.

Denevan 1976, 5. Yellow fever has generally been believed introduced from the Old World after Columbus, but the reservoir of yellow fever among South and Central American monkeys and historical evidence suggest otherwise.

Villacorta Cifuentes 1976. Yellow fever quite certainly was present in the reservoir provided by monkeys, and there is evidence that periodically, under certain ecological conditions, it had severe effects on humans.

Bustamente 1958. A physician argues at length for the presence of yellow fever in pre-Columbian Mesoamerica.

Van Blerkom 1985, 103. Since the vectors of yellow fever require tropical conditions for growth, the infection could not have been carried into the New World across the Bering Strait. Several considerations strongly suggest that it was not indigenous to the monkeys of the New World either. Yellow fever never got out of West Africa into East Africa and Asia, for inobvious reasons.

Giardia lamblia

Origin: Old World

Summary: Supposing Alchon’s evidence indicates not only the genus *Giardia*, but the species *lamblia*, the question should be asked, how did this organism reach theAmericas? By humans traveling across the ocean is a plausible answer.

Grade: C

Sources: *Giardia lambli*a—a protozoan that infects principally the upper small intestine

Chin 2000, 220–1. Reservoir: humans and possibly certain wild and domestic animals. Associated with drinking water from unfiltered surface water sources. Person-to-person transmission occurs by hand to mouth transfer involving feces of an infected individual.

Alchon 1991, 20. *Giardia*s were a source of infection (giardiasis) in pre-Columbian times in coastal Ecuador.

Pike 1967, 185. Two coprolites of human origin from a cave near the Dead Sea in a layer about 1800 years old contained cysts of *Giardia lamblia*. [Witenberg 1961, 86.]

Reinhard 1988, 356. Small band populations and limited contact between bands would have lowered parasite diversity within each band. Only parasites with long periods of infectiveness can survive in small populations. [These considerations fit with the cold-screen hypothesis to make it very unlikely that helminths and protozoa too arrived via Beringia.]

Human (alpha) herpes virus 3

Origin: Old World

Summary: It could be that American natives received this organism from Brazilian monkeys, but in the absence of any evidence that that was so, it is a much simpler explanation to see infected Asians coming by sea than to explain its presence in any other way.

Grade: B

Sources: Human (alpha) herpes virus 3 (Herpes zoster) (varicella-zoster virus VZV) the cause of chicken pox, shingles, etc.

Chin 2000, 91–3. Chicken pox (varicella) an acute, generalized viral disease. Herpes zoster, or shingles, is a local manifestation of latent varicella infection. The infectious agent is human (alpha) herpes virus 3 (varicella-zoster virus VZV, a member of the herpes virus group). Reservoir: humans. Transmission: from person to person by direct contact or droplet or airborne spread of fluids from an infected person.

350–1. Human (gamma) herpes virus 4, the Epstein-Barr virus, is closely related to other herpes viruses morphologically, but distinct serologically. Involved in infectious mononucleosis.

Stodder and Martin, 1992. Herpes was present in the Southwest U.S. before the Spaniards arrived.

Alchon 1991, 23. A family of herpes viruses, including herpes simplex (cold sores), varicella (chicken pox and shingles), and cytomegalovirus (a mononucleosis-like illness), can remain latent within the human body for years after the initial attack. By remaining dormant for long periods and allowing their hosts a chance to recover, herpes viruses bypass the need for a constant supply of new victims or for intermediate reservoirs. These viruses were endemic in the pre-Spanish coastal Ecuadorean population. They leave no evidence on skeletons but have been found in isolated populations of Amazonian natives.

Hare 1967,120. “It is highly improbable that any of this class of organisms would have become established in a scattered community with a Palaeolithic culture. And, certainly, none of them were present in the Americas [*sic*].” 121. Nothing whatever is known about the early history of chicken pox. [Nevertheless] there is no doubt about its [relative] antiquity [in the Old World]. It was known by the 1st century AD.

Van Blerkom 1985. 27–28. Causes varicella and shingles, Epstein-Barr virus, and cytomegalovirus. Varicella (‘chicken pox’) is endemic in Brazilian tribes as well (29) as in other primates. Herpes zoster, like the other herpes viruses, is therefore [*sic*] an ancient primate virus.

Human (gamma) herpes virus 4

Origin: Old World

Summary: See the summary for the preceding entry.

Grade: B

Sources: Human (gamma) herpes virus 4 (syn., Epstein-Barr virus; syn., cytomegalovirus) source of infectious mononucleosis

Chin 2000, 91–3. Epstein-Barr virus, human (gamma) herpes virus 4, is closely related to other herpes viruses morphologically, but distinct serologically. Involved in infectious mononucleosis, etc.

Alchon 1991, 19–55. 23. A family of herpes viruses, including herpes simplex (cold sores), varicella (= zoster, cause of chicken pox and shingles), and cytomegalovirus (a mononucleosis-like illness), can remain latent within the human body for years after the initial attack. By remaining dormant for long periods and allowing their hosts a chance to recover, herpes viruses bypass the need for a constant supply of new victims or for intermediate reservoirs. These were endemic in the pre-Spanish coastal-Ecuadorean population.

Van Blerkom 1985, 29. Widely endemic, and a related virus is found in chimpanzees and Old World monkeys, so [?*cf*. Hare 1967, 119–20, under Influenza] the natural history of Epstein-Barr virus is similar to that of the other herpes viruses.

See also the material under Human (alpha) herpes virus 3.

Influenza viruses

Origin: Old World

Summary: Passage to the Americas by sea migrants is a plausible mechanism to explain its presence here, but with so little evidence we cannot tell. More study is needed.

Grade: incomplete

Sources: Influenza viruses

Chin 2000, 270–1. Three types of influenza viruses are recognized: A, B, and C. Humans are the primary reservoir, although swine and birds are also in play. Transmission is mainly airborne, or by direct contact.

Newman 1976, 667–72. 669. Native American diseases included viral influenza and pneumonia.

Hare 1967, 119–20. This disease fits with other acute infectious diseases that were relatively late developing in history (*i.e.*, in urban times) and which would quite surely not have been maintained in a Palaeolithic population and thus have crossed the Bering Strait.

Van Blerkom 1985, 30–31. Influenza was described in the writings of Hippocrates. The earliest record in the New World was not until 1647, so it could have been brought over after European contact. Brazilian Indians do not show antibodies to influenza type A but possibly some show antibodies for type B. She thinks it is unlikely that influenza was in the Americas before Columbus.

Leishmania sp.

Origin: Presumably Old World

Summary: The possibility of voyagers from Asia introducing this organism must be recognized. However, much more needs to be known about distribution in both hemispheres before any judgment could be made.

Grade: incomplete

Sources: *Leishmania*

Merriam-Webster's Collegiate Dictionary, Tenth Edition, s.v. *leishmania*. Any of a genus (*Leishmania*) of flagellate protozoans that are parasitic in the tissues of vertebrates.

Weiss 1984, 29. The endemicity in distant populations of specific infections which require contact persons or co-dwellers for their spread illustrate past (historical) contacts. The problem is a real puzzler since it treats of specific infectious agents transmitted, for example, by the same winged agent, although this is of short flight (capability) as in the case of Leishmaniasis, with its vector of the genus *Phlebotomus*. The Leishmaniasis-Phlebotomus Complex is mysteriously repeated even in some cases with the same species in Peru, on both sides of the Andean Cordillera, the Amazonian selva, in regions of Brazil, Colombia, Central America, Mexico, the other side of the European Mediterranean, and in distant places in Asia and Africa. He adds (33), "The autochthonous [*i.e.*, ancient] character of American skin Leishmaniasis is demonstrated by ceramic human effigy figures and by carious lesions in the bones of the nose, manifest in skulls of the region of Peru where the disease is endemic."

Microsporum sp.

Origin: Asia

Summary: Fonseca demonstrated beyond question that both *Microsporum* and *Trychophyto*n organisms were present in aboriginal South America. There is no explanation for the diseases they produced except that they were brought by sea-borne peoples. (*Tlrychophyton* organism is listed separately below. It remains possible that the other infectious agents mentioned by Chin in this class—*Epidermophyton floccosum*, *Scytalidium dimidiatum,* and *S. hyalinum*—might also be identified by further research.)

Grade: A

Sources: *Microsporum* spp.—infectious fungi causing ringworm of the body.

Chin 2000, 147–53. Species differ depending on the area infested (head, beard, groin, body, foot (*i.e.*, athlete's foot), or nails. Transmission is skin-to-skin or indirect contact through shared objects. Reservoir: humans for the most common forms of the disease, *tinea corporis* (ringworm of the body), or *tinea cruris* (ringworm of the groin and perianal region). A fungal disease of the skin other than of the scalp, bearded areas, and feet, that characteristically appears as flat, spreading, ring-shaped lesions. Infectious agents: most species of *Microsporum* and *Trichopohyton*; also *Epidermophyton floccosum*. *Scytalidium dimidiatum* and *S. hyalinum* cause 'dry type' *tinea corporis* in tropical areas.

Fonseca 1970, 147*ff*. The disease that he called *tinha* (or *tinea*) *imbricada* is the same as earlier literature called *toquelau*, or *tokelau* (in Oceania), and *chimbêrê* (in Brazil). 148. The area of distribution is detailed: most of Polynesia, Micronesia, Melanesia, and Malaysia, as well as in the indigenous population of Formosa, and in Indochina, and, with less frequency, south China, Burma, Ceylon, and the south of India. Brazilian authors continue to maintain that the earliest focus of this disease was the Malay Archipelago and elsewhere in Southeast Asia. It is endemic among tribal Formosans, as the author found by field research in Formosa in 1927. It prevailed among the natives, being there before the Chinese or Japanese dominated that island or other areas of Southeast Asia. 216–7. Presents a systematic argument on ten points supporting the proposition that the introduction of this parasite was by infected immigrants from outside the area [anciently]. Investigators have also found cases of this disease in central Mexico, Guatemala, and El Salvador. 40–41. Ringworm is totally absent among indigenes of the north of America, Alaska, or Canada. Early Mexican sources (*e.g*., Las Casas) do not mention it. Similarly, the chroniclers on Peru fail to make any mention of it. But Brazil, yes, from earliest colonial times. 44–45. None in Africa. 195–196. Discusses the earliest discovery of *chimbêrê*, by him, in the Mato Grosso in 1924. Goes on to justify the assumption that the bearers of the disease were virtually isolated and untouched by European influence. 216. It is impossible that this disease was introduced from Europe after Columbus, because it did not occur in Europe.

Laming-Emperaire 1980. She accepts that Fonseca has convincingly demonstrated that *tinea imbricata* (ringworm), among other parasite-caused diseases, was shared between the Old World and pre-Columbian South America.

Mycobacterium leprae

Origin: Old World

Summary: The evidence adduced for American incidence is very weak. In the future further data might come to light, so we do not abandon the possibility.

Grade: incomplete

Sources: *Mycobacterium leprae*—cause of leprosy

Van Blerkom 1985, 32–37. An isolated report of pre-Columbian Mexican skeletal evidence exists (Goff 1967, 291), but the evidence is equivocal, for other conditions can produce similar changes.

Van Blerkom cont’d. “Sahagun’s Aztec informants described a condition similar to leprosy which they called ‘disease of the gods,’ but this could have been any disfiguring skin disease (Ashburn 1947, 233–4).” Mycobacteria similar to Hansen’s bacillus have been found in Bolivian frogs and wild armadillos of Louisiana and Texas. 37. “One cannot dismiss the possibility that leprosy, like tuberculosis, is an ancient disease which has become localized because of the more successful spread of TB,” a related infection. Since it depends on humidity, heat, and crowding, it is not a good candidate to have come across the Bering Strait, although we cannot be sure.

Goff 1967, 281, 291. A skull is illustrated and discussed showing what may be leprosy, from Mexico (probably pre-Columbian).

Sandison and Tapp 1998, 42. A case of leprosy in a Coptic Christian (6th century) body discovered by Elliot Smith and Derry in 1910 in Nubia is unquestioned. This has been confirmed macroscopically (1960) and radiologically (1967). There is no direct evidence in the pharaonic period for leprosy, and evidence for it in the medical papyri is tenuous.

Mycobacterium tuberculosis complex

Origin: Old World

Summary: Tuberculosis has been established as present in the Americas anciently, but no credible theory for its origin within the hemisphere has been presented. Sea migrants, now known to be a population source, would provide a satisfactory explanation.

Grade: A minus

Sources: *Mycobacterium tuberculosis*—the tuberculosis bacterium

Chin 2000, 523–4. This complex includes *M. tuberculosis* and *M. africanum*, primarily from humans, and *M. bovis*, primarily from cattle. Other *mycobacteria* occasionally produce disease clinically indistinguishable from tuberculosis. Transmission is by exposure to tubercle bacilli in airborne droplet nuclei produced by people with pulmonary or laryngeal TB by coughing or sneezing. Extra-pulmonary TB (other than laryngeal) is generally not communicable.

Alchon 1991, 19–55, 23–4. Archaeological evidence indicates that acute respiratory infections were the most frequent cause of death among pre-Columbian Andean residents, just as today. Paleo-pathologists have discovered “incontrovertible evidence” from mummies dating from the 8th century demonstrating the presence of tuberculosis in South America, both pulmonary and blood-borne (miliary) tuberculosis.

Allison, Gerszten, *et al.* 1981. Reports on eleven Peruvian and Chilean mummies that evidence TB and range in radiocarbon dates from 800 BC to AD 1600, with five earlier than AD 300.

Karasch 1993, 537. In a study of 11 mummies from Chile and Peru, two dating from AD 290 had “cavitary pulmonary lesions from the walls of which acid-fast bacilli were recovered.” According to William Sharpe, two of these mummies have “diagnoses of tuberculosis about as solidly established as paleo-pathologic techniques will permit” (Sharpe, William D. 1983. Essay-Review. Trans. and Studies of the College of Physicians of Philadelphia, Ser. 5: 278–81).

Buikstra 1981, 13. “In the absence of appropriately-timed migrations from the Old World, we must develop and defend a reasonable model for the origin of this disease in the absence of [animal reservoirs in the form of] domestic herd animals such as cattle.”

Powell, 1992. The earliest documented cases of tuberculosis are from Chile (160 BC). North American cases postdate AD 850 (Ontario, and Georgia through Arkansas to the Southwest).

Clark, Kelley, *et al.* 1987. 46. In order to explain the high susceptibility of Amerindian populations to many Eurasian diseases, Black (1960; see also Stewart 1960) postulates that the migrations over the Beringian and Panamanian land bridges were so rigorous that all individuals with latent infection developed overt disease and died. Accordingly, many endemic diseases including tuberculosis, found in extinct [see below Hare, who makes clear there is insufficient evidence to attribute TB to any people in the world as early as those usually supposed to have crossed the Bering Strait] and extant Eurasian populations were screened out and prevented from reaching the prehistoric Americas.

Comment on Clark *et al.* by Linda L. Klepinger, 52–53. “Current paleo-pathological evidence would suggest that the *mycobacteria* responsible for the New World disease were not carried over by the Beringia transmigrants but more likely arose *de novo* in the Western Hemisphere. Evidence for the disease appears relatively later in North America compared to the Peruvian cases and is associated with the denser populations which arose with intensive maize agriculture. Also, temporal estimates for the arrival of the Asian immigrant (citations) place all three migrations earlier than the domestication of cattle in the Old World and earlier than any evidence of human-to-human-transmitted tuberculosis.”

Comment on Clark *et al.* by Nancy C. Lovell, 53. “But where did that organism come from? They say that there are many theories for the origin of *M. tuberculosis* but give us only two—both of which are based on origination from the bovid infection. Why do they choose these theories? While the presence of an acid-fast bacillus in pre-Columbian South America has been demonstrated [citing Allison], this bacillus could not have derived from an infection of cattle. Cattle are not indigenous to that area. Prehistoric groups hunted camelids and deer, not bovids. We are left to conclude that (1) the acid-fast bacillus is not *M. tuberculosis*, (2) *M. tuberculosis* did not originate from the bovid infection, or (3) while *M. tuberculosis* may have derived from *M. bovis* in the Old World it has some other origin in the New.” [But she raises no possibility of voyaging as a means of introducing *M. tuberculosis* into the New World.]

Hare 1967, 117. *M. tuberculosis* has never been isolated from wild animals, nor has it ever become established as a human parasite. But it has infected dairy herds since before the Christian era. Because Palaeolithic societies did not domesticate cattle, it is improbable that this organism caused infection at that time, but it may well have done so in Neolithic and more recent societies. Actually, very little is known about the antiquity of this disease.

125–6. The earliest sure evidence for pulmonary tuberculosis in the Old World is late in the 2nd millennium BC—India, China, and Egypt. Bones with lesions suggestive of tuberculosis may go back as early as 3700 BC, but that may be deceptive. It was never found in the thousands of mummies from Egypt and Nubia examined by Dawson, Smith, *et al.* 127. Repeats dependence on the bovine source theory.

Verano 1998, 217–9. Since Allison's pioneering study, many additional cases of probable TB have been identified from skeletal and mummified remains from Peru and Chile. Recent developments in DNA recovery and amplification by polymerase chain reaction have resulted in a major advance. Salo *et al* (1994) recently reported the successful extraction of DNA characteristic of *M. tuberculosis* from a Peruvian mummy. Other documentation is given.

Necator americanus

Origin: Old World

Summary: The only credible explanation for the presence of this hookworm in the Americas is arrival by boat of immigrants to (South) America.

Grade: A

Sources: *Necator americanus*—hookworm

Darling 1920. Surveys distribution of the two genera of hookworms, *Ancylostoma* spp. and *Necator americanus*. 221. It is possible that either or both were in the Americas in pre-Columbian times from Asia, Indonesia, or Polynesia by voyagers. Cold on the Bering Strait route would have prevented the continuance of infection, so that migrants would arrive free from hookworm. 223–3. "If certain tribes in America are found to be infected with *A. duodenale* as well as *Necator*, this will suggest their having come to this continent by way of the sea from those countries in Asia where *A. duodenale* and *Necator* are [both] found to be infecting the natives, *i.e*., Japan and China."

Ferreira, Araújo, and Confalonieri 1988, 65–7. Human coprolites found in a cave site in Minas Gerais state, Brazil, date between 3490 and 430 BP. Eggs of two types of ancylostomids were identified (one of which is *Necator*).

Reinhard 1992. Includes a treatment headed "Transpacific Contact?" on page 241. He reprises South American incidence of the hookworm parasites (*Ancylostomidae*), whipworm (*Trichuris trichiura*), and *Necator americanus*.

Onchocerca volvulus

Origin: Old World

Summary: Weiss states that *Onchocerca volvulus* might have been present in theAmericas based on distribution study. Further work is needed.

Grade: incomplete

Sources: *Onchocerca volvulus*—a filarial worm (nematode) causing onchocerciasis

Chin 2000, 363–4. The female worm discharges microfilariae that migrate through the skin. Pigment changes produce the condition known as 'leopard skin.' Upon reaching the eye, they may cause blindness. Found in Guatemala and southern Mexico, Venezuela, Colombia, Ecuador, and parts of Brazil, as well as in subsaharan Africa and Yemen. Transmitted only by the bite of infected female black flies of the genus *Simulium* (different species are involved in Central America, South America, and Africa; there are several species in Africa). Reservoir: humans.

Hoeppli 1969. "Some of the infections introduced by Africans already occurred in the New World in pre-Columbian time." Onchocerciasis is one.

Weiss 1984, 32. Some historians of medicine believe that onchocercosis was not brought by slaves from Africa, the common belief, but was autocthonous in the Americas. Its extensive diffusion in this continent supports this possibility for, besides Mexico, Guatemala, and Venezuela, it has been found in Peru, in the high forest Amazonian area (Chanchamayho).

Pediculus humanus capitis* and *P. humanus corporis

Origin: Old World

Summary: These lice were definitely present in both hemispheres. Only one explanation will serve: ocean voyaging that brought humans infested with the pests. The patent similarity in the name of the louse between the Solomon Islands and the Maya is more than suggestive.

Grade: A

Sources: *P. humanus capitis* and *P. humanus corporis*—lice

Chin 2000, 372–3. Lice are host specific; those of lower animals do not infest people. The body louse is the species involved in outbreaks of epidemic typhus caused by *Rickettsia prowazekii* and epidemic relapsing fever caused by *Borrelia recurrentis*. Transmission is by direct contact with infested persons or objects used by them. They can survive for only a week without a food source.

Fonseca 1970. Following a long treatment of issues of taxonomy of *pediculi* on 145–147, he discusses particularly matters pertaining to Old and New World distribution of *Pediculus pseudohumanus*. "A form of louse found solely in indigenes of America and of Oceania and in American macaques." Quotes Ferris (1951, 275) [Fonseca promises a bibliography at a later time but failed to present one, as far as we know, so we presume that Ferris (1935) is what he intended] thus: "Here we have a most extraordinary situation. The form which Ewing [the first to report this louse] described exists, without question, but its distribution is extremely peculiar. Ferris (1935) mentioned the presence in his material of specimens from Central American Indians and from natives in the Marquesas Islands in the South Pacific, which show a slight lateral lobing of certain of the paratergal plates. This is the form that Ewing ascribes to his *pseudohumanus*, and the illustration here given based upon a specimen from the Marquesas Islands almost duplicates that given by him. It may be noted that those from the South Pacific all have a noticeably larger number of setae on the dorsum of the abdomen than do those from the New World." The material of *Pediculus pseudohumanus* that Ferris had available and which serves this author for identification, comes from the Marquesas and from some natives of Tahiti. On the other hand they [now] come from a household of Indians in Santa Emilia, Guatemala, and a mummified head from Ecuador. Examples also come from the head of a mummy of a Maya Indian of Xinchel, Yucatan, plus other natives of Guayabelete, Panama. In his monumental monograph, Ferris (1951, 275) notes the puzzle this poses: "Here is a form that is supposed to occur both on New World monkeys and upon man. More than that, it occurs not only upon man in the region where these monkeys occur naturally, but what is apparently the same form occurs on man in the far distant South Sea Islands."

Sandison 1967, 178–83. Lice are known from pre-Columbian Mexico and Peru as well as the Mediterranean through China.

Karasch 1993, 538. Some parasite remains have been recovered in autopsies on mummies from Chile and Peru. An examination of the body of a young boy revealed those for head lice. According to chroniclers, the poor in the Inca Empire had to "pay tribute in the form of small containers of lice." Not surprisingly, typhus was "a very common disease in ancient Peru."

Alchon 1991, 22. One can build a strong case for the existence of both endemic (flea-borne) and epidemic (louse-borne) typhus in the New World, based on lice on Peruvian and Chilean mummies. (*Cf*. Roys 1931. 341. Mayan: "*Uk*. The louse found on man and quadrupeds." Motul dictionary.

Schuhmacher *et al*. 1992, 18. Ethnically-Papuan Austronesian Buma tribe, on Vanikoro, eastern Solomon Islands, *uka* (last vowel is a schwa) = louse. Austronesian Ontong Java (western Solomons), *uku* = louse. Maya (southern Mexico), *uk* = louse.

Zinsser 1960, 254–61. Was typhus in humans in the Americas before the Spaniards? Perhaps. Mooser found Tarascan and Aztec words relating to the disease. Much historical evidence involving lice found on mummies suggests typhus was present in South America.

Hoeppli 1969. "Some of the infections introduced by Africans already occurred in the New World in pre-Columbian time." "Lice" were present.

Van Blerkom 1985, 4. "The lice found on pre-Columbian American mummies are of the same species (with only slight differences, on the order of a subspecies) as those on Old World humans (El-Najjar and Mulinski 1980,111; Zinsser 1964, 176–7)."

Piedreaia hortai

Origin: Old World

Summary: Fonseca's evidence is straightforward. This organism causes the same growth in the hair of occupants of Asia and Africa and of the Amazon Basin.

Grade: A

Sources: *Piedreaia hortai*—the fungus that causes *piedra* (*negra*), a disease of the hair

Chin 2000, 147–8. Under the discussion of *Tinea capitis*, or ringworm of the scalp, he observes that *T. capitis* is "easily distinguished from *piedra*, a fungus infection of the hair occurring in South America and some countries of Southeast Asia and Africa. *Piedra* is characterized by black, hard ‘gritty’ nodules on hair shafts, caused by *Piedraia hortai* ….”

Fonseca 1970, 262. This fungal disease, commonly called *piedra negra* but which he wants to call *piedra ascospórica*, is especially characteristic of inner South America, although found very rarely in North America. He cites such limited literature as exists. 264. “Separated from South America by the two great ocean barriers,” this disease is in both hemispheres; [for] it is also in Southeast Asia—Thailand, Vietnam, Burma, Malaya, Indonesia. “In all these regions of Oceania and of Southeast Asia, *piedra ascospórica* presents exactly the same clinical, epidemiological, and parasitological characteristics with which it appears on the American continent.” 270–2. Gives names for the disease in Guaraní and Tupí languages (lowland South America). In previous works, he has concluded, and has justified the conclusion, that this disease was introduced to the Americas by pre-Columbian migrations by natives of Oceania. Argues anew why that must be so. It is missing in those parts of northern Asia and in North America which could have been involved in transmission by any migration across the Bering Strait that might have brought this disease. None of the disease existed in Europe or Africa. Because it was widely distributed in South America, among many language groups, it must have arrived long ago.

Laming-Emperaire 1980. Fonseca has demonstrated that the disease *pierre noire* [what Fonseca calls *piedra negra*, or *piedra ascospórica*], as well as other parasite-caused diseases, were shared between Old World and pre-Columbian South American Indians.

Plasmodium falciparum

Origin: Old World

Summary: The evidence is in dispute whether malaria occurred in America, but what is true is that a significant number of researchers who have investigated the matter think it was.

Grade: C

Sources: *Plasmodium falciparum*— the sporozoan parasite which causes malaria

Chin 2000, 310–12. There are four human malarias which can present sufficiently similar symptoms to make species differentiation generally impossible without lab studies. The most serious malarial infection is *falciparum* malaria. The others (*vivax, malariae*, and *ovale*) are generally not life-threatening. Humans are the only important reservoir of human malaria. Nonhuman primates are naturally infected by many (other) malarial species, which can infect humans experimentally, but natural transmission to humans is rare. Transmission is by the bite of an infective female *Anopheles* mosquito.

Bruce-Chwatt 1965. Argues from physical remains, epidemiology of living native groups, names of disease and use of cinchona bark, plus ethno-historical/chronicle sources that malaria was present in pre-Columbian times. A personal communication to the author from Fonseca says the latter believes that several diseases were imported to the Americas from Polynesia, Micronesia, and Melanesia, and that malaria might have been included. Bruce-Chwatt is confident that malaria was present. Today, the judgment regarding its presence in pre-Columbian America should not be “improbable though not impossible” (so Jarcho 1964) but “probable but not proved.”

Cabieses 1979, 539. Malaria may have been indigenous and hence may have been the reason ancient Peruvians built their houses far from the rivers; it also might have been one of the ‘fevers’ that attacked the Inca armies as they invaded the Upper Amazon.

Hoeppli 1959. Emphatic that malaria was pre-Columbian in the New World.

Jaramillo-Arango 1950. Includes a “critical review of the basic facts in the history of cinchona.” Malaria was known among American Indians from earliest times and cinchona was familiar to them as a remedy.

Sandison 1967, 182. “Probably malaria also occurred in pre-Columbian America.”

Villacorta Cifuentes 1976. The preponderance of evidence is against Malaria being present; however, the fact that the Peruvians knew of the value of quinine as an agent against it in colonial times leaves a question.

Goldstein 1969. Ackerknecht, Bruce-Chwatt, and Sandison say that malaria probably occurred in the Americas before Columbus, although malaria probably originated in the Old World. Goldstein tends to agree with them.

Alchon 1991, 63. By 1630, when malaria had become a serious problem in Quito, the Spaniards had recognized the value of cinchona bark, the remedy for malaria. [Whether that remedy had been used earlier (by natives) is somewhat uncertain.]

Van Blerkom 1985, 37–42. “Malaria has been widespread in the Old World since most ancient times.” Many species of simian *plasmodia* exist, which can be transmitted to man. Angel suggested the human infection may have been present at Çatal Huyuk in Anatolia by 6000 BC. It is also manifest in the oldest Egyptian mummies. 40. However, malaria in humans was probably not in the Americas in pre-Columbian times. Furthermore, the New World simian malaria is severe, not a condition to be expected in a long-present disease. Some think it was present, including Bruce-Chwatt (1965) and T.D. Stewart (1973, 38–40).

Millet *et al.* 1998, 192. A 3200-year-old Egyptian mummy had had malaria at one point in his life as shown by a test for a protein antigen of *P. falciparum*.

Sandison and Tapp, 1998. Millet and his colleagues (1994) recently detected an antigen produced by *Plasmodium falciparum* in mummies from all the periods they tested, indicating the presence of malaria.

Dunn 1993, 860. Malaria could have reached the New World before 1492 only as an infection of migrants from northeast Asia or by pre-Columbian sea-borne introductions. The possibility that humans brought malaria overland into North America from Siberia can almost certainly be discounted…. Similarly, any voyagers landing on American shores from the central or eastern Pacific could not have carried the parasites with them because islands in that region are free of anopheline vectors and thus of locally transmitted malaria. Voyagers reaching the American coasts from eastern Asia (*e.g.*, fishermen adrift from Japan) could conceivably have introduced malaria, but this possibility too is remote. Moreover, colonial records indicate that malaria was almost certainly unknown to the indigenous peoples. Also, absence of any blood genetic polymorphisms associated with malaria elsewhere in the world is evidence consistent with American absence.

Rickettsia prowazekii

Origin: Old World

Summary: Fairly clearly, epidemic typhus, and of course the human body louse, manifested itself in America. No other explanation other than the arrival of voyagers from across the Pacific is plausible.

Grade: A

Sources: *Rickettsia prowazekii*—agent of louse-borne typhus (epidemic Typhus)

Chin 2000, 372, 541–542. The body louse (*Pediculus humanus corporis*) is infected by feeding on the blood of a patient with acute typhus fever. People are infected by rubbing louse feces or crushed lice into the bite or into superficial abrasions. Humans are the reservoir during inter-epidemic periods. 372. The body-louse (*Pediculosis humanus corporis*) is involved in outbreaks of epidemic typhus caused by *Rickettsia prowazeki* and epidemic relapsing fever caused by *Borrelia recurrentis*.

Alchon 1991, 22. Disease before 1534. One can also build a strong case for the existence of both endemic (flea-borne) and epidemic (louse-borne) typhus in the New World, based on lice on mummies. Examinations of mummified human remains have revealed that head and body lice commonly infested native populations. Most native households included several guinea pigs in the family’s living quarters; these animals can be reservoirs for the typhus *rickettsiae*. Infected fleas can easily jump from rodent to human, transmitting the endemic form of the disease. There are pre-Conquest traditions of epidemics occurring during periods of social turmoil—wars, famines, and natural disasters—supporting the assertion that typhus existed in the Americas before the 16th century. Guaman Poma described two epidemics long before the Spanish Conquest of Peru.

Cabieses 1979. Typhus was common in pre-Columbian Peru.

Guerra 1966, 330–2. The two most important aboriginal Aztec disease entities were *matlazahuatl* and *cocolitztli*. They caused major epidemics. Translation of the terms remains unclear. His analysis of the symptoms indicates that the former was exanthematic typhus, with a faint possibility that it was typhoid fever.

Ackerknecht 1965, 32–43. Petechial typhus (spotted fever) is at least as old as AD 1083 in Mexico, according to Aztec traditions. 53. The epidemic of 1454 on the plateau of Mexico was in all probability typhus, not the yellow fever claimed by some.

Goldstein 1969. Ackerknecht, Bruce-Chwatt, and Sandison say typhus probably occurred in the Americas before Columbus, and Goldstein appears to agree.

Villacorta Cifuentes 1976. Exanthematic typhus was present anciently.

Fonseca 1970, 332–6. Nicolle (1932) drew attention to the distribution of typhus that supports the idea that pre-Columbian migrations reached the mericas from Oceania. 335. Cites a large literature (Mooser, Gay, Miranda, Gaitán, Nicolle) representing what Fonseca refers to as “most authors” who have written on this point and who have considered that exanthematic typhus existed in pre-Columbian America. Furthermore, several wild rodents in the Americas (*Sigmodon hispidus, Microtus mexicanus, Geomys virginianus, Neotoma fuscipes*) have been shown to be capable of acquiring typhus murin infection experimentally, which supports the idea that they could have constituted a reservoir.

Hare 1967, 118. This is probably a mutant of *R. mooseri* that ceased to infect the rat flea and became a parasite of the human body louse, citing Zinsser. This probably occurred in the 16th century. The first outbreaks [known in European medical history] were in Italy [only] in 1505. Epidemic typhus is therefore a comparatively modern disease and could not have come across Bering Strait.

Rickettsia rickettsii

Origin: Old World

Summary: Though disputed by many, there is significant evidence for the presence of spotted fever(s). How and when it reached the Americas is unclear. By infected persons on ancient transoceanic vessels is the most plausible scenario.

Grade: B

Sources: *Rickettsia rickettsii*—infectious agent for various spotted fevers

Chin 2000, 372. Rickettsioses are a group of clinically similar diseases caused by closely related *rickettsiae* [Rocky Mountain spotted fever is the only American version discussed]. They are transmitted by ixodid (hard) ticks, the tick species differing markedly by geographic area. 430–1. Rocky Mountain spotted fever is the prototype disease of the spotted fever group *rickettsiae*. Reservoir: maintained in nature in ticks. Both the Rocky Mountain wood tick, *Dermacentor andersoni*, in the eastern and southern U.S., the American dog tick, *Dermacentor variabilitis*, and in Latin America, *A. cajennense*, are the principal vectors.

Woodbury 1965, 31–32. Maintained by ticks in relation to their hosts, principally rabbits and rodents. Humans are incidental victims. It is a very severe disease.

Saunders *et al.* 1992, 118. Newman (1985) considered that pre-European contact diseases included rickettsial and viral fevers. (Saunders seems to acquiesce.)

Newman 1976, 669. Rickettsial and viral fevers were present in pre-Columbian America.

Ackerknecht 1965. He considered that petechial typhus (spotted fever) was at least as old as AD 1083 in Mexico, as he reads the Aztec traditions.

See also Alchon under *R. prowazekii* below.

Rickettsia typhi

Origin: Old World

Summary: See summary for the previous item.

Grade: A

Sources: *Rickettsia typhi* (ex. *Rickettsia mooseri*)—agent for Typhus murine (*i.e*., endemic typhus)

Chin 2000, 544–5. Murine typhus is like louse-borne typhus but milder. Found where humans and rats cohabit. Rats, mice, and other small mammals form the reservoir. Infective rat fleas (usually *Xenopsylla cheopis*) defecate *rickettsiae* while sucking blood, which contaminates the bite site and other skin wounds. Once infected, fleas remain so for up to their one year of life.

Laming-Emperaire 1980. Fonseca has convincingly demonstrated that typhus murine, among other parasite-caused diseases, was shared between Old World and pre-Columbian South American Indians.

Nicolle 1932. The typhus of Mexico and Guatemala was murine typhus, the same as in New Zealand, Australia, and Southeast Asia. Typhus murine might have come via the Vikings, but that is not very logical. He supposes that it reached the Americas via rats on Polynesian vessels.

Fonseca 1970, 333–6. Murine typhus was at first assigned primarily to two distinct geographic areas: certain regions of the Americas (Mexico, Guatemala, southern U.S.); the other area was the Far East and Pacific (India, Malaysia, China, Manchuria, Formosa, Australia, New Guinea, New Zealand, and Hawaii.)

Alchon 1991, 22. Diseases before 1534. One can build a strong case for the existence of both endemic (flea-borne) and epidemic (louse-borne) typhus in the New World, based on lice on mummies. Examinations of mummified human remains have revealed that head and body lice commonly infested native populations. Most native households included several guinea pigs in the family's living quarters; these animals can be reservoirs for the typhus *rickettsiae*. Infected fleas can easily jump from rodent to human, transmitting the endemic form of the disease. Pre-Conquest traditions of epidemics occurring during periods of social turmoil—wars, famines, and natural disasters—support the assertion that typhus existed in the Americas before the 16th century. Chronicler Guaman Poma described two epidemics long before the Spanish Conquest.

Newman 1976, 669. Among diseases that were part of man's primate ancestry and that either crossed the Bering Strait cold-screen or "were acquired" in the Americas: "various rickettsial fevers such as Verruca and Carrion's disease, insect-borne and altitude localized." "This list could well include typhus on the grounds that the Aztecs had a name, *Matlazahuatl*, for the disease, and depicted it in conventionalized pictures of Indians with spots and nosebleeds, and the generally subclinical nature of the disease in the South Peruvian Sierra" (citing Ashburn).

Hare 1967, 118. *Rickettsia mooseri* may be the oldest of the typhus group. Principal host is the rat flea, and Baker (1943) suggested that those at the eastern end of the Mediterranean were the first to be parasitized. Hippocrates (*ca*. 400 BC) may describe this disease, but the first recorded cases clearly recognizable as typhus occurred in Spain in 1489.

Salmonella enterica serovar Typhi, or *S.* Typhi

Origin: Old World

Summary: Evidence for presence of the typhoid bacillus in the New World is limited. Much more evidence would be needed before we could be confident of the pre-Columbian presence of *S. enterica* and thus of the possibility of a transoceanic transfer.

Grade: incomplete

Sources: *Salmonela enterica*—the typhoid bacillus

Chin 2000, 535–7. A new nomenclature for *Salmonella* has been proposed based on DNA relatedness. Only two species would be recognized, *S. bongori* and *S. enterica*. All human pathogens would be regarded as serovars within subspecies I of *S. enterica*. The proposed nomenclature would change *S. typhi* (italicized) to *S. enterica* serovar Typhi (last term not italicized), abbreviated *S.* Typhi (Typhi here is not italicized and a capital letter is used). The new nomenclature had not been officially approved as of mid–1999, but some official agencies have adopted it.

Alchon 1991, 20. Marvin Allison has suggested that typhoid fever may have existed in the Americas before 1492 (citing Allison 1979 *in re*. his finding of *Salmonella* antigens in Peruvian mummies; others doubt its presence).

Saunders *et al*. 1992, 118. Newman (1985) suggests pre-European contact diseases included *Salmonella* infection.

Guerra 1966, 330–2. The two most important aboriginal Aztec disease entities were *matlazahuatl* and *cocolitztli*. Translation of the terms remains unclear. His analysis of the symptoms indicates that the former was exanthematic typhus, with a faint possibility that it was typhoid fever (his emphasis).

Hare 1967, 124. "There is no reason to doubt that this bacillus could have become established in Palaeolithic societies and might even have been taken to the Americas [via Bering Strait] …. [But the reference has to be to the *salmonella* subspecies that caused gastroenteritis, for serovar Typhi probably was not yet in existence.] None of this can be proved but all [organisms of this type] were causing disease in the Old World before the Christian era" [but how much before?]

Van Blerkom 1985, 67–8. A short treatment. *S.* Typhi was probably not indigenous (*i.e*., in existence in pre-Columbian times] to the New World, while other forms undoubtedly were.

Schistosoma sp.

Origin: Old World

Summary: Because Hoeppli believed that Schistosomiasis was in the New World before Columbus, questions should be studied about whether and how this trematode reached theAmericas.

Grade: incomplete

Sources: *Schistosoma haematobium*—cause of bilharziasis (snail fever)

Chin 2000, 447–8. A blood fluke (trematode) infection with adult male and female worms living within mesenteric or vesical veins of the host over a life span of many years. Three major species cause human disease: *S. mansoni, S. haematobium*, and *S. japonicum*. Four other species are of importance only in limited areas. *S. mansoni* is found in Africa, Arabia, and eastern South America. *S. haematobium* is in Africa and the Middle East. *S. japonicum* is in China and Indonesia. None of the species is indigenous to North America. Epidemiologic persistence of the parasite depends on the presence of an appropriate snail as intermediate host, *i.e*., species of the genera *Biomphalaria, Bulinus, Oncomelania, Neotricula*, and *Robertsiella*. Infection is acquired from water containing free-swimming larval forms (cercariae) that have developed in snails. Transmitted usually while the person is working, swimming, or wading in water.

Hoeppli 1969. “Some of the infections introduced by Africans already occurred in the New World in pre-Columbian time.” Schistosomiasis is one.

Millet *et al*. 1998, 99, 101, 104. *Schistosoma haematobium* is confirmed in a 3200-year-old Egyptian mummy by the presence of *S. (?haematobium)* ova.

Sandison and Tapp 1998, 40. They accept that *S. haematobium* ova were found in the ROM I mummy (Egyptian).

Kuhnke 1993, 456. Schistosomiasis. Described in Egyptian inscriptions and papyri. Ova found in Egyptian mummies from 1200 BC. Snail hosts lived in slow-moving water, as in oases.

Shigella dysenteriae

Origin: Old World

Summary: New information would have to be found demonstrating shigellosis in the New World before this question could be considered seriously.

Grade: incomplete

Sources: *Shigella dysenteriae* (or *S. sonnei, S. flexneri, S. boydii*)—causes of bacillary dysentery

Chin 2000, 451–3. Human reservoir. Transmitted by fecal/oral contamination. The *S*. genus is comprised of four species, or serogroups.

Saunders 1992, 118. Newman (1985) suggests that pre-European contact diseases included bacillary dysentery.

Newman 1976, 669. Among diseases that were part of man’s primate ancestry and that either crossed the Bering Strait cold-screen or were “acquired in the Americas”: “bacillary … dysentery.”

Kunitz and Euler 1972, 27–8. Turkeys have been implicated in the spread of *Shigella* organisms. Occurs among modern Indians of the Southwest U.S.

Hare 1967, 124. “There is no reason to doubt that this could have become established in Palaeolithic societies and might even have been taken to the Americas [via Bering Strait] …. None of this can be proved but all [disease organisms of this type] were causing disease in the Old World before the Christian era.”

Van Blerkom 1985, 67–9. Could have come in Paleolithic hunting populations. There are no ethno-historical records of shigellosis, for it was only distinguished from other dysenteries in 1873.

Staphylococcus aureus

Origin: Old World

Summary: As a first approximation (in the absence of much data) transmission to the Americas via Bering Strait makes sense; however, transmission by voyagers at a later time provides an acceptable alternative explanation.

Grade: incomplete

Sources: *Staphylococcus* x *aureus*

Chin 2000, 460–2. Bacterial skin lesions are common: impetigo, carbuncles, abscesses, etc. There are various strains and many varied manifestations of staph infection. Reservoir: humans. Major site of colonization is the anterior nares. Transmission is through contact with a person who is a carrier of a pathogenic strain. Twenty to thirty percent of the general population (nowadays) are nasal carriers.

Newman 1976, 669. Among diseases that were part of man's primate ancestry and that either crossed the Bering Strait cold-screen or were "acquired in the Americas": "a range of bacterial pathogens such as staphylococcus."

Saunders *et al*. 1992. Newman (1985) suggests that pre-European contact diseases included staphylococcus.

Hare 1967, 128. Commensal organisms such as *S. aureus* and *S. albus* are worldwide. "They have almost certainly accompanied man from his pre-hominid ancestor."

Van Blerkom 1985, 75–6. It is reasonably certain that staphylococcal infections were universally distributed through both hemispheres before Columbus. Some authors believe *staphylococci* were absent from the Americas, but she considers that they have ignored substantial evidence.

Streptococcus pneumoniae

Origin: Old World

Summary: That there was transfer between the hemispheres there is no doubt. When and how this came about is unknown. It could have been by Paleo Amerindians but equally well by voyagers.

Grade: incomplete

Sources: *Streptococcus pneumoniae*

Chin 2000, 387–8. The infectious agent for pneumonia. Reservoir: humans. Pneumococci are commonly found in the upper respiratory tract of healthy people throughout the world. Transmission is by droplet spread, oral contact, or indirectly through articles soiled with respiratory discharges.

Newman 1976, 669. Among Amerindian native diseases: pneumonia.

Allison, Pezzia, Hasegawa, and Gerszten 1974, 468. Cited by Newman as documentation for the presence of pneumonia.

Verano and Ubelaker 1991, 213. "Studies of mummified human remains from the coastal desert of southern Peru and northern Chile have provided conclusive evidence for the presence of … pneumonia." (Emphasis added.)

Hare 1967, 119. This organism may persist for long periods in carriers, rendering it much more capable of surviving in scattered Palaeolithic populations. Pre-Columbian skulls have been found in the Americas showing evidence of acute infection of the mastoid from *S. pyogenes* [agent of 'strep' throat infection] or *Diplococcus* (=*Streptococcus*) *pneumoniae*. (Cites Hooton 1930, on Pecos). "… It would seem probable that one or both of [those two] organisms had become established in the Old World and were carried to the Americas before the land bridge over the Bering Strait was covered …." 123. Related streptococcal infections likewise probably were this old.

Van Blerkom 1985, 59–60. A variety of agents cause pneumonia: adenoviruses, parainfluenza viruses, respiratory syncytial virus, and others. Also can be caused by various bacteria, many of them normal nose and throat inhabitants, pneumocystis (a protozoan), and a chlamydia. Cook (1946) reports that the Aztecs probably suffered from respiratory infections; some of these were most likely rhinoviruses and other cold viruses. Some were probably due to some of the causative agents of pneumonia. "In particular, there is evidence that pneumococci, *Streptococcus pneumoniae*, were present in the pre-Columbian New World because these micro-organisms also cause mastoiditis, ample skeletal evidence of which exists for prehistoric America (Moodie 1967, 43)." *S. pneumoniae* naturally infects wild primates and has a worldwide distribution in all climates and races. Found in mummies from Egypt and Peru.

Streptococcus pyogenes

Origin: Old World

Summary: It is evident that there was a transfer of this organism. Transfer via Bering Strait may be doubted because of the assumed cold-screen. That leaves transfer by voyagers as plausible.

Grade: B

Sources: *Streptococcus pyogenes*—scarlet fever, strep sore throat, rheumatic fever

Chin 2000, 470–3. Group A streptococci occur in approximately 80 serologically distinct types that vary greatly in geographic and time distributions. Skin infection sources are usually of different type from those associated with throat infections. Scarlet fever is one manifestation, as are erysipelas, impetigo, puerperal fever, and rheumatic fever. Reservoir: humans. Transmitted by large respiratory droplets or direct contact with carriers.

Newman 1976, 669. Among diseases that were part of man’s primate ancestry and that either crossed the Bering Strait cold-screen or were “acquired in the Americas”: “a range of bacterial pathogens such as streptococcus.”

Hare 1967. Pre-Columbian skulls have been found in the Americas showing evidence of acute infection of the mastoid from *S. pyogenes* or *Diplococcus pneumoniae*. (Cites Hooton 1930, on skulls from Pecos.) “… It would seem probable that one or both organisms had become established in the Old World and were carried to the Americas before the land bridge over the Bering Strait was covered ….”

Van Blerkom 1985, 76–8. *S. pyogenes* was undoubtedly present in the New World before Columbus. Probably came across the Bering Strait.

Strongyloides sp.

Origin: Old World

Summary: Transfer is definite, and sea travelers are the most (only?) plausible means for it to be accomplished.

Grade: B

Sources: *Strongyloides* sp.—hair worm, threadworm nematode

Reinhard 1988, 359. From Antelope House (New Mexico) traces of this parasite were recovered from a coprolite. 362. It was also found in dog coprolites at this site, which suggests that dogs acted as a reservoir of infection for the human population.

Sandison and Tapp 1998, 40. The (Egyptian) mummy Asru showed larval forms of this worm in the intestines.

Verano 1998, 221. Once thought absent from New World, the presence of *Strongyloides* is now confirmed from (Peruvian) mummy study.

Patterson 1993, 1016. Occurs around the world with a range similar to that of the hookworms. Like hookworms, the filariform *Strongyloides* larvae penetrate human skin, often through an unshod foot, reach heart and lungs, etc.

T-cell lymphotropic (retro)virus (HTLV-I)

Origin: Old World

Summary: Only a limited number of peoples in the Americas have this disease. To appeal to any early Bering-Strait explanation to account for that distribution is implausible. A limited number of voyages account for the observed facts.

Grade: A

Sources: HTLV-I.

León, De León, and Ariza 1996, 132–6. The route by which the human T cell lymphotropic (retro)virus (HTLV-I) reached the Americas has been much discussed. Seroepidemiologic, genetic, virologic, molecular, anthropological, archaeological, and oceanographic data lead the authors to conclude that this virus could have arrived not only from Africa (as previously suggested, via colonial-era slaves), but also from Kyushu Island in Japan more than 5000 years ago through direct voyaging. (The subjects of this study, the Noanama people, were Amerindians from the high mountains of southwestern Colombia; their geographical and social isolation reduces the chance of any contact with the slaves of African origin brought to Colombia by the Spaniards.)

A comparative study made some years ago utilized thirteen genetic markers to distinguish racial groups of the world. The study yielded one very interesting result—the Noanama had very close relations with Samoans on the one hand and Japanese—especially Ainu—on the other. This result suggests that HTLV-I was introduced to South America from the Far East thousands of years ago by a route other than the Bering Strait. Furthermore, recent genetic studies on native South Americans showed that their ancestors possessed genetic markers related to the histo-compatibility leucocyte antigen (HLA) like the Japanese of Kyushu (citing Sonoda *et al*.). A direct voyaging contact from Japan to Colombia would explain this relationship, because populations of North and Central America are totally without the HLA markers. At a mitochondrial DNA level, study of the deletion 9 bp in the human genome has shown it to be Asiatic, especially being found in North American Indians and Polynesians (citing Torroni *et al*., and Hanihara *et al*.). Yet, it is not present in the (Jomon-derived) Ainu, and the 9 bp deletion is also absent among the Noanama (as well as on the coasts of Chile and Peru a thousand years earlier). This suggests an intrusion of people from Japan. They cite the archaeological findings of Meggers *et al*. for the intrusive Valdivia culture of Ecuador as confirming their position.

Finally, Japanese investigators have voyaged across the Pacific by the North Pacific route to Colombia, which the authors suppose was used anciently, and these researchers used vessels similar to those of prehistoric times. This demonstrates that it was possible to make such a voyage (Errazurriz and Alvarado, 1993).

Miura *et al*. 1994, 1124–7. Specimens of T-lymphotropic virus type I (HTLV-I) were phylogenetically analyzed from native inhabitants in India, Colombia, Chile, and Ainu of Japan (the last "regarded as pure Japanese descendants from the pre-agricultural 'Jomon' period"). The phylogenetic tree for the 'cosmopolitan' type virus involved groupings into three lineages. One consists of some Caribbean, two South American, and some Japanese isolates, including that from the Ainu plus an (Asian) Indian isolate. This subtype implies a close connection of the Caribbean and two narrowly-defined South American peoples with the Japanese and "thereby a possible migration of the lineage to the American continent via Beringia in the Paleolithic era." [Their 1996 article expands upon and essentially supercedes this one. One cannot attribute an infection found in only a few limited areas in the Americas to communication across Bering Strait many millennia ago.]

Treponema pallidum **subspecies** ***pallidum***

Origin: Old World?

Summary: The single treponeme at the root of the whole range of manifestations called yaws, pinta, endemic syphilis, and venereal syphilis could have been and probably was present in both hemispheres very anciently. The diseases caused by the micro-organism depended upon environmental and social conditions in the lives of host humans. Nevertheless, hemispheric or regional sub-developments in the infection of a special nature could have been transmitted across the ocean by one or more of the voyaging parties now known to have made the trip. If so only very special evidence of unusual virulence in a given location would have to be detected to demonstrate the connection. While the possibility is open, the likelihood of finding such evidence is unlikely.

Grade: incomplete

Sources: *Treponema pallidum*—the infectious agent producing syphilis, yaws, etc.

Rose 1997, 24–5. Bruce and Christine Rothschild examined 687 skeletons from New World archaeological sites, ranging in age from 400 to 6000 years. Populations in New Mexico, Florida, and Ecuador proved to have syphilis, while those to the north (Ohio, Illinois, Virginia) had yaws. By contrast, 1,000 Old World skeletons dated to before contact with the New World revealed no cases of syphilis. They had begun by analyzing collections of skeletons from Guam where the only treponemal disease predating 1668 was yaws. Also, they analyzed Near Eastern Bedouin for *bejel* and in both cases, as well as in North American cases of syphilis (diagnosed at autopsy), identified characteristic bone changes for each disease. The earliest New World yaws cases were at least 6,000 years old, while the first syphilis cases were at least 800 and perhaps more than 1,600 years old. This suggests that syphilis may be a New World mutation of yaws.

Meanwhile, Olivier Dutour of Marseilles has recently claimed that a 4th-century AD skeleton of a seven-month-old fetus found in France has lesions from congenital syphilis, but B. Rothschild has examined the skeleton and contends that it is not a case of congenital syphilis but of lithopedion, calcification of a fetus, a rarity.

Alcina F. 1979. Verneau examined 39 skills apparently of pre-Columbian Guanche people, and they seemed to him to exhibit lesions of syphilitic origin. Others have questioned that identification.

Anderson 1986, 341–50. Ninety-five skeletons examined reveal bone conditions compatible with treponemal infection, suspected to be endemic syphilis. This occurrence dates earlier than 1531, the earliest known date for syphilis from Norway. No evidence has been reported previously from any part of Europe for this period for endemic syphilis. It appears that an impoverished segment of the Trondheim population suffered endemic (not venereal) syphilis in the 16th century.

Bogdan and Weaver 1992, 155–63. Summarizes the three competing theories for the evolution of treponematosis: (1) New World origin of syphilis, (2) Europe-to-New World, and (3) unitary or both-hemisphere presence. Advocates of the second maintain that venereal syphilis in Europe was not distinguished from a number of diseases grouped under the term 'leprosy,' including Roman, Greek, and later references to "venereal leprosy."

Goldstein 1969, 285–94. It is now known that treponematosis in one form or another has been present on every continent for thousands of years; "the old argument about whether Columbus' sailors brought syphilis to the New World or carried it back to Europe is moot."

Bullen 1972, 133–74. Recapitulates literature showing that treponemiasis was recognized in Florida skeletons 90 years ago and since. Evidence for syphilis is as early as the Archaic, *ca*. 3000 BC.

Daws and Magilton 1980. They report a probable European case of syphilis dating before AD 1500.

El-Najjar 1979, 599–618. Only one treponeme, *T. pallidum*, exists. European and New World strains were apparently interchanged at the time of the Conquest, with extreme virulence manifest in both areas as a result of the new introductions.

Goff 1967, 287–93. "Treponematous ancient bone lesions have been difficult if not impossible to identify scientifically in the light of our present knowledge."

Hackett 1967, 152–69. A series of maps displays the author's inferences about probable geographical distributions of the four treponematoses—pinta, yaws, endemic syphilis, and venereal syphilis. Pinta, the earliest, was essentially worldwide by about 15,000 BC. From about 3000 BC to the 1st century BC endemic syphilis existed throughout northern Africa and Arabia to Mongolia (as well as in central Australia and Bechuanaland). At the same period, yaws was present in tropical Africa and south and Southeast Asia through Oceania. Pinta was only American, essentially limited to Mexico through Brazil.

Hare 1967, 125. Depends chiefly on Hackett. About 7000 BC, *T. pallidum* was evolved in the Old World and caused endemic syphilis. This was largely confined to the warm arid climates of North Africa, Southwest Africa, and ultimately, Australia. The same organism then about 3000 BC began to cause venereal syphilis in the mild form. The urban revolution facilitated this change. It continued to behave in this way but in the early years of the 16th century AD was supplanted by a more virulent mutant that produced the widespread epidemic of severe syphilis in Europe frequently considered to have been imported from the Americas by Columbus. [Hare says nothing about a duplicate mutation sequence in the Americas. Either that happened apart from the Old World sequence, or the venereal syphilitic organism had to have reached the New World via migrants after 3000 BC, when, according to Hare, the venereal syphilis treponeme originated. Of course, the orthodox interpretation is that there were no migrants to the New World after 3000 BC.]

Tisseuil 1974, 40–4. Endemic syphilis was widespread in Europe in the Middle Ages ("by cutaneous transmission"), mainly among the deprived classes. At the end of the 15th century, movements of armies and populations favored an epidemic explosion of venereal syphilis in Europe which was promptly carried to the New World.

Willcox 1972, 21–37. Considers that endemic syphilis was common in pre-Columbian Europe.

Hudson 1958. American pinta was essentially a variety of yaws, the latter somehow derived from the Old World in prehistoric times.

Hudson 1965, 885–901. The four syndromes of treponematosis are from one organism. Their manifestations form a continuum from yaws to venereal syphilis, variations dependent on local natural and social conditions. Lesions representing effects of the disease are evident in bones worldwide. No definitive indicator allows distinguishing in the bones venereal syphilis from the other forms. It would have appeared in many places after it spread in relatively benign forms in Mesolithic/Neolithic times. Certainly, there is no merit in the theory that Columbus' crew carried syphilis to a previously untainted Europe.

O'Neill 1991, 270–87. Because of similarities of the early stages of leprosy and syphilis, syphilis may have been present in medieval Europe and mislabeled leprosy.

Livingstone 1991, 587–90. Treponemes were ubiquitous in human populations in both hemispheres but changed in different habitats. Epidemics of diseases no longer present but which had pathologies similar to modern treponemes no doubt occurred in the past. Syphilis in Europe may have come from the New World, but the tropical regions of the Old World, at that time being heavily contacted by Europeans for the first time, seem a more likely source. A non-venereal treponeme from Africa may have made the adaptation to venereal form at that time, hence syphilis is [still conditional: "may be"] one of the world's newest diseases. Increased occurrence of it in the Americas in post-Columbian times is evidence that a virulent strain was brought from the Old World (*i.e*., Africa) at the time of Columbus.

Weiss (1984, 35–37) considers three kinds of treponemal infections to have been present in pre-Columbian America—endemic syphilis (not the same as classic syphilis however) and 'pian' and 'mal del pinto.' Both these are rural infections. Syphilis is urban (today). "The fact is very significant that some of the traits that a comparative clinical study of treponemiasis seem properly to belong to the evolved characterization of *mal del pinto* have been noted also as traits of the so-called endemic syphilis known as *bejel* of the Bedouins of the Euphrates, the syphilis of the Arabs."

Van Blerkom 1985, 100–1. The causative agent of pinta is difficult to distinguish from that of yaws. Since yaws is a tropical disease (because growth of the spirochete in the skin requires warmth and humidity), it could not have been carried to the New World via early hunter groups across Bering Strait. There is one report of yaws in a pre-Columbian Mexican skull (Goff 1967, 291), but the evidence is questionable. The oldest evidence of yaws is in the Mariana Islands, from about 850 BP, and Iraq, dating to AD 500.

Goff 1967, 279–94. Many reliable investigators believe yaws was endemic in the New World at the Conquest. 291, 293. Bones from Mexico are illustrated and discussed showing what may be yaws (probably pre-Columbian).

Trichophyton concentricum

Origin: Old World

Summary: This fungus at least (as well as, perhaps, others of the genus) is manifest in Oceania and Southeast Asia, as well as in Tropical America. No explanation for the distribution is plausible other than movement by infected voyagers across the Pacific Ocean to the Americas.

Grade: B

Sources: *Trichophyton* spp. (includes *T. concentricum*)—ringworm of the body

Chin 2000, 147–53. Transmission is skin-to-skin or by indirect contact through shared objects. This is a fungal disease of the skin, other than of the scalp, bearded areas, and feet that characteristically appears as flat, spreading, ring-shaped lesions. Infectious agents: most species of *Microsporum* and *Trichophyton*

Regarding literature on distribution, see *Microsporum* spp.

Ainsworth 1993, 731. *Trichophyton concentricum* (tinea imbricata) is endemic in Southwest Asia and the South Sea Islands. It has other minor endemic centers in South America.

Ajello 1960, 30. *Trichophyton* spp. are some of the eleven species of fungi that are cosmopolitan, seven of which are anthropophilic. *T. concentricum* is recorded from Oceania, Asia, and North, Central and South America, but not north of Mexico or in Europe or Africa. 34. The geographic distribution of *T. concentricum* may be of anthropological significance. It is widespread among the inhabitants of Polynesia and the countries bordering the western shores of the Pacific Ocean; however, it is only a sporadic parasite of Indians living in the tropical forests of Brazil, Guatemala, Mexico, and San Salvador. The disparity in prevalence between the Asian endemic areas and those of Latin America leads him to speculate that the fungus was introduced from Asia into the New World.

Trichosporon ovoides

Origin: Old World

Summary: There is no explanation for the bi-hemispheric distribution except that voyaging humans conveyed it from other areas to the Americas.

Grade: A

Source: *Trichosporon ovoides* (or *T. inkin*; formerly *T. beigelii*)—a fungus causing a disease of the scalp and hair

Fonseca 1970, 228–32. Known particularly from Brazil, but also Asia. Causes a group of nodular parasitic diseases of the hair and beard characterized by white or clear nodules on individual hairs. The fungus is of the genus *Trichosporon,* so he calls the disease *piedra tricospórica*; others have called it *piedra branca*. It stands in contrast to the disease *piedra*, for which see *Piedraia hortai*.

Trichuris trichiura

Origin: Old World

Summary: No explanation for the Asian-South American distribution is plausible except that humans brought the organism via voyaging.

Grade: A

Sources: *Trichuris trichiura*—whipworm

Reinhard 1992, 231–45. He reprises South American incidence of the whipworm (*Trichuris trichiura*). The findings suggest direct transpacific contact, some think by way of Japan and Ecuador. Since both hookworms and whipworms require warm, moist conditions for the completion of their life cycles, finding human-specific parasites in the Americas is circumstantial evidence for transpacific contact.

Verano 1991, 15–24. Coprolites from coastal Peru show the whipworm by 2700 BC.

Verano 1998, 221. *T. trichiura*, one of parasites once thought absent from New World, but now found.

Ferreira *et al*. 1988, 65–7. Evidence was found in a cave site in Minas Gerais state, Brazil, dated between 3490 and 430 BP, consisting of eggs of *T. trichiura* and *Necator americanus.* The same parasites, found at Unai, Minas Gerais (*i.e*., *Trichuris trichiura* and *Necator americanus*), have now been identified in human coprolites from Boqueirão do Sitio da Pedra Furada, Brazil, in a stratum dated to 7320±80 BP.

Patterson 1993,1058. (*Trichuris trichiura*). Archaeological evidence shows that this worm infected people in the Americas prior to the voyage of Columbus.

Trychostrongylus sp.

Origin: Old World

Summary: If this find is accepted, then it is the only one in the Western Hemisphere. Such spotty distribution would not have resulted from an early spread via Bering Strait. That leaves a limited-destination voyage as the only theory. More data are needed.

Grade: Incomplete

Source: *Trychostongylus* sp.—a helminthic parasite

Reinhard 1988, 359, 361. Found the organism in a coprolite from Antelope House, New Mexico. Other parasitologists dispute his identification, suggesting hookworm.

Tunga penetrans

Origin: New World

Summary: Blanchard’s report is highly suggestive of a sudden intrusion if this organism into Africa. More historical evidence would have to turn up in Africa to show definitely that a pre-Columbian voyage was responsible.

Grade: incomplete

Sources: *Tunga penetrans* (syn. *Pulex penetrans*)—chigger, nigua

Blanchard 1890, II, 484–93. In AD 1324, according to chronicles, a caravan of Mansa Musa in Touat (In-Salah) (in the center of modern Algeria) was attacked by a strange disease. People suffered in their feet by a foot-penetrating parasite/flea (considered here to be *Pulex penetrans*), which is a particular species of Central America, perhaps *Sarcopsylla penetrans* (called *nigua* in Mexico, *pique* in Peru, and *pula penetrante* in the Antilles). It was first medically observed in Africa in the year 1870.

Weiss 1984, 19. A nigua is represented in a ceramic effigy in the Museo Amano, Lima.

Karasch 1993, 537. *Tunga penetrans*, the chigger that burrows into the feet where it lays its eggs and causes painful foot ulcers, was native to Brazil.

Wuchereria bancrofti

Origin: Old World

Summary: Much more evidence than Hoeppli offers would have to turn up before we could take a voyaging transmission of this organism seriously, but such study should be made.

Grade: incomplete

Sources: *Wuchereria bancrofti*—a threadlike worm or nematode

Chin 2000,197–9. The cause of Bancroftian filariasis. Transmitted by the bite of a mosquito, the most important being several *Anopheles* and *Aedes* species.

Hoeppli 1969. “Some of the infections introduced by Africans already occurred in the New World in pre-Columbian time.” Elephantiasis [filariasis] was one.

Yersinia pestis

Origin: Old World

Summary: It may be said that *Y. pestis* is simply zoonotic in origin and as such has no relevance to the question of human incidence. But that dodges the question of exactly how the infectious organism, a bacillus, came to be in the Americas at all. Either an infected animal or an infected human crossed the ocean. (Bering Strait won’t do if we are talking about small animals.) Van Blerkom’s observations about *Y. pestis orientalis* involve a crucial consideration. We are not persuaded that an introduction of the plague by a human being in 1855 provides an adequate explanation for the occurrence of *Y. p. orientalis* a century and a half later for the bacillus infecting a wide variety of wild rodents over a good deal of the hemisphere. An introduction of the organism by voyagers from “Southeast Asian seaports” several millennia ago provides a far superior explanation.

Grade: B

Sources: *Yersinia pestis* (ex. *Pasteurella pestis*)—the plague bacillus

Chin 2000, 381–3. Endemic in eastern and southern Asia and sub-Saharan Africa. Reservoir: wild rodents, especially ground squirrels, and also rabbits and hares. Transmission is as a result of human intrusion into the zoonotic (sylvan or rural) cycle, or by the entry of sylvatic rodents or their infected fleas into man’s habitat. Domestic pets may carry plague-infected wild rodent fleas into homes. The most frequent source of exposure that results in human disease has been the bite of infected fleas (especially *Xenopsylla cheopis*, the oriental rat flea). Person to person transmission by *Pulex irritans* fleas, the ‘human’ flea, is presumed important in the Andes area.

Stodder and Martin 1992, 55–73. Sylvatic plague probably occurred in the Southwest U.S. before the Spanish arrival (citing Van Blerkom 1985)

Hare 1967, 115–131. *P. pestis* parasitizes many species of rodents, although most human infections are caught from the black rat. There is no evidence that the disease occurred at any time during the pre-Christian era. [Ergo, it could not have reached the Western Hemisphere via early settlers traversing the Bering Strait.]

Van Blerkom 1985, 48, 50–9. Although human plague is more commonly zoonotic in origin, it can be transmitted from man to man, with or without the agency of vector fleas, and humans can act as a reservoir of the disease. Two forms are differentiated ecologically: sylvatic, the original form, and urban. Sylvatic, of course, is present in wild rodents and their fleas. The same organism can produce three different forms of plague, depending on the mode of transmission and climate: (1) bubonic, (2) pneumonic, and (3) septicemic. Pneumonic plague is more common in dry temperate zones and as a result of contact with infected wild rodents (usually contracted while skinning or otherwise handling the animal, or from a bite). Highly contagious, it localizes in the lungs and is rapidly fatal without medical treatment. It spreads rapidly to other humans via the respiratory route. Human fleas, *Pulex irritans*, can spread bubonic plague without the involvement of rats, and *Xenopsylla cheopis* (the flea of *R. rattus*) also readily infests humans. Over 200 species of rodent, as well as other mammals, can carry plague. Most domesticated and commensal rodents do. 57. Many (Schwabe {1969, 282} calls it a consensus) believe that sylvatic plague is indigenous in the Americas. Several lines of evidence seem to support this conclusion. The most compelling evidence in favor of pre-Columbian plague is the existence of several extensive sylvatic foci in both North and South America, with the largest being in western North America in ground squirrels and other rodents. Also focussed in eastern Siberia and western Canada. This distribution suggests that plague is an ancient and widely distributed disease of rodents diffused across the Bering Strait. She disagrees. 58. There are three subspecies, *Y. p. orientalis*, endemic in India, Burma, and South China; *Y. p. antiqua*, carried by rodents in Central Asia and Africa; and *Y. p. mediaevalis*, of the Black Death and Europe and today found only in West Africa. If New World sylvatic plague were an indigenous disease of the rodents of this hemisphere, one would expect it to be the same strain found on the other side of the Bering Strait, *Y. p. antiqua*, the parent of the others. However, American plague is the same as the urban strain found in Southeast Asian seaports, *Y. p. orientalis* (Alland 1970, 101–2; Hull 1963, 534). This suggests that plague was carried by ship to the Americas from Southeast Asia during the last pandemic. She considers that to have been in China in 1855. Only later was plague found in wild rodents, and it seems to have spread rapidly into wild reservoirs from the original murine foci in seaports (Hull 1963, 547–54). [This presumes an unbelievable rate of spread to a wide variety of rodents (up to 200 species; see her p. 56) over a wide geographical range. The presence of *Y. p. orientalis* in the Americas can be explained much more economically by supposing its arrival on a pre-Columbian voyage from Southeast Asia, allowing time for a normal rate of dispersion.]

Other fauna

Alphitobius diaperinus

Origin: Old World
Summary: This species is present in parallel mortuary circumstances in ancient Egypt and Peru.
Grade: A

Sources: *Alphitobius diaperinus* (Panzer)—the lesser mealworm beetle

Buckland and Panagiotakopulu 2001, 554. They note that Riddle and Vreeland (1982) report two species of Coleoptera, *Stegobium paniceum* and *Alphitobius diaperinus*, present in pre-Columbian Peruvian mummies examined in Lima. “Both species are recorded also from Pharaonic Egypt and Roman sites in Britain (*e.g*., Hall and Kenward 1990), and must therefore be of Old World origin.”

Riddle and Vreeland 1982, 7. For discussion of the mummy bundles analyzed, see under *Stegobium paniceum*. *Alphitobius diaperinus* (Panzer) is known as the ‘lesser mealworm.’ It is a common pest of stored dried foods, such as grains, cereals, and seeds.

Panagiotakopulu 2000, 16, Table 3–3. *Alphitobius diaperinus* (Panz.). Earliest archaeological examples: British Isles, 2nd century AD. Also in Egypt *ca*. 1350 BC. 110. Also recovered in the (Roman) Mons Claudianus (Egypt) samples. It is an omnivorous feeder, associated with a wide range of commodities, *e.g*. grains, flour, leather, bones, ground nuts, etc. The species has recently been recorded from Tell el-Amarna, Egypt. 12. An omnivorous feeder, associated with grains, flour, leather, bones, etc.

Alfieri 1976, 200. Collected from Alexandria, Cairo, El Wasta, Asyut, and Siwa areas.

Canis familiaris

Origin: Old World
Summary: One or more of the specialized varieties of dogs known in pre-Columbian America probably were, or could have been, imported to the hemisphere, but none of the evidence is conclusive.
Grade: C

Sources: *Canis familiaris*—the dog

Mair's data (1998) clarify the age of the domesticated dog. It turns out that the dog-in-the-company-of-humans, even in the Old World, is not as old as has commonly been assumed. The earliest domestication (or taming) was in the Near East (the Natufian era) only around 12,000 years ago. Dogs in the European Mesolithic period date to the order of 9000–6000 BP. 22–3. The earliest dogs we know of in China belong at around 6000 BP. Moreover, the common hypothetical root word for dog in ancestral language groupings, like Nostratic and Afro-Asiatic, appears to date "closer to 6000 BCE than to 10,000 BCE." These data might mean that domesticated dogs would not have been available in northeastern Asia to accompany migrants to the New World until a number of millennia after the first settlement of the Western Hemisphere.

Three varieties of canines may have been brought to the New World by voyagers from across the ocean:

(1) A voiceless, hairless dog

Coe (1968, 59) found physical evidence for eating small dogs at San Lorenzo in southern Mexico around 1000 BC.

Fiennes (1968. 26, 53–55, 103–110) wrote of the same special breed of hairless, 'toy' dogs that were kept and bred in China as well as in west Mexico and Peru as temple and sacrificial animals and for eating.

Campbell 1989, 385. Includes discussion of the place of hairless dogs in Mexico, Ecuador, and China. Dogs for eating appear in the Chorrera phase in coastal Ecuador, about 1500–500 BC, alongside such Asiatic traits as house effigies, roller and flat stamps, and ceramic pillows.

Tolstoy (1974) saw the hairless dog of Mexico derived from Asia (along with chickens and several plants).

Ling (1957) found what he considered "striking similarities" in a dog sacrifice complex that is ancient in Chinese archaeology, and that also occurs in parts of northern North America, South America, and Polynesia.

Roys 1931, 328. "*Ah Bil*, or *Kik-bil*. *Canis caribaeus*, L. (Gaumer 1917, p. 197). *Perro mudo*. '*Bil*. Hairless dogs.' (Motul.) 'These were used to hunt birds and deer and were also eaten.' (Rel. de Yuc. I, 63; Landa 1900, p. 400)." 340. *Tzotzim-pek*. "A dog of this land with very short hair." (Motul.) "Also the Indians have another sort of dogs which have hair, but they do not bark either, and are of the same size as the others (hairless dogs)." (Rel. de Yuc. I, 63). Lit. 'hairy dog.'

Latcham 1922, 37. Three varieties of domestic dog can be suggested as having been brought by voyagers from the Old World. The first is the small hairless, often voiceless, dog used for food. In general, Latcham (1922, 37) observes that such creatures were used for food in Mexico, Central America, the Antilles, and Peru. Coe (1968, 59) reports their skeletons at the Olmec site of San Lorenzo at the Isthmus of Tehuantepec in the late 2nd or early 1st millennium BC. He also notes that the bones give evidence that the dogs were eaten.

Covarrubias (1957, 93) observes that raising and eating voiceless, hairless dogs was a characteristic of ancient Chinese culture (as early as the Shang Dynasty in the late 2nd millennium BC, according to Simoons, 1961).

(2) A possible European dog among the Inca of Peru

Friant and Reichlen (1950, 1–18) determined that "the Inca dog was not domesticated from a South American wild form but was brought from elsewhere already domesticated." Subsequently, Friant (1964–1965, 130–5) examined mummified dog remains and dog skulls in Inca burials and found that they compared closely with dog remains from Denmark in the late Neolithic. They postulated that the similarity must be due to the hybridization of Viking dogs with those of the "Indians," which eventually reached the Inca area. This proposition, which seems fanciful at first glance, is supported by the existence of a surprising corpus of inscriptions of runic type from numerous sites in Brazil, Paraguay, and Argentina, reported and photographed by Mahieu (1988).

(3) A third variety documented by early naturalists visiting Northwest coastal Indian tribes

Lord (1866, 215; compare Vancouver 1798, I, 266; Kane 1859, 210) stated that "along the coast several tribes at one time kept dogs of a peculiar breed, having long white hair, that were annually shorn as we shear sheep, and the hair so obtained was woven into rugs." Kept on separate islets so as not to run away or mix with common canines, they differed "in every specific detail from all the other breeds of dogs belonging to either coast or inland Indians" (Lord 1866, 216). Kissell (1929, 85) further noted that the weaving of this dog hair was done on "a foreign loom" using an "archaic style of spinning found nowhere else in the world." This ethnographic anomaly was due, it was speculated, to possible contact with Asia. Lord observed, "Whence came this singular white long-haired dog?" His answer: "The … probable supposition is that it came from Japan; and I am informed by a friend who has been there, that the Japanese have a small long-haired dog, usually white, and from description very analogous to the dog that was shorn by the Indians of the coast and of Vancouver Island." The only other possible view (page 217) was that "it could have come … from the north, which is far from likely." That the dog was not indigenous, he was quite sure.

Kissell 1929, 85. Among unique features of weaving in this area are a foreign loom (possibly from Colombia), an archaic style of spinning found nowhere else in the world, and a strange domestic fleece-bearing dog that furnished textile fiber and is thought to have come from Asia, being raised solely for its hair and kept in dog folds on islands away from domestic dogs. (Kane 1859, 210 and Eells 1887, 630).

Vancouver 1798, I, 266. The dogs belonging to (certain Indians on the Puget Sound) were numerous and much resembled those of Pomerania, though in general somewhat larger. All were shorn as close to the skin as sheep in England. Their fleece was composed of a mixture of coarse wool with very fine long hair, capable of being spun into yarn. The abundance of these garments amongst the people indicates the animal from whence the raw material is procured to be very common in this neighborhood, as they have no one domesticated excepting the dog. 284. A survey vessel went ashore and found "upwards of two hundred people, attended by about forty dogs in a drove, shorn close to the skin like sheep."

Kane 1859, 210. (Northwest coast tribe not identified on this page.) "They have a peculiar breed of small dogs with long hair of a brownish black and a clear white. These dogs are bred for clothing purposes. The hair is cut off with a knife and mixed with goose down and a little white earth, with a view of curing the feathers." This is then "twisted into threads by rubbing it down the thigh with the palm of the hand …." "These threads are then woven into blankets by a very simple loom of their own contrivance."

Cicada **sp.**

Origin: Old World?

Summary: The occurrence of cicadas in both hemispheres, according to Balser, and similarities in cultural practices in relation to the insect, raises the possibility of a transfer of the genus, if not a particular species, to the Americas from East Asia by ancient voyagers. Or possibly the practices were transferred by Asian travelers when they discovered American cicada insects upon arrival in Central America. More research is desirable.

Grade: incomplete

Source: *Cicada* sp.—cicada, harvest fly

Balser 1988, 18. *Cigarras*, or *chicharras*, are of the sub-order *Homoptera*, known also by the Latin name *cicadas*. Their chirps are the song of the males. Females deposit their eggs in incisions made by them in the tender twigs of trees. These branches are broken off by even a gentle wind and fall to the ground. The larvae (wingless, scaly) thus reach the earth and enter the soil, where they live from four to twenty years (depending on the species and the latitude). The adult larvae feed on the fluids of roots. After a considerable time, they return to the surface of the earth. When fully developed, they climb the trunk of a tree to which they cling tightly. The larval skin then splits, and the adult insect emerges. It lives a little more than a week, during which time copulation is effected and a new life cycle begins. In the ancient cultures of China, the cicadas were a symbol of the resurrection. This is shown in a Han tomb (at Loyang) of the 1st or 2nd century AD, where a jade cicada was found placed in the mouth of the cadaver. Use of this insect as a funerary offering can be documented in China from the Eastern Chou Dynasty (770–256 BC) through the Ming Dynasty (until AD 1644). It seems that in China the metamorphosis of the cicada is intimately related to the calendar by its coinciding with the summer solstice.

Balser cont'd. In pre-Columbian America, we have little data on the cicada, except that the great naturalist, Anastasio Alfaro, in his book *Investigaciones Científicos*, refers to ancient documents (traditions) that speak of the immortality of the spirits of the natives, indicating that they (the natives) in the first months of the rainy season noted that out of the soil came bees, 'sphinxes,' and cicadas. Here, Balser reports several jade artifacts discovered in burials on the Nicoya peninsula of Costa Rica, which are carved in the form of cicadas, very similar to those cicada carved in jade in ancient China. He illustrates one of the Costa Rican examples (his Example No. 4 on p. 20).

Crax globicera

Origin: South Asia

Summary: Whitley's evidence is persuasive, but he involves so many disciplines that one wants confirmation of aspects of his argument from relevant specialists before accepting it at face value.

Grade: B

Source: *Crax globicera* (ex *C. rubra*)—the curassow

Whitley (1974) argues that this large bird was first tamed in Southeast Asia, then was carried to Africa. The evidence comes from comparisons of the names for the bird and cultural traits associated with it. From Africa, it reached eastern South America, where some group speaking a language of the Tupí-Guaraní family domesticated it. From there, it spread to Mesoamerica, where it was a domesticated species around the time of the Spanish Conquest (Tozzer 1941, 202).

Dendrocygna bicolor

Origin: South Asia

Summary: Whitley's evidence is persuasive, but he involves so many disciplines that one wants confirmation of aspects of his argument from relevant specialists before accepting it at face value.

Grade: B

Source: *Dendrocygna bicolor—*fulvous tree duck

Whitley (1974a) characterized this as one of eight species of a genus that originated in India. To the east of India, the East Indian Tree Duck has a relatively compact and coherent range extending through three subspecies to southern China, northern Australia, the Philippines, New Guinea, and Fiji. Westward, the fulvous tree duck reaches to Madagascar and East Africa. But it also has three loci in the New World: southern Brazil and Paraguay, Venezuela, and surrounding areas of northern South America and Mexico. (Leopold {1959} maps it along both coasts of Mexico.) In the Americas, it competes with an indigenous tree duck.

Whitley maintains that man must have had a role in the distribution of this domesticated duck. When he compared local names, the terms appear to have spread from Africa to South America (he proposes that this took place via the Cape of Good Hope aboard vessels with humans). Separate names appear among the Arawak- and Tupí Guaraní-speaking peoples on the lower and middle Amazon. The Mexican name seems to have come from Paraguay.

Gallus gallus

Origin: Southeast Asia

Summary: A variety of evidences from the American sources indicates that the distribution of Asiatic varieties of chickens in the Americas can only be accounted for by pre-Columbian voyages from Asia.

Grade: A minus

Sources: *Gallus gallus*—chicken

The conventional position among ornithologists has been that chickens were first imported to the New World by the Spaniards. If that had been the case, the chickens in the hands of Amerindians immediately after the Conquest all ought to have been of Mediterranean type, but they were certainly not exclusively so. Especially in the Andes, the native peoples soon after the Conquest had many chickens whose widespread name had no relation whatever to any name they might have learned from the Spaniards. Rather, various Asiatic-type chickens were manifest, that is, they were different in appearance, names, behavior, and uses from what the Spaniards knew (Carter 1971; 1998, 151–3; *cf*.

Bright quoted in Hamp 1964). Multiple introductions of fowls across the Pacific are required to account for the disparate characteristics.

Latcham 1922, 175. At least three kinds of chickens used later by Indians in Chile were very distinct from those brought by the European conquerors. Those three types were present before the Spanish Conquest and are still represented among fowls kept by Araucanian Indians.

Castello 1924. He identified four varieties in Chile beyond the one brought by the Spaniards. The exotics all show Asiatic features; some are tailless and have multiple rows of comb on their foreheads as well as balls of puffy feathers at the sides and atop their heads, as do fowls in China (Carter 1971; Finsterbusch 1931; Sauer 1952).

C. Sauer (1952) summarized some of the evidence for the presence in South America of a black-boned, black-meated (BB-BM) chicken. Its breast meat is dark, a melanotic sheath surrounds the bones, and it bears tufts on the sides of its head. It also has raised hackles, a black tongue and legs, and characteristic coloring of the feathers that mark it as distinctively Southeast Asian.

Johannessen and collaborators (Johannessen 1981; Johannessen and Fogg 1982; Johannessen *et al*. 1984) have subsequently paid special interest to BB-BM chickens that are still found among various Indian groups in the Americas. This is a non-flocking chicken, displaying the social psychology characteristic of the chickens of Southeast Asia that leads them to stay apart from others when feeding.

At least among the groups that speak Mayan languages, Johannessen *et al*. found that the BB-BM chicken is not normally eaten but is used in divination or medical treatments in essentially the same manner as recorded in China in a great encyclopedia of medicine about 1530. The treatments in China and the Americas are highly esoteric. For instance, in highland Guatemala the chicken is cut sagitally, the cut surface bound against the soles of a patient’s feet and left there for two or more hours; it is supposed to absorb pulmonary problems resulting from or causing an asthma attack. It is also used to cure ‘omen’s problems.’ The curer has specific incantations in a non-Mayan language that must be recited while candles and copal incense are burned and rum is blown onto the patient’s bare skin for shock effect. Other rituals involving the BB-BM chicken take the fowl’s life in order to protect a house, family members, tools, and even ships against hexes by painting all with the blood of the chicken. The South American groups who use the BB-BM chickens (Araucanians of Chile and the Chipaya of Bolivia) have been said to be tied linguistically to the Maya.

These beliefs and practices correspond to Chinese ways with BB-BM fowls. Transmission of these cultural matters must have involved careful teaching by Asian cult practitioners. Such rites and beliefs could not have been imported by such ephemeral contact as natives had with people off the 17th-century Manila galleons. And it is only speakers of Maya who received, or at least have carried on, these practices.

Hartman’s (1974) survey of the literature on the types of American chickens concluded that the Asian characteristics in American fowl can only be explained by voyagers’ having introduced fowl to the New World across the Pacific Ocean before Columbus.

Most recently, linguist Soren Wichmann (1995, 76, 276) has reconstructed a term (*ce:wE{kV?}{n}) for ‘chicken,’ or ‘hen,’ in the Proto-Mixe-Zoquean language of Mexico, which is believed to have been in use in the territory of the Olmec civilization of Mexico of the 2nd millennium BC (Campbell and Kaufman 1976). He also reconstructed the expression *ná’w-ce:wy for ‘cock.’ Wichmann also gives nearly the same term for ‘gallo/cock’ for Proto-Zoquean from the 1st millennium BC. Both terms are distinct from words for ‘turkey’ in those tongues.

Guillemaud’s (1947, 112) list of Mixe language terms in southern Mexico includes *tseuk* for ‘gallina/hen,’ and *tsag-naj* for ‘gallo/cock,’ which look as if they are in agreement with Wichman’s terms.

Lasioderma serricorne

Origin: Americas (unclear)

Summary: The issue hinges on the place of origin of the species. It is well known now in the ancient Old World, but because it has been supposed connected with tobacco, it has been supposed to come from the New World. If from the Old World, no transoceanic transport can be supposed.

Transfer: Americas to Europe and the Mediterranean

Time of transfer: by the Egyptian Late Bronze Age, *ca*. 1400 BC

Grade: incomplete

Sources: *Lasioderma serricorne*—tobacco, or cigarette, beetle

Jett 2003. The species was first described in Europe in 1798, on dried American materials, especially tobacco, and was first recorded in the United States in 1886. The beetle has also now been reported from the Late Bronze Age Minoan town of Akrotiri on the island of Thera in the Aegean, as well as at two Egyptian sites.

Panagiotakopulu 2000, 9. Noting the archaeological appearance in the Mediterranean region of this species, she thinks that "Its origin could be also Near Eastern." Its first archaeological record is from Akrotiri (Late Bronze Age). It has also been found in Tut's tomb in Egypt. But on page 6, Table 3–1, opposite *L. serricorne*, under "Place of origin," the column is left blank, meaning that she considers the place of origin to be undetermined.

Alfieri 1931. First report on the finding of *L. serricorne* in King Tut's tomb.

Alfieri 1976, 82. Seven species/varieties are recorded. *Lasioderma* (Hypora) *serricorne* Fabricius, speciments from Alexandria, Cairo, Delta, Faiyum, and Luxor regions. "Numerous individuals found in an alabaster jar hermetically sealed in Tut Ank Amoun tomb 3500 years old."

Steffan 1982, 1985. *L. serricorne* was found in the mummy of Rameses II.

Steffan 1985. *L. serricorne* has several congeners, largely feeding on thistles, in the Old World. Hill (1994) considered the species of tropical origin. There are Mediterranean fossil records, which would support this explanation. Nevertheless, Steffan still relates the Rameses specimen to an unidentified species of *Nicotiana* from the mummy's visceral cavity.

Kislev 1991, 121. Origin of *L. serricorne*, Tropical America. 124. "The cigarette beetle." Attacks mainly high value commodities such as cocoa and finished goods such as tobacco products and various processed foods. 128 (Table 11.2.) *L. serricorne* is listed as having archaeological manifestations in Egypt (only). "Among the seven beetles [listed], two of them should be excluded from this context: the find of *L. serricorne* in an ancient Egyptian site (Alfieri 1931) has to be considered as a modern intrusion because the beetle is known to originate in Tropical America." He repeats the point on page 129: "The absence of *L. serricorne* … (which originated in the tropics) from the ancient Old World means that at least pulses were less likely to be damaged by pest beetles."

White 1990, 344. *L. serricorne* is "closely allied" with five species in North America. "In its native habitat" the species *L. haemorrhoidale* (Illiger), which he here reports, "exhibits a circum-Mediterranean distribution." The original host of *L. serricorne* was evidently the thistle, but at some time in the past it underwent an alteration of its feeding preference and became a pest of stored starches. There are more than 50 world species belonging to the genus *Lasioderma*, but the feeding preferences of fewer than 12 of these are known. There has never been a summary published of the genus. 347. Table 1 lists for *L. serricorne*'s distribution, "Cosmopolitan," with no reference to literature.

Munro 1966, 93. *Lasioderma serricorne* probably had a sub-tropical origin although it is now cosmopolitan.

Littorina littorea

Origin: Old World
Summary: Transatlantic transplantation would be impossible without voyagers being involved.
Grade: A

Source: *Littorina littorea*—a mollusc

Spjeldnaes and Henningsmoen 1938. They suggest that this mollusc was introduced to North America by Norse settlers about AD 1000. There is no other apparent way to account for its presence on the west side of the Atlantic. It is a hardy species that could survive for a long time in the bottom water of open boats.

Meleagris gallopavo

Origin: New World

Summary: Archaeological, artistic, and historical documentation shows that the turkey reached and was in use in Europe and perhaps elsewhere in the Old World before Columbus' first voyage. Only by voyages across the ocean can this distribution be explained logically.

Grade: A

Sources: *Meleagris gallopavo*—turkey

Hennig (1940) claimed that an American turkey could be seen in a painted frieze at Schleswig Cathedral, which had been built about AD 1280. (That claim was rebutted by Stresemann (1940; also Rieth 1967) who showed that the mural had been restored in the 1800s and 1900s, hence the turkey figure as it existed in 1940 could have depended on knowledge acquired after Columbus had brought knowledge of the turkey to Europe (the situation was reprised in Bökönyi and Jánossy {1959} and Varshavsky {1961}).

Meanwhile, Hungarian archaeologists have recovered turkey bones in the 14th-century royal castle at Buda. Turkey bones have also been excavated from a carefully-dated 14th-century site in Switzerland (Bökönyi and Jánossy 1959). Other sites in Hungary of the 10th to 13th centuries have yielded signet rings engraved with images of this fowl, showing the fleshy pendent growth on the turkey's neck. In the light of these facts, it is possible that the Schleswig representation is authentically pre-Columbian.

Bökonyi and Jánossy (1959) reproduce a letter written in 1490 by Hungarian King Matthias, who died that same year, requesting through an envoy that the Duke of Milan send him turkeys 'galine de Indie.' (In post-Columbian Italy, the turkey was termed 'gallo de Indie.' 'Indie' refers to the Americas, 'the Indies,' while the common Mediterranean chicken was called 'fowl of Persia'). The Hungarian wished to acclimatize the turkey in his country. He asked that a man be sent who knew how to tend turkeys properly.

Confirmation of the late medieval European distribution of the turkey is provided by a comment in a Relación (colonial report of inspection) from Mérida, Yucatan, from about 1579, which says: "There are many turkeys in the mountains which differ little from those in Spain, very good to eat, very timid birds" (Tozzer 1941, viii, 186; emphasis added). Traditionally, turkeys have been thought to have arrived in Spain from the Americas via conquistadors no earlier than 1523, and descendants of those fowl would not likely have multiplied so fast in Spain in the intervening half century as to be spoken of in the implied familiar manner.

Mya arenaria

Origin: Western North Atlantic Ocean

Summary: Appearance of this mollusc in the ocean near Europe is unexplainable without involving humans and voyaging.

Grade: A minus

Source: *Mya arenaria*—American soft-shell clam

Petersen *et al*. 1992. They report that shells of this clam have been discovered off the Danish coast. Until now the view had been that it was distributed only in the Americas. A radiocarbon date in the 13th century has been obtained for a specimen of shell that leaves only "very slight probability" of its dating after Columbus. Since the transfer had to have involved human voyaging (presumably involving the clam only inadvertently), it "could have been transferred from North America to Europe by the Vikings."

Rhyzopertha dominica

Origin: unclear

Summary: Some authors had apparently supposed this insect to be from South America. Kislev and Panagiotakopulu have stated that it came from India, without any supporting information (so said also by Potter, see below). If from the Old World, transoceanic transport in antiquity cannot be claimed, but if from South America, then an explanation is called for to account for its presence in Old World archaeological sites.

Transfer: Americas to the eastern Mediterranean?

Grade: incomplete

Sources: *Rhyzopertha dominica*—lesser grain borer

Panagiotakopulu 2000, 9, 62, 104, 110–11. Found at the Minoan site of Akrotiri on the Island of Thera as well as in a Roman site in Egypt. While commonly referred to as the 'South American lesser grain borer,' Panagiotakopulu lists the origin (in the table on page 9) as "India." Also from Kahun in Egypt (1900–1800 BC), and in a vessel from Tut'ankhamun's tomb of 1345 BC. 9. "The lesser grain borer." It is a usual pest on grain in warmer countries, and is also recorded from a wide variety of crops, such as wheat, barley, millet, rice, maize, and sorghum as well as other products. It was originally described from South America (Munro 1966, 95), but may have originated in India, citing Kislev (1991).

Kislev 1991, 121. Lists the place of origin of this insect as "India" (without any discussion or justification). 124. It was found at Nahal Yattir, Israel, from the 2nd century AD. 124, Table 11.2. He shows archaeological manifestations of this species in Spain, Israel, and Egypt.

Hill 1983, 433. *R. dominica*, the lesser grain borer, infests stored cereals. It was originally described from South America but now is cosmopolitan.

Potter 1935, 451. The original home of *R. dominica* is not known for certain, but the balance of opinion is that it is India or the Indian subregion. 452. It is known from Central America (AD 1792), Cuba (1857), and Mexico and Honduras (1883). (Potter's comprehensive survey of the literature makes it doubtful that it was "originally described from South America."

Stegobium paniceum

Origin: Old World

Summary: This same species of beetle in both Egyptian and Peruvian burials can have no other explanation than transport by voyagers from the Old to the New World. (*Cf*. the presence of identical drugs in the burials in the same two areas, *i.e*., tobacco, coca, and hashish.)

Grade: A

Sources: *Stegobium paniceum*—the drugstore beetle

Riddle and Vreeland 1982. They speak of two species of *Coleoptera*, *Stegobium paniceum* and *Alphitobius diaperinus*, that come from pre-Columbian Peruvian mummies examined in Lima. Three bundles studied were radiocarbon dated to the Paracas (AD 86), Epigonal (AD 1231), and Huancho (AD 1240) periods. It was found on the Paracas bundle between the innermost and the second-layer wrapping cloth, and on the surface of the fourth wrapping cloth, which lay directly beneath a wig of braided human hair, which had been placed over the top of the bundle. The Epigonal bundle showed adult *Alphitobius diaperinus*, associated with a cotton garment folded and placed over the area of the knees directly in front of the body. The Hunach (*sic*; Huancho) bundle showed adult beetles of *Stegobium paniceum* in direct association with the fragments of cooked roots. "The possibility of post-exhumation contamination of the mummy bundles with modern insect populations was considered unlikely, because the outer wrappings showed no evidence of activity by boring insects, the storerooms in which the mummies had been located were periodically fumigated, and one of the Hunach (Huancho) mummy bundles was dissected just a few days after its excavation."

Buckland and Panagiotakopulu 2001, 6. *Stegobium paniceum* is commonly known as the 'drugstore beetle' or 'biscuit beetle,' a well-known pest which has been found in stored food of agricultural societies, including Old Kingdom Pharaonic Egypt (*ca*. 2700–2181 BC).

Panagiotakopulu 2000, 9. Breeds in starchy materials, including cereals and many other commodities such as spices, cocoa, beans, etc. Also known as the 'biscuit beetle.' It was recovered from deposits of 1399 BC and bread of 2049 BC from Egypt. 62. "The biscuit beetle" was found at Bronze Age Wilsford, Wiltshre, in England, and in Egypt *ca*. 3400 BC.

Kislev 1991, 128, Table 11.2. Shows archaeological manifestations of stored-product pest, *S. paniceum*, at four sites in England and two in Egypt.

Illustrations

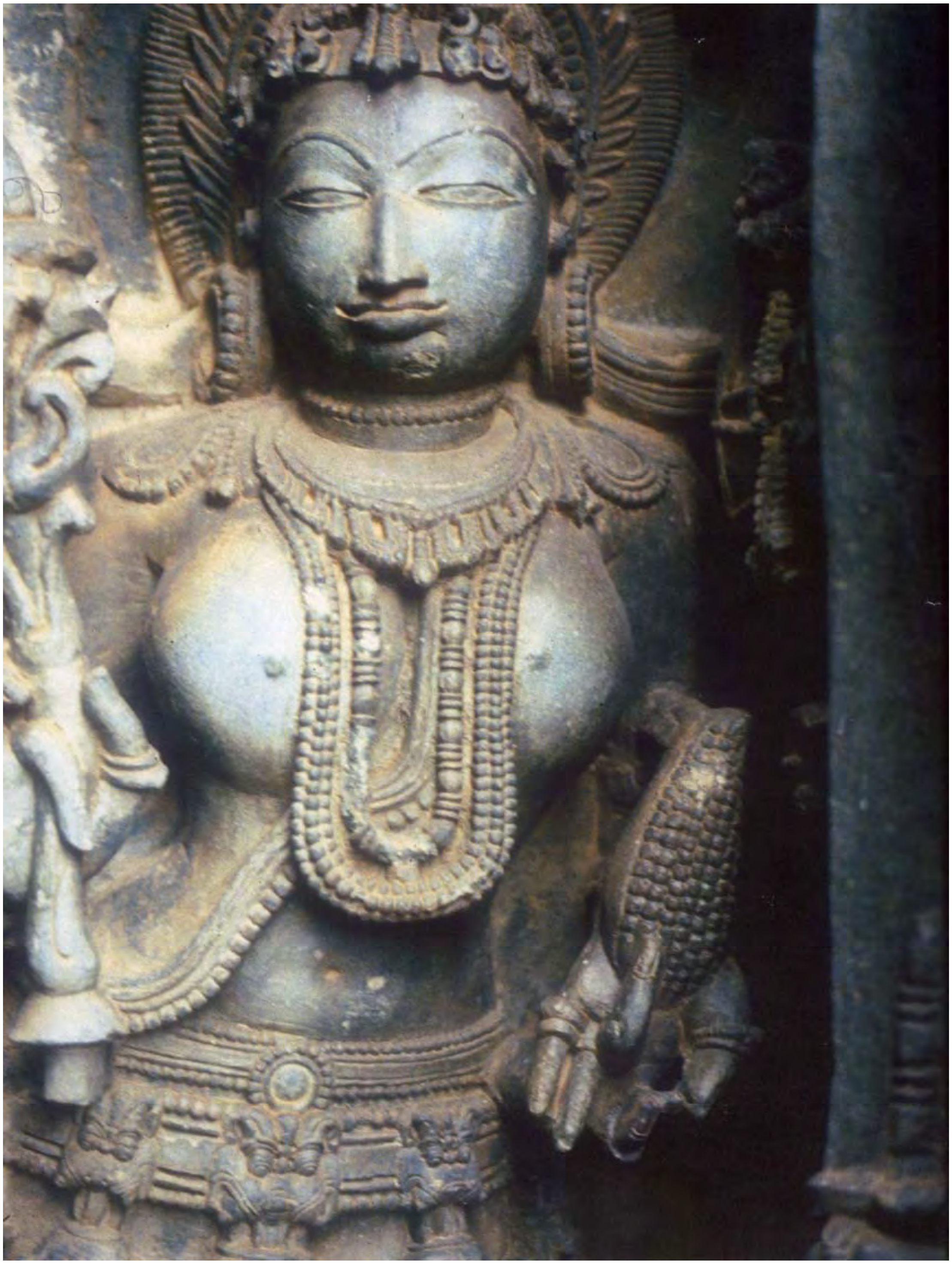

Figure 1
This wall sculpture from a temple at Somnathpur, Karnataka, India, is dated to AD 1268. The shape of the maize ear, the kernels offset in relation to those in adjacent rows, the presence of part of the husk, and other features ensure that no object other than an ear of maize could be represented. Other sculptures also portray ears showing corn silk on the outside of the husk. The *mudra* made by the figure’s left hand underlines the sacred significance of the context and

thus of maize. (Photograph by C. Johannessen.)

Figure 2
A curl of maize silk is shown atop an unhusked ear of maize in a medieval sculpture from India. (Photograph by Carl L. Johannessen.)

Figure 3
Artistic canons for showing maize changed over the centuries. This example is from the 8th century AD, in Udaipur Museum, Karnataka. Later images show buxom females holding maize ears; earlier art frequently shows an ear of corn held by a male. Here, the stubby pyramidal ear resembles maize grown at high altitudes in Peru and Central America. (Photograph after Bussagli and Sivaramamurti 1971, 192, used by permission.)

Figure 4
This earliest (1st century AD) representation of maize so far known from India is held horizontally in the hand of the god Vishnu at Cave Temple III, Badami, India. (Photograph by C. Johannessen)

Figure 5

A pottery effigy of a bird, which is barely visible in this photograph, was formed of clay, shaped around a maize cob; when the clay was fired, the cob was consumed, leaving on the interior of the clay object impressions where the kernels had been. The object was from a Han Dynasty tomb (no later than AD 200.) near Xinxiang, Henan, China, and is now in the Xinxiang Archaeological Museum. (Photograph by C. Johannessen.)

Figure 6

This bas-relief from an early wall panel from a temple ruin is in the garden of a temple at Parambanan, Java, is at least a thousand years old. The row of plants shows leaves, tassels, and ears characteristic only of maize. (Photograph by E. McConnaughey, used by permission.)

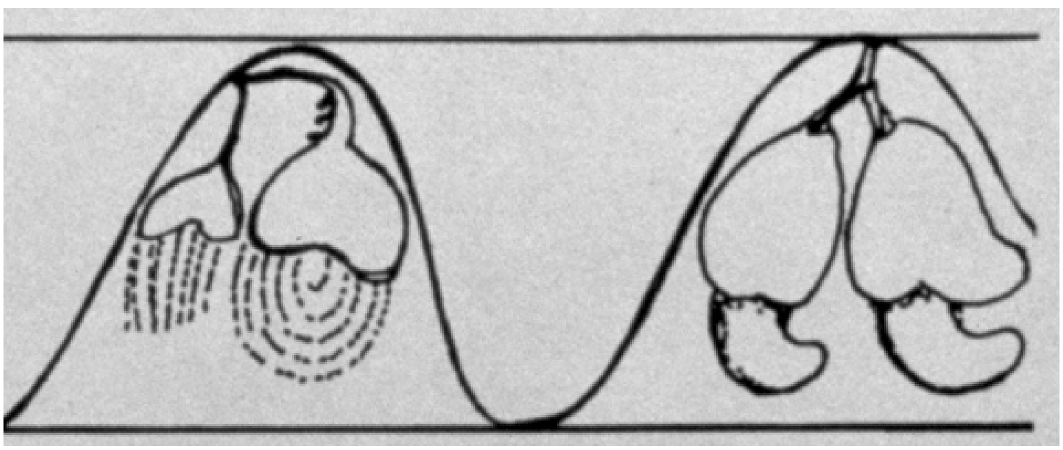

Figure 7

Cashew nuts are represented on the balustrade of the Bharhut Stupa in Madhya Pradesh, India, dating to the 2nd century BC. Only this sketch now exists picturing this section of the ruin. (Photo of the sketch courtesy of the American Institute for Indian Studies, copyright holder.)

Figure 8
Ananas comosus, the pineapple, is depicted at a cave temple at Udaiguri, India, dated ca. the fifth century AD. (Discussed in Gupta 1996, 18. Photo courtesy of the American Institute for Indian Studies, copyright holder.)

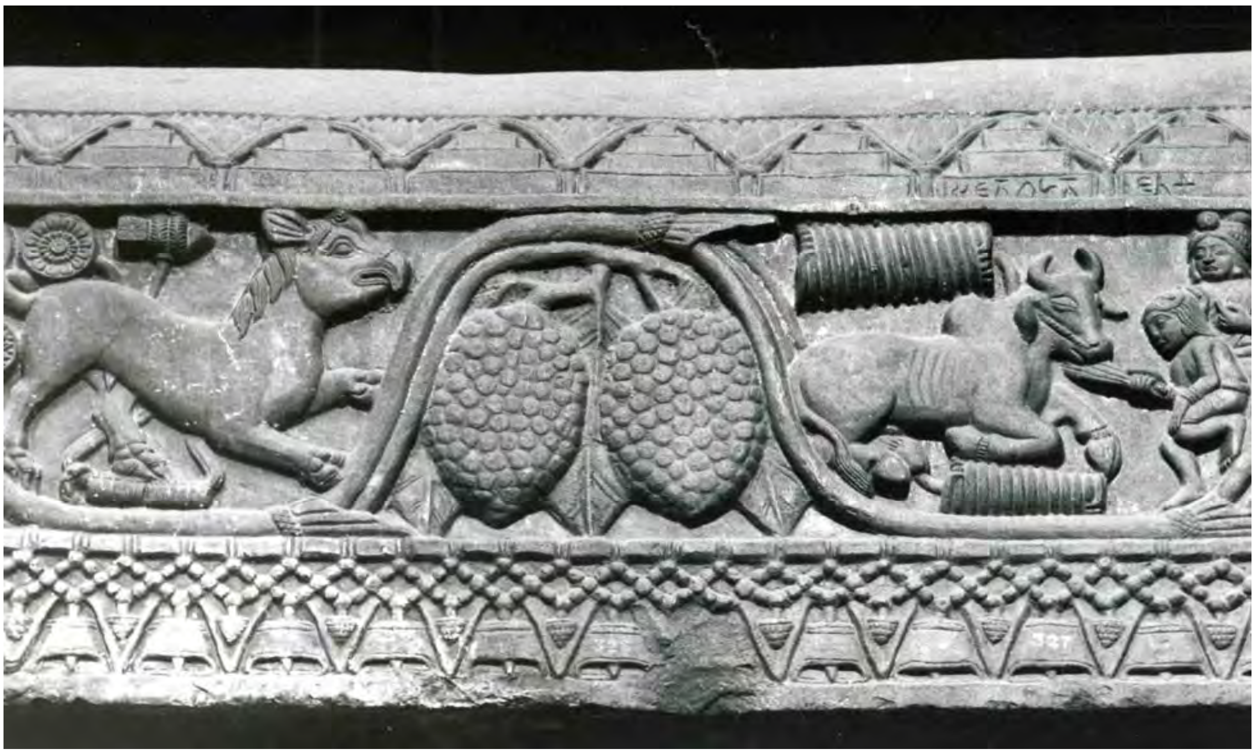

Figure 9
Fruits of *Annona squamosa* were carved on the balustrade at Bharhut Stupa, Madhya Pradesh, near the representation of cashew nuts shown in Figure 7. Cunningham (1879) first identified these fruits as from the American tree, but nobody pursued the implication. (Photo of the sketch courtesy of the American Institute for Indian Studies, copyright holder .).

Figure 10

An annona fruit is held in the hand of a goddess at the Durga Complex temple, Aihole, India. The date is medieval. (Photo by C. Johannessen.)

Figure 11

A very explicit rendering of chile pepper plants is found on a wall panel of a temple ruin in the garden at the temple at Prambanan, Java, adjacent to the bas-relief of maize plants shown in Figure 6. The panel is at least a thousand years old. Representations of chile peppers have also been found in India (see Gupta 1996, 50). (Photo by E. McConnaughey, used by permission.)

Figure 12

This teapot in the shape of a green *moschata* squash is in Zhejiang Provincial Museum, Hangzhou, Zhejiang, China, and is assigned to the Song Dynasty (AD 960–1279). (Photograph by C. Johannessen.)

Figure 13

A sculpture of Nandi, the mythological bull associated with Shiva, bears this modeled sunflower between its ear and horn. Sunflowers at several positions on bull figures at Shiva temples mark sight lines to the sun rising on the horizon on key days in the calendar. Here at a temple at Halebid, Karnataka, India, a live sunflower is juxtaposed with the sculpted stone. The notch made by the sunflower and the sculpture allows the illumination of Siva for a few minutes at dawn on the equinox. (Photograph by C. Johannessen.)

Figure 14
At Pattadakal temple, Karnataka, a carving on a pillar shows a large sunflower seed-head. From its edge a perched parrot is eating seeds. No other plant bears a seed-head of this size nor has a stalk this strong. (Photograph by C. Johannessen.)

Figure 15

Large dissected leaves of *Monstera deliciosa* appear on sculptures at Hindu and Jain temples in Gujarat and Rajasthan, India. This statue of Vishnu, from Jodhpur, is framed by the plant’s foliage. The small figure on Vishnu’s right holds a fruit of *M. deliciosa* on a plate. (Photo courtesy of the American Institute for Indian Studies, copyright holder).

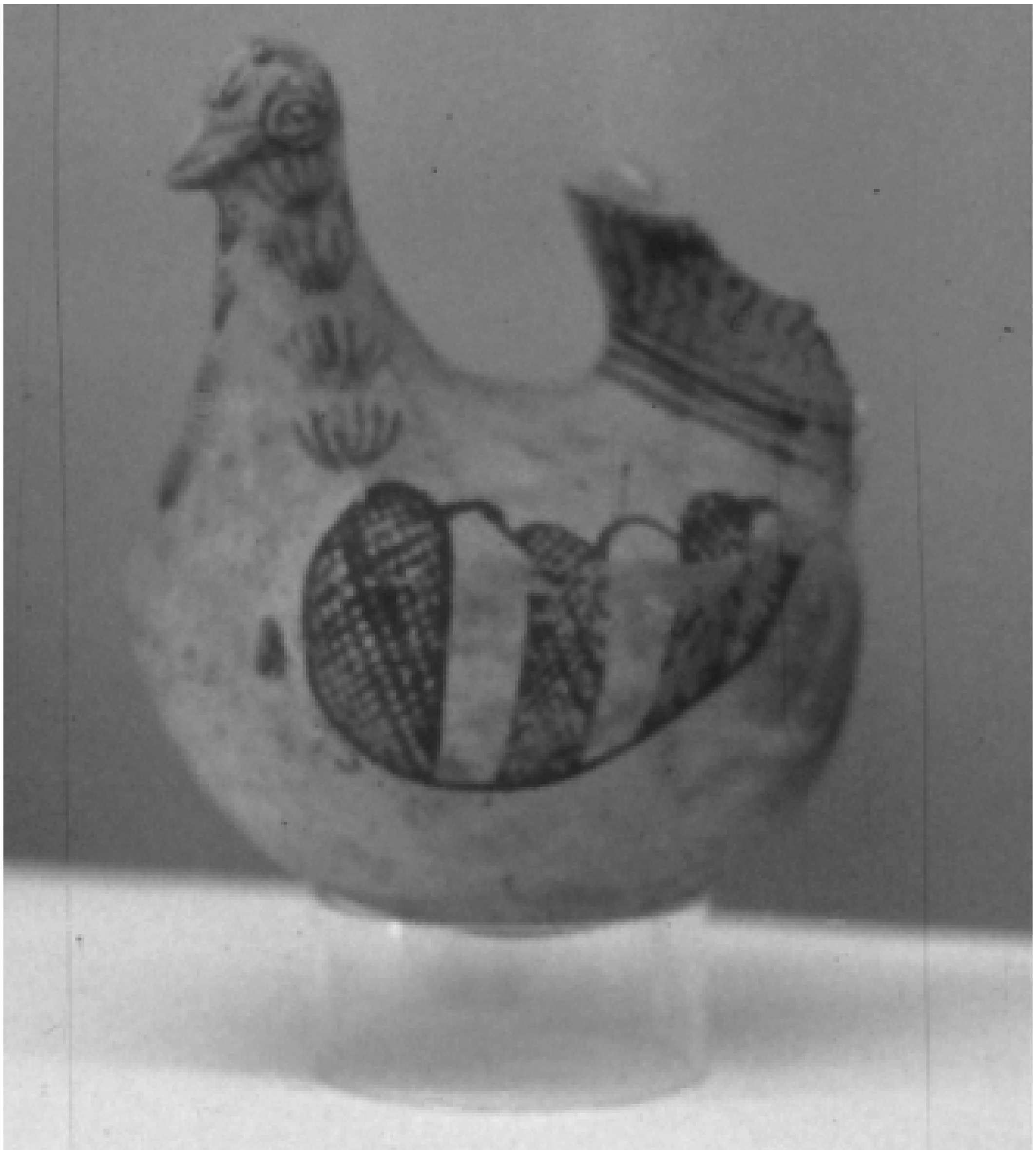

Figure 16
Pottery effigy of a chicken, attributed to Chimú culture (13th-14th centuries), National Museum, Lima, Peru. (Photograph by C. Johannessen).

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