BLOSSOMING TREASURES OF BIODIVERSITY

53. Coconut Palm – the superstar partner of coral reefs

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Introduction

This issue of Biodiversity is dedicated to coral ecosystems, which are predominantly populated by marine species, including numerous algae. A few flowering land plants are ecologically important occupants of shorelines bordering coral systems, particularly seagrasses (various genera including species that grow underwater) and mangroves (several genera of shrubs growing with their roots in seawater), but the Coconut Palm (Cocos nucifera) is the only flowering plant naturally occurring near corals (Figure 1) that has also become a major world crop. Indeed, probably for hundreds of thousands of years people in tropical Pacific areas have harvested every part of the ‘Tree of Life’ as it has come to be known, not just for food and drink, but also for many non-edible usages, such as house construction, utensils, tools, musical instruments, medicine, cosmetics, fuel and much more. As will be noted, some seashore animals also find Coconut Palms to be a valuable resource.

Corals usually establish in relatively shallow waters of tropical and semi-tropical shores. Coconut Palms are very closely associated with the same terrestrial coasts occupied by corals, and Charles Darwin (1842) noted that corals were important to the success of Coconut Palms. It has even been hypothesised that the Coconut Palm evolved on the coastal beaches of coral atolls, reefs and islands, when its ancestor adapted to the habitat by acquiring the ability to be dispersed by sea (Harries 1995; Harries and Clement 2014). Keys to this aquatic mode of dispersal were: (1) a thick water-resistant fibrous outer fruit layer which protected the floating fruit against salty water infiltration; and (2) huge fruit size containing considerable food reserves allowing the seedling to survive when the fruit washed up on distant shores and the young plant needed time to develop foliage to compete against established plant species and to grow a deeply penetrating root reaching fresh water.

Figure 1. Coconut Island, an 11 ha (28 acre) coral reef island near the Island of Oahu, Hawaii. Currently employed as a marine biology laboratory, the location became famous as a film site for the television program Gilligan’s Island. Photo by Forest & Kim Starr (CC BY 3.0).

Figure 2. Coconut Palm trees in a characteristic lean towards the sea, an adaptation allowing young plants to establish on the margins of islands that are occupied by other trees producing dense shade (Harries and Clement 2014). Photo by Phillip Capper (CC BY 2.0).
fruits are generally as large as a man’s head, and consist of several layers (Figure 3). The outer layer is a fibrous husk, which is green when immature and brown at maturity. Inside this is a hard shell, 15–20 cm (6–8 inches across), and inside the shell is a relatively thin, white, fleshy layer consisting of white, oily ‘meat’. The interior of the fruit is hollow and partly filled with watery, sweet liquid, especially in unripe fruits. The husks of coconuts are generally inedible, but some rare plants produce fruit with a spongy, easily cut husk that is sweet to chew like sugar cane. The milky tissues within a coconut are intended to feed the growing embryo. However, the embryo’s leaves and root develop mostly outside of the fruit (Figure 4). A connection (a sort of very short umbilical cord called a haustorium which acts like a placenta) allows the young plantlet to absorb nourishment from the coconut. As the feeding process continues for up to 15 months, the connection can become quite large. The connection is edible, and is called a ‘coconut apple’. Because it is still within the coconut, it is commonly obtained by grasping the leaves of a sprouted coconut, uprooting it, and swinging it against the trunk of a nearby tree to split open the fruit. The ‘apple’ is then picked

Figure 3. Coconuts sectioned to show their anatomy. (a) Longitudinal view. Photo by Rotational (released into the public domain). (b) Diagram of cross section. Prepared by Kerina yin (CC BY SA 3.0).

The plant

‘Coconut’ refers both to the Coconut Palm and its fruit. The picturesque slender tree grows up to 30 m (100 feet) or more. The trunk may be as wide as 60 cm (2 feet). The top of the tree is crowned with a thatch of feather-like leaves 2.7–5.6 m (9–18 feet) long. Several dwarf varieties have been selected by humans. These grow to a height of 7.6–9 m (25–30 feet), and may begin to flower after 3 years at a height of only 1 m (about 1 yard). The life span of these small trees is only about 30 years, but they are valued because they bear early and are resistant to lethal yellowing disease, a very serious problem of Coconuts. Coconut Palms grow naturally on tropical seacoasts throughout Asia, Africa, Latin America and the Pacific region (Figure 3). In the Old World, they occur in the tropics and subtropics of thousands of islands in the Pacific and Indian Oceans and the West Indies, and along the coastal lowlands of South and Southeast Asia and parts of east Africa. In the Americas, Coconut Palms are found on tropical coasts of both the Pacific and Atlantic. They do not like dry climates, and in the United States the plants survive well only in southern Florida and the southernmost tip of Texas. Most climates suitable for the Coconut Palm are found between the Tropics of Cancer and Capricorn, excluding the highlands.

Botanically, a coconut is a ‘drupe’ – a type of fruit in which a seed is surrounded by a hard stony shell which in turn is covered by an outer fleshy layer (examples of other drupes: peaches, plums, cherries, walnuts, almonds and pecans). However, the most frequent term describing a coconut is ‘nut’. Botanically a ‘nut’ is usually defined as a seed covered by a hard shell that does not split to release the seed. Frequently an added criterion is that nuts lack a fleshy covering. However, in common language the word nut is applied to many fruits that are not technically nuts, such as almonds, pecans, pistachios, walnuts and coconuts.

Coconuts sold in stores have been de-husked, so that their enormous size is generally not appreciated. The unhusked

Figure 4. Coconut seedlings emerging from their fruits. Photo by Jason Thien (CC BY 2.0).
out and consumed. The makapuno coconut (Nguyen et al. 2016) is famous for having no milk cavity. Its jelly-like flesh fills the middle of the coconut, and can be eaten with a spoon.

Confusion of coconut plants with chocolate plants and cocaine plants

‘Coconut’ and the genus name Cocos are said to be derived from the Portuguese (and Spanish) word coco meaning grimace or grin, apparently named for the three germinating pores of the fruit, resembling a spooky face (Figure 5). Coconut has no relationship with the coca plant (Erythroxylum coca), the foliage of which yields the drug cocaine. Because of a mistake in spelling, probably made by English importers many years ago, cacao beans (from Theobroma cacao, employed to make chocolate) became known as cocoa beans in English-speaking countries. As a result, many people think that chocolate come from the Coconut Palm tree instead of the Cacao Tree. ‘Coco butter’ is a misspelling of ‘cocoa butter’, which is obtained from cacao beans, not from coconuts. To add to the confusion, ‘Coco Bean’ is a variety of the Common Bean, Phaseolus vulgaris.

History

Coconut Palm is the only currently recognised species of the genus Cocos. Fossils assigned to the genus have been found in India, New Zealand, Australia and South America, but have not been definitive in interpreting where the species originated. In the Old World, Coconut Palm is recorded in literature tracing back millennia (Ahuja, Ahuja, and Ahuja 2014; Nayar 2016).

Coconuts falling on beaches are often captured by tides and float out to sea, and subsequently perhaps for thousands of km to wash up on distant shores. The husk protects the embryo from sea water; although the plant is relatively tolerant of salinity, seedlings will die if immersed continuously in the sea. In some Coconut Palm biotypes (particularly forms considered to be wild) floating coconuts can remain viable for months. However, some varieties, especially kinds that have been domesticated, float less well, and sometimes some coconuts germinate while still attached to the parental tree (in common with animals which bear live young, the phenomenon is called ‘vivipary’). Because the coconut is widely distributed by sea, its centre of origin is unclear – perhaps the Indo-Malaysian region or the Pacific islands. Most specialists believe the Coconut Palm originated in Asia and/or Melanesia (the western Pacific area, including Vanuatu, the Solomon Islands, Fiji, and Papua New Guinea).

Coconut Palms occur along the tropical coasts of Latin America. Whether they originated by flotation across the Pacific or were established by human transport has been argued (Dennis and Gunn 1971; Ward and Brookfield 1992). There is evidence that Coconut Palms were present in the Americas in pre-Columbian times (Baudouin and Lebrun 2009; Baudouin, Gunn, and Olsen 2014; Clement et al. 2013). Certainly Coconut Palms that became established on coral atolls, mainly in the Pacific region, were an indispensible source of food and water for pre-historic sea-going colonisers of the Pacific islands. Wild-growing trees on coastal regions of the Indian Ocean may have assisted the earliest humans in migrating from Africa to Asia and from Asia to Australasia. Over time, various forms of coconuts would have been selected (Figure 6) in different locations, and indeed there is evidence that Coconut Palms were independently domesticated in different regions (Gunn, Baudouin, and Olsen 2011).

Culinary uses

A single coconut has as much protein as a quarter pound of beefsteak, and so coconuts have been an important...
flavour than dried coconut. As the fruit ripens, the meat becomes solid, coating the inner wall, and there is less water. The meat of the coconut, known as copra, is an important commercial source of vegetable fat, and its production provides employment in many rural areas (Figure 8). Copra contains about 60% oil. This coconut oil (which is also called coconut butter, since in the unrefined state it is a white, fatty solid at room temperature) is used for margarine and especially as a cooking oil. The oil is not suitable for use as a salad oil. Desiccated coconut is dried coconut meat, like copra, but is ground before drying.

In regions where coconuts are produced, Natural ‘coconut water’ (sometimes called coconut juice, and not infrequently confused with coconut milk, described below) is a refreshing drink obtained directly from fresh coconuts (Figure 7). In recent years this beverage has acquired a reputation as a promoter of health and has become widely marketed, often as a ‘sports drink’ (Yong et al. 2009). ‘Coconut syrup’ is made by evaporating coconut juice and adding sugar. ‘Coconut honey’ is a concentrated form of coconut syrup. In temperate regions, ‘coconut milk’ is usually obtained by squeezing liquid out of grated coconut meat or by pouring boiling water over grated coconut meat and squeezing the mixture. Coconut milk resembles cow’s milk somewhat, and occasionally has been used as a substitute. ‘Coconut cream’ is simply a more concentrated form of coconut milk (‘cream of coconut’ is an advertising phrase, often referring to a highly sweetened confection). Very young coconuts, which are too perishable to ship, are an exceptional treat, containing ‘spoon coconut’ – a soft, gelatinous meat with the consistency of melon, which is eaten with a spoon from the shell, and possesses a better

Figure 7. Consumption of coconut water directly from coconuts. Unripe fruits have more water than ripe ones, and are often employed for drinking. Historically, coconut water was an essential survival resource for mariners, and selection for increased water content was a principal goal of early domestication (Harries 1978). (a) Photo by U.S. Department of the Army (public domain). (b) Photo by Sémhur (CC BY SA 3.0).

Figure 8. Copra farm in the Philippines. The mature fruits will be dehusked, split, and the ‘meat’ (constituting the copra) removed. Photo by Lawrence Ruiz (CC BY SA 4.0).
individuals have suffered allergic reactions, including anaphylaxis, from consuming the proteins in coconuts.

Sap from the tree is sometimes milked from the flower stalks before the flowers open (Figure 9). This is evaporated down to make sugar, or fermented to produce alcohol, the mildly alcoholic (up to 8%) beverage called toddy, and a potent spirit called arrack (also spelled arak). Arrack is made in the Far East and Middle East, from fermented rice and molasses, to which the fermented sap of the Coconut Palm (or other palms) is frequently added. Indonesia is said to make the best arrack. Toddy can be converted to vinegar.

The terminal growing bud of palm trees, nestled in the crown of the tree, can be used to produce an unusual, expensive, salad vegetable with a crisp, crunchy texture and taste reminiscent of white asparagus and bamboo shoots. This looks like a bundle of tightly packed, yellow-white, cabbage-like leaves. Because harvesting this ‘palm heart’ kills the tree, it is generally collected from trees felled for lumber. Because the tree has to be sacrificed, this tasty preparation has been called ‘millionaire’s salad’.

A good-quality coconut should feel heavy and when shaken should produce the impression that it is full of liquid as the water is sloshed around. Avoid mouldy coconuts, or those with wet ‘eyes’. To extract the liquid, use an ice pick to poke holes in two of the three eyes, and drain. To remove the thick outer covering, place the coconut in an oven at 200°C (400°F) for 20 min, allow to cool slightly, hold over a large bowl, and strike it all the way around with the back of a knife or cleaver until it splits open. Alternatively, some people strike the coconut with a mallet or hammer, or simply drop it onto a hard floor that will withstand damage. Instead of heating the coconut, an alternative is to place it in a freezer (at 0°C or 32°F) for an hour. The flesh should taste sweet, but if not, the material should be discarded or returned. A clean screwdriver can be employed to chip off most of the meat from the shell, and a vegetable peeler can be used to scrape away the brown, thin skin that remains attached to the pieces of flesh. A food processor, blender or fine grater can be used to shred the coconut. Alternatively, dried, shredded coconut can simply be purchased for most cooking needs and, when a superior taste is desired, some supermarkets stock freshly frozen shredded coconut. Dried, grated coconut is often coated with sugar, and for those wishing to avoid the sugar it may be necessary to purchase unsweetened coconut in natural-food stores.

Until the last decade, coconut oil was widely perceived to be a health risk, particularly for heart disease, because of its high content of saturated fat, which can contribute to the development of atherosclerosis and cardiovascular diseases. It has been argued, however, that much of the fatty acids of coconut oil are of the medium-chain type, less likely to cause damage in humans than long-chain fatty acids, and possibly even promote health. At present the potentially harmful effects of consuming coconut oil are contentious and unsettled (for a range of viewpoints, see Foale 2003; Eyres 2014; Boemeke et al. 2015; Eyres et al. 2016; and Lockyer and Stanner 2016). The American Heart Association recommends that coconut oil, like animal fats, butter, and other tropical oils, be avoided: http://www.heart.org/HEARTORG/HealthyLiving/HealthyEating/SimpleCookingandRecipes/Healthy-Cooking-Oils_UCM_445179_Article.jsp#.WKR4tvE0zVaQ). Rarely,
only be determined by opening the shell. Extracted coconut meat should be consumed quickly, but may be refrigerated for several days. Dried coconut stores indefinitely in a cool, dry place, protected from air and insects in a tightly sealed container.

**Economics**

The Coconut Palm is one of the most valuable tropical plants, and indeed one of the ten most useful trees in the world. About 60 million tonnes of coconuts are produced annually in the World (Prades, Salum, and Pioch 2016). Approximately ten million families in over 80 countries rely on the tree as their principal source of food and income (Perera et al. 2010). Although Coconut Palms generally grow on tropical seacoasts, inland plantations (Figure 11) have been established. However, by the mid-twentieth century, with the rise of Soybean, Canola (Rapeseed), Cottonseed, Sunflower and Oil Palm, the once dominant role of Coconut Palm as a source of vegetable oil diminished considerably, and there are now relatively few large plantations. Of considerable concern to the coconut industry, sales, research and development have been relatively limited for decades compared to other major tropical crops. Nevertheless, the fruits remain a significant crop in the humid areas of many tropical countries, particularly in the Philippines, Indonesia and India. Coconuts are also very important to the economies of small islands in the Pacific, Indian Ocean and the Caribbean. Coconut Palm is planted on about 12 million ha (30 million acres) globally, of which 85% are in the Asia-Pacific area (Batugal, Bourdeix, and Baudouin 2009). The trees can start bearing at 6 years of age, and sometimes live for 100 years. Coconut Palms can produce clusters of 6–12 fruits as often as 12 times yearly. Good trees in their prime produce about 75 coconuts annually, but generally trees yield about 25 each year. A coconut requires 6–12 months to ripen. Coconuts may be left to mature and fall off naturally, but are usually harvested by climbers, sometimes by trained monkeys (Bertrand 1967), or cut off with knives attached to the ends of long bamboo poles.

**Miscellaneous uses**

Extracted fibre from the fruit husk is known as coir, and is used to make ropes, mats (Figure 10), fishing lines, carpets, baskets, brooms and brushes. The fibre is also used for thatching roofs and for making charcoal. Coconut leaves are often woven into baskets, platters, mats and hats. Coconut shells can be used as bowls and cooking utensils, and they can be ground up and employed to reinforce construction aggregates such as concrete. In Hawaii the swollen base of the trunk of Coconut Palms is hollowed out and turned into a hula drum. The outer part of the trunk of the Coconut Palm furnishes a construction lumber known as porcupine wood for houses and furniture; the name porcupine wood is based on the surface pattern, suggestive of porcupine quills. In addition to the culinary uses noted in the preceding, coconut oil is employed in making soap, detergents, shampoos, face creams, shaving cream, perfumes, candles, synthetic rubber, hydraulic brake fluid and many other manufactured products. Coconuts are sometimes split open and hung outdoors as bird feeders, especially in winter. While coconuts have quite limited medical uses in Western medicine, they have various applications in traditional herbal medicinal practice, and also have various nutritional and potentially valuable pharmacological properties (DebMandal and Mandal 2011; Hooda et al. 2012; Lima et al. 2015; Roopan 2016).

**Figure 10.** Doormats made of coir (coconut fibre). Photo by Midori (CC BY SA 3.0).

**Figure 11.** A Coconut Palm plantation in Goa, India. Photo by Alok Kumar (CC by SA 4.0).
Coastal animal–coconut interactions

The Coconut Crab, *Birgus latro* (Figure 12), a relative of the Hermit Crab, is the world’s largest crab, and indeed the world’s largest land invertebrate. An adult may stretch over a metre (more than a yard) from claw to claw, weigh up to 4 kg (9 lb), and live for over 30 years. The crab occurs in the tropical Indian and Pacific Oceans, but because of excessive harvesting, it has disappeared over much of its range. The larvae are aquatic, but the adults are terrestrial, and can drown if immersed too long in water. Coconut Crabs eat fruit, rotting leaves, animals and, most notably, coconuts, which they open with their massive claws, which can exert a force exceeding the bite force of most terrestrial predators (Oka, Tomita, and Miyamoto 2016). Although they can climb trees to reach fruit, and are reputed to cut off coconuts, they depend on fallen coconuts. When it is in its larval stages, it is believed that the crab can be transported long distances on floating coconuts. When young and their abdomens are still soft, the crabs use abandoned shells as armour, in the manner of hermit crabs. As they get bigger and run out of suitable shells, some may use discarded coconut shells. The alternative name of the coconut crab, ‘robber crab’, is due to its attraction to shiny pots and trinkets which it steals from tents and houses.

The Coconut Octopus, *Amphioctopus marginatus*, which is about 15 cm (6 inches) long (including its arms), occurs in tropical parts of the western Pacific Ocean. This cephalopod appears to have evolved relationships with coconuts in two respects. First, it has been observed employing coconut shells for defence and shelter (Finn, Tregenza, and Norman 2009; Figure 13). Second, it has been claimed to exhibit a bipedal movement mimicking a floating coconut in an area littered with coconut shells.

Biodiversity values

Coastal ecosystems in general and coral island and reef associations in particular are fragile, and as indicated in the following discussion, are much more suited to subsistence agriculture than to intensive modern ‘advanced’ production systems such as those in most of the Western World and much of the Temperate Zones. To save on labour costs, planting, harvesting and processing of products are highly mechanised in First World nations, which necessitates the production, maintenance and operation of costly machinery and associated expenditures on fossil fuels, fertilisers, irrigation and biocides, all of which are damaging to biodiversity and ecosystems. By contrast with ‘factory farming’ common in advanced countries, about 96% of coconuts are produced by smallholders tending 4 ha (10 acres) or less of land (Batugal, Bordeix, and Baudouin 2009). Another consideration is that most of the world’s principal crops are raised as annuals, which is consistent with growth usually not being possible during the winter. By contrast, perennials (especially shrubs and trees) in the tropics have a natural seasonal advantage, since they can take advantage of the higher sunlight levels and the much longer season of growth. Moreover, perennial crops need not be planted every year, require fewer agricultural inputs, and are much more compatible with biodiversity than annual crops. Still another consideration is the fact that Coconut Palm trees do not produce ‘waste’, virtually every part being employed for some purpose. This is not to suggest that tropical regions are immune from damage associated with monocultural crops, and indeed vast plantations of Oil Palm (*Elaeis guineensis*) are a current concern. Coconut oil has potential to provide biodiesel (Hossain et al. 2012), a renewable fuel that can alleviate the ecological damage from burning of fossil fuels. In the humid tropics where the Coconut Palm...
grows best, the culture of livestock is often integrated with arboriculture (Reynolds 1988), representing an ecologically friendly form of agriculture. In the same vein, Coconut Palms are intercropped with other species (Paul and Ramkaleawan 2016), avoiding some of the destructive aspects of monocultures. In Indonesia, the world’s larger producer of coconuts, about half of the crop is used for local consumption (Marikkar and Madurapperuma 2012), which is consistent with the ‘locavore’ ideal of minimising transportation of agricultural products. All things considered, the Coconut Palm is one of the world’s most desirable crops from the viewpoint of minimising agricultural harm to biodiversity.

Believe it or not

- Coconut water is so pure and sterile that, during World War II, it was used in emergencies instead of sterile glucose solution, and put directly into a patient’s veins. Because coconut water is naturally sterile, it is used as a diluent, in combination with egg yolk, in artificial insemination.
- So-called ‘coconut-banana honey’, said to be made by bees frequenting both banana and coconut groves, has sold as a luxury food in Paris at $90.00 for a 400 g (14 oz) jar.
- Until the middle of the twentieth century, all floating soaps were made from coconut oil. Then it was discovered that most soaps can be made to float simply by pumping air through the mixture during manufacture.
- Coconut Palms are often grown as ornamental trees in tropical regions. Unfortunately the nuts are so heavy that they sometimes cause injuries to humans, cars and rooftops when they fall. Some people have even been killed by falling coconuts (note Figure 14). Coconut Palm trees have been removed from some resorts in Florida and the Caribbean in order to avoid lawsuits from injured guests. Cadang-cadang disease, which occurs in coconut trees, is named after the noise the coconuts make when they fall to the ground.
- A freshly harvested coconut from a bunch that has been in the sun has a natural effervescence, and when opened will hiss while the gas is released.
- Scientists are not immune to hoaxes, and (mostly in the past) some were taken in by the following story. The ‘coconut pearl’ has been claimed to be the rarest and most valuable ‘botanical jewel’ in the world. Like the pearls of oysters, this is said to be a shiny calcareous sphere that occasionally forms inside a coconut. The allegation that there really are coconut pearls is extremely doubtful. Nevertheless there are instances of pearls that have been claimed to have originated from coconuts, including the ‘Maharaja coconut pearl’ once displayed in the shell of a coconut at the Fairchild Tropical Garden in Coral Gables, Florida (a research centre with an outstanding reputation).

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Key information sources

Ahuja, S. C., S. Ahuja, and U. Ahuja. 2014. “Coconut – History, Uses, and Folklore.” Asian Agri-History 18: 221–248.
Batugal, P., R. Bourdeix, and L. Baudouin. 2009. “Coconut Breeding.” In Breeding Plantation Tree Crops: Tropical Species, edited by S. M. Jain and P. M. Priyadarshan, 327–375. New York: Springer-Verlag.
Baudouin, L., and P. Lebrun. 2009. “Coconut (Cocos nucifera L.) DNA Studies Support the Hypothesis of an Ancient Austroasian Migration from Southeast Asia to America.” Genetic Resources and Crop Evolution 56: 257–262.

Baudouin, L., B. F. Gunn, and K. M. Olsen. 2014. "The Presence of Coconut in Southern Panama in Pre-Columbian Times: Clearing up the Confusion." Annals of Botany 113: 1–5.

Bertrand, M. 1967. “Training without Reward: Traditional Training of Pig-Tailed Macaques as Coconut Harvesters." Science 155: 484–486.

Boemeke, L., A. Marcadenti, F. M. Busnello, and C. B. A. Gottschall. 2015. “Effects of Coconut Oil on Human Health.” Open Journal of Endocrine and Metabolic Diseases 5: 84–87.

Clement, C. R., D. Zizumbo-Villarreal, C. H. Brown, R. G. Ward, A. Alves-Pereira, and H. C. Harries. 2013. “Coconuts in the Americas.” Botanical Review 79: 342–370.

Darwin, C. 1842. The Structure and Distribution of Coral Reefs. London: Smith Elder and Company.

DebMandal, M., and S. Mandal. 2011. “Coconut (Cocos nucifera L.: Arecales): In Health Promotion and Disease Prevention.” Asian Pacific Journal of Tropical Medicine 4: 241–247.

Dennis, J. V., and C. R. Gunn. 1971. "Case against Trans-Pacific Dispersal of the Coconut by Ocean Currents." Economic Botany 25: 407–413.

Eyres, L. 2014. “Coconut Oil and the Heart.” New Zealand Heart Foundation. https://www.heartfoundation.org.nz/resources/coconut-oil-and-the-heart-evidence-paper.

Eyres, L., M. F. Eyres, A. Chisholm, and R. C. Brown. 2016. “Coconut Oil Consumption and Cardiovascular Risk Factors in Humans.” Nutrition Reviews 74: 267–280.

Finch, J. K., T. Tregenza, and M. D. Norman. 2009. “Defensive Tool use in a Coconut-Carrying Octopus.” Current Biology 19: R1069–R1070.

Foale, M. 2003. The Coconut Odyssey: The Bounteous Possibilities of the Tree of Life. Melbourne, Australia: Australian Centre for International Agricultural Research.

Gunn, B. F., L. Baudouin, and K. M. Olsen. 2011. “Independent Origins of Cultivated Coconut (Cocos nucifera L.) in the Old World Tropics.” PLoS ONE 6: e21143. doi:10.1371/journal.pone.0021143.

Harries, H. C. 1978. “The Evolution, Dissemination and Classification of Cocos nucifera L.” Botanical Review 44: 265–319.

Harries, H. C. 1995. “Coconut (Cocos nucifera).” In Evolution of Crop Plants. 2nd ed, edited by J. Smartt and N. W. Simmonds, 389–394. Burnt Mill, Harlow, Essex: Longman Scientific & Technical.

Harries, H. C., and C. R. Clement. 2014. “Long-Distance Dispersal of the Coconut Palm by Migration within the Coral Atoll Ecosystem.” Annals of Botany 113: 565–570.

Harries, H. C., and R. E. Paul. 2008. “Cocos nucifera. Coconut.” In The Encyclopedia of Fruit and Nuts, edited by J. Janick and R. E. Paul, 107–118. Wallingford, Oxfordshire: CABl.

Hooda, V., G. N. Sharma, N. Tyagi, and A. Hooda. 2012. “Phytochemical and Pharmacological Profile of Cocos nucifera: An Overview.” International Journal of Pharmacy & Therapeutics 3: 130–135.

Hossain, M. A., S. M. Chowdhury, Y. Rekhu, K. S. Faraz, and M. U. Islam. 2012. “Biodiesel from Coconut Oil: A Renewable Alternative Fuel for Diesel Engine.” World Academy of Science, Engineering and Technology International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering 6: 524–528.

Lima, E. B. C., C. N. S. Sousa, L. N. Meneses, N. C. Ximenes, M. A. Santos Junior, G. S. Vasconcelos, N. B. C. Lima, et al. 2015. “Cocos nucifera (L.) (Arecales): A phytochemical and Pharmacological Review.” Brazilian Journal of Medical and Biological Research 48: 953–964.

Lockyer, S., and S. Stanner. 2016. “Coconut Oil – a Nutty Idea?” British Nutrition Foundation Nutrition Bulletin 41: 42–54.

Marikkar, J. M. N., and W. S. Madurapperuma. 2012. “Coconut.” In Tropical and Subtropical Fruits: Postharvest Physiology, Processing and Packaging, edited by M. Siddiq, J. Ahmed, M. G. Lobo and F. Ozadali, 159–177. Ames: Wiley-Blackwell.

Nayar, N. M. 2016. The Coconut: Phylogeny, Origins, and Spread. New York: Academic Press.

Nguyen, Q. T., H. D. Bandupriya, M. Foale, and S. W. Adkins. 2016. “Ecology, Propagation and Utilization of Elite Coconut Varieties (Makapuno and Aromatics).” Plant Physiology and Biochemistry 109: 579–589.

Oka, S., T. Tomita, and K. Miyamoto. 2016. “A Mighty Claw: Pinching Force of the Coconut Crab, the Largest Terrestrial Crustacean.” PLoS ONE 11 (11): e0166108. doi:10.1371/journal.pone.0166108.

Paul, C. L., and E. Ramk增长率. 2016. Coconut Intercropping Systems. Geneva, Switzerland: International Trade Centre.

Perera, L., Suriya A. C. N. Perera, C. K. Bandaranayake, and H. C. Harries. 2010. “Coconut.” In Oil Crops, edited by J. Vollmann and I. Rajcan, 369–396. New York: Springer-Verlag.

Prades, A., U. N. Salum, and D. Pioch. 2016. “New Era for the Coconut Sector. What Prospects for Research?” OCL (Oilseeds & fats, Crops & Lipids) 23(6): D607.

Reynolds, S. J. 1988. “Some Factors of Importance in the Integration of Pastures and Cattle with Coconuts (Cocos nucifera).” Journal of Biogeography 15: 31–39.

Roopan, S. M. 2016. “An Overview of Phytoconstituents, Biotechnological Applications, and Nutritive Aspects of Coconut (Cocos nucifera).” Applied Biochemistry and Biotechnology 179: 1309–1324.

Van Houtte, L., ed. 1850. Flore des serres et des jardins de l’Europe [Flora of the Greenhouses and Gardens of Europe]. Ghent: A. Gand.

Ward, R. G., and M. Brookfield. 1992. “The Dispersal of the Coconut: Did it Float or Was It Carried to Panama?” Journal of Biogeography 19: 467–480.

Yong, J. W. H., L. Ge, Y. F. Ng, and S. N. Tan. 2009. “The Chemical Composition and Biological Properties of Coconut (Cocos nucifera L.) Water.” Molecules 14: 5144–5164.