Modelling the pre-historic arrival of the sweet potato in Polynesia

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1. Introduction

The sweet potato (Ipomoea batatas, Lam.) is a domesticated root plant that ranks as the fifth most important food crop in developing countries (Zhang et al. 2000). Wild varieties of sweet potato are not known to exist today. Vegetative reproduction, involving cuttings taken from the plant or the tuber, is the form of reproduction employed in areas of the world where it is cultivated, though sweet potato seeds have been collected across the plant’s range in the Pacific and the Americas. It is unclear how readily the plant is able to reproduce from seeds without human intervention (Yen, 1960).

It is generally accepted that the sweet potato is indigenous to the Americas, although there is some debate as to its exact center of origin. The oldest remains of domesticated sweet potatoes, dated to ~2000 B.C., come from Peru (O’Brien 2000). A fossilized sweet potato tuber dated to 8080 ± 170 B.C. was found in Peru’s Chilca Canyon region, but it is unclear if this specimen belonged to a wild or domesticated variety of the plant (Engel 1970). Studies based on the plant’s present day genetic variability suggest that Central America, and not Peru, was the most probable center of origin (Zhang et al. 2000). Yen (1974) discusses the further possibility of the independent evolution of the plant in Mexico and Peru but suggests that the single origin hypothesis may be preferable.

1.1. The sweet potato in Polynesia

The sweet potato is an important food crop in Polynesia (Hather and Kirch 1991). It was initially thought that it had been introduced to the islands by the Spanish and Portuguese during the early 16th Century, but there is a significant amount of direct evidence which indicates the sweet potato had a prehistoric introduction into Polynesia. The oldest archaeological find is the carbonized remains of tubers from Mangaia Island in the Cook Islands of Central Polynesia, dated to ~1000 - 1100 A.D. (Kirch, 2000; Green 2005). Sweet potato remains predating European contact have been recovered from Hawai‘i (1290 - 1430 A.D.), Easter Island (recovered from an earth oven dated to 1526 ± 100 A.D.) and at a prehistoric site in New Zealand (Ladefoged et al. 2005, O’Brien 2000). These finds demonstrate that the crop was not only present in Polynesia in pre-historic periods, but had dispersed throughout the region by the time of European contact.

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1.1.1. Natural Transport Mechanisms

A series of mechanisms have been proposed to explain the prehistoric transfer of the sweet potato from the Americas to Polynesia. Bulmer (1966) investigated the propagation of different varieties of sweet potato in cultivation gardens in New Guinea, suggesting that dispersal can occur via birds that had ingested the plant’s seed or traveled with seeds clinging to their bodies. According to Bulmer (1966), acid in a bird’s stomach could cause scarification of the sweet potato’s seeds which could help improve the chances of the plant’s successful germination. Bulmer (1966) suggested that trans-Pacific transport could have been carried out by the Golden Plover, which is found throughout Polynesia and is known to visit the west coast of South America. While Bulmer believed it is plausible that birds are involved in helping to disperse different varieties of sweet potato between nearby cultivation areas, he concluded, on account of the large distances involved, that a bird introduction from South America was unlikely. Based on their Central American source region, Zhang et al. (2004) point to birds as possible transfer agents but do not suggest a particular species or group.

Sweet potato seeds are contained within spherical seed capsules about 1 cm in diameter. Each capsule holds one or two seeds. Unlike the plant’s tubers and seeds, the capsules are buoyant. This led Purseglove (1965) to propose that the plant may have been introduced into Polynesia by capsules that had drifted across the Pacific. Sauer (1993) argued that it is unlikely that seed capsules could survive for long in the surf zone along a beach, but that the plant’s seeds could have established themselves in a tidal estuary or have been collected by Polynesian islanders. We could find no information on how capsule contact with salt or fresh water might affect seed viability and are unable to estimate how long a capsule could remain afloat and still produce viable seeds. Additionally, sweet potato seeds, seed pods or tubers could have rafted to Polynesia on mats of floating debris.

1.1.2. Human Mediated Transport Mechanisms

While uncertainties remain, there seems to be a growing consensus that the transfer from South America into Polynesia was performed by humans (see the Ballard et al., 2005 compilation). One of the arguments supporting this position is the similarity between the word for sweet potato in many Polynesian languages and *cumal* or *cumar*, words for the sweet potato found in dictionaries of Chinchasuyo, a regional dialect of Quechua, a language originating in Peru (Brand 1971). According to O’Brien (1972) the term for sweet potato in the Polynesian languages can be reconstructed to the Proto-Polynesian word *kumala*. Yen (1974) presents a list of similar sounding words for the plant found in languages from Peru, Ecuador and Colombia. Brand (1971) argues there is no evidence for the use of the word *cumal* anywhere along the coast of Ecuador or Peru, but Scaglion (2005) suggests that the term *comal* or *cumal* was used by the Cañari people of Ecuador whose territory, prior to European contact, likely included sections of the Ecuadorian coastline along the Gulf of Guayaquil.

Jones and Klar (2005) argue that sewn-plank canoes and fishhooks from prehistoric
sites in Channel Islands off the coast of Southern California are similar to the ones used in Polynesia. Additionally, three words used to refer to boats by the Chumashan and Gabrielino speakers of the southern California coast are similar to Proto-Central Eastern Polynesian terms pertaining to canoe construction, suggesting to the authors that there may have been contact between Polynesians and the peoples of this region at some point in prehistory.

According to Green (2005), the sweet potato could have been introduced to the islands by Polynesian voyagers who sailed across the Pacific to the New World, retrieved the plant and returned to Polynesia.

Alternatively, travelers from South or Central America could have (deliberately or accidentally) reached Polynesia in boats carrying the sweet potato. Among the different watercraft used along the west coast of South America prior to Spanish contact, the most capable of withstanding a journey to Polynesia were probably the balsa log sailing rafts from the area that today encompasses Ecuador and Northern Peru. Based on reports by early Spanish visitors, Edwards (1965) concludes that these “…were evidently designed for lengthy voyages and large cargoes. They were provided with huts for shelter and frameworks or bulwarks to contain the cargo.” One early Spanish account describes a raft capable of carrying fifty man and three horses, other states that the observed raft could hold thirty large casks (Edwards, 1965). Anecdotal reports indicate that these rafts were in use as far south as Lima (~12°S) and guares or steering foils associated with these vessels have been unearthed at a site in Ica (~14°S) dating to circa 300 B.C. Later reports suggest that the rafts were used for long-distance trade voyages even as far as from Lima to the Gulf of Panama (Edwards, 1965; McGrail, 2001). Scaglion (2005) notes that the distribution of these sailing rafts is thought to have been concentrated in the Gulf of Guayaquil region, which has been mentioned above in connection with the Cañari people. Smaller vessels (including log, bundle and hide float rafts as well as dugout canoes) were used for fishing and transport on rivers and coastal areas of Chile, Peru, Ecuador, Colombia, Panama and Mexico (McGrail 2001).

By sailing the Kon-Tiki from Peru to the Tuamotu Archipelago, Thor Heyerdahl’s expedition demonstrated that a balsa wood raft based on traditional South American designs could survive a crossing into Polynesia. Pottery found in archaeological sites in the Galápagos Islands correlate with the pottery complexes from several different time periods in Peruvian and Ecuadorian prehistory, suggesting that the islands had been visited by several different groups of South Americans in pre-contact times, further demonstrating that the peoples of this region were capable of long distance ocean voyages (Heyerdahl & Skjölsvold, 1956).

It is worth noting that any crew (Polynesian or American) need not have survived the voyage from the New World into Polynesia. The sweet potato could have established itself on an uninhabited island if the tubers were washed ashore. Also, if the boat reached the coast of an inhabited island, the people living on the island could have happened upon it and planted the sweet potato themselves (O’Brien 1972).

1.1.3. Areas, sources and timing of initial introduction
Based on anatomic variation between sweet potato populations, Yen (1974) proposed three main introduction paths for the crop into Oceania: a prehistoric transfer from South America to Polynesia, transport by the Spanish from Mexico to the Philippines and an introduction from Europe to the East Indies and Papua New Guinea. Yen (1974) suggested that most likely area for prehistoric introduction lay in a 'central ellipse region' encompassing the Marquesas, Cook and Society Islands. However, as specimens from Hawai‘i and Central America were not analyzed in his study, he cautioned that his results could not be used to rule out a possible introduction from Mexico to Hawai‘i.

Green’s (2005) two way trip hypothesis agrees with Yen's main conclusions, but further defines the potential arrival sites within the central ellipse and also goes on to add an initial crossing from Polynesia to South America. Green (2005) proposes that Polynesian voyagers from Easter Island or the Mangareva-Temoe-Pitcairn region made their way to South America and reached the Gulf of Guayaquil area, where they acquired the sweet potato. These voyagers then sailed back toward Polynesia but, instead of returning to their original departure site, made landfall somewhere in the area limited by Mangaia Island in the southwest and the Marquesas in the northeast, including the Society Islands and the Tuamotu Archipelago. According to Green (2005), an introduction in this area is more likely, since the islands in this region form a screen within which it would be hard to avoid sighting land and also because there were substantial interactions between the islands in this group in prehistoric times. The two proposed American source regions from which the plant could have been introduced into Polynesia coincide with the suggested centres of origin mentioned earlier. The linguistic findings linking the Polynesian terms for sweet potato to Quechua and the languages of the Cañari people point to northwest South America as the source for the plant. On the other hand, genetic analyses of specimens from present day cultivars, conducted by Zhang et al. (2004) indicate that Central America was the region from which the Oceanian sweet potato originated. However, these analyses have been criticized (Scaglion, 2005; Green, 2005) for being based on the contemporary distribution of the sweet potato and hence failing to account for the multiple introductions of the sweet potato into Oceania following Yen’s tripartite hypothesis. In the case of New Zealand at least, there are indications that the genetic makeup of pre-historic and post-contact sweet potato cultivars are different from each other (Harvey et al. 1997).

Jones and Klar (2005) suggest that there may have been prehistoric contact between Polynesia and Southern California; although the prehistoric range of the sweet potato did not extend this far to the north. If such contact did occur, the voyagers might have sailed south along the coast, collecting the sweet potato from Mexico or Central America before crossing into Polynesia. This hypothesis would be in agreement with a Central American source for pre-contact Polynesian sweet potato.

Establishing a time frame for the introduction of the sweet potato is challenging and in many cases depends upon the interpretation of secondary evidence, since dated sweet potato remains from Polynesia are scarce. It is known that the plant was present in Mangaia, the southernmost of the Cook Islands, at around 1000 A.D. (Kirch, 2000). O’Brien (1972) suggested, on the basis of linguistic evidence, that the sweet potato could have arrived in Polynesia as early as the migration into Samoa, but was
certainly present by the dispersal out of the Marquesas. Colonization of centraleastern Polynesia, including the Marquesas, is thought to have resulted from a dispersal out of Tonga and Samoa. Radiocarbon dates from the Marqueas are inconsistent, making it difficult to pinpoint the date of initial settlement. Kirch (2000) suggests that the expansion out of Tonga and Samoa had begun by AD1 at the latest, but Hunt and Lipo (2006) argue that this expansion did not occur until after 800 AD, followed by rapid colonization of eastern Polynesia, including the Marquesas. Ballard (2005) proposed a much more narrow timeframe for the introduction of the sweet potato. He suggests that the plant was introduced after the initial colonization of Hawai’i and Easter Island but prior to the colonization of New Zealand. This would imply that the introduction occurred not much earlier than 1000 AD nor much later that 1150 AD.