

in interior districts where larger amounts of sunlight and heat are available, as in the valleys of southern California and Arizona. The coconut, like many other palms, is not tolerant of shade nor of long continued cool and cloudy weather. Other species of *Cocos* that are less exacting in their requirements of sunlight and heat have been found to do well along the California coast.

The possibility of introducing coconut palms into southern California is not disproved by the absence of these palms from Egypt and Palestine. Though the climatic conditions are probably favorable, it does not appear that any adequate effort has been made to introduce

the palms in those countries.

The ability of the coconut to thrive on seacoasts shows that its requirements of heat are not as great as those of the date palm. Though probably less hardy than the date palm, it is not impossible that the coconut may be able to exist in frost-free localities that have not enough heat for the ripening of dates.

The possibility of introducing the coconut palm into southern California and Arizona can not be fairly tested by the planting of the maritime varieties. The chances of success will be very much greater with the varieties that are adapted to the dry interior localities of the temperate plateaus of the Andes.

The Origin and Dispersal of *Cocos nucifera*

O. BECCARI

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Having had the opportunity of meeting Mr. J. F. Rock shortly after his trip to the Palmyra Islands I became much interested in his account of the exceptional conditions which he found in the flora of this small and isolated group. This flora proves, at least as far as the phanerogams are concerned, to be composed of an extraordinarily small number of species, belonging to the common strand flora of the Malay Archipelago and Polynesia, and of the coconut palm, which composes nearly the whole of the forests that cover these islands.

The Palmyra Islands belong to the category of those uninhabited coral islands, covered with dense groves of coconut palms, and of which Simmonds writes, as reported by O. F. Cook,⁽¹⁾ "the ungathered nuts which have fallen year after year, lie upon the ground in incredible quantities."

The special circumstances in which

⁽¹⁾ History of the coconut palm in America, *Contr. U. S. Nat. Herb.* 14 (1910) 298.

the Palmyra Islands are placed; their coral origin; their isolation, consequent to the great distance from any other land; the complete absence of indigenous inhabitants; the want of drinking water; the absence of any traces of economic plants that might suggest that they had ever been inhabited; and the certainty that they are but seldom visited either by fishermen or by any person who had tried to turn their wealth (which consists of the coconut solely) into a source of profit — all these give me the occasion, in addition to describing the peculiar characteristics of the coconut produced in these islands,⁽²⁾ to offer certain considerations of an evolutionary and geographic nature, opposed to those which Mr. O. F. Cook has advanced with much competence and erudition in his two memoirs on the

⁽²⁾ *Cocos nucifera* Linn. forma *palmyrensis* Becc. in Rock, J. F., Palmyra Island with a description of its flora, *College of Hawaii Bull.* 4 (1916) 1-53, t. 1-20.

coconut palm.⁽³⁾ Cook, in effect, sustains three principal theses, with which I entirely disagree. They are:

1. That *Cocos nucifera* must have assumed its actual specific characters upon the American continent, where it was found by Polynesian navigators, who later diffused it among their own islands, from whence it passed at a still later date into the Malay Archipelago and to the continent of Asia.

2. That *Cocos nucifera* in Asia, Malaya, and Polynesia, as in all other places where it is now found, can in no wise dispense with man's assistance and protection, without which it is incapable of maintaining its existence on the sea coasts.

3. That the ocean currents *cannot* have been efficacious means of its diffusion or be responsible for its wide distribution.

I have been the more induced to write these criticisms of Mr. Cook's assertions because this opinion of the American origin of the coconut palm appears to have found favor with several scientific authorities, among them Hugo de Vries⁽⁴⁾ and Geoffrey Smith.⁽⁵⁾

Is the Coconut Palm of South American Origin?

According to the thesis so ably and fully sustained by Cook, *Cocos nucifera* cannot be of Asiatic, Polynesian, or Malayan origin, but must be "a native of South America and carried westward across the Pacific in prehistoric times;" and its "original home must be sought in some sheltered valley of the Equatorial Andes."

⁽³⁾ The origin and distribution of the cocoa palm, *Contr. U. S. Nat. Herb.* 7 (1901) 257-293; and History of the coconut palm in America, *ibid.* 14 (1910) 271-342. The first of these memoirs will be denoted by "I" in this article; the second, by "II."

⁽⁴⁾ Species and Varieties, etc., ed. 2, p. 82.

⁽⁵⁾ The Cambridge Natural History 4 (1909) Crustacea 173.

The old argument — and it was a very good one for holding *Cocos nucifera* to be of American origin — namely, that all the other members of the *Coccoineae* (except *Elaeis guineensis*) are American,⁽⁶⁾ has no longer any great weight, in view of the exceptions that recent botanical discoveries have made known.

In fact, the existence of a distinct species of *Elaeis* in Madagascar, different from *E. guineensis*, *E. madagascariensis* Beccari,⁽⁷⁾ and the discovery of another true *Coccoinea*, *Jubaeopsis caffra* Beccari,⁽⁸⁾ in South Africa, must weaken the belief in a necessarily American origin of all the *Coccoineae*.

Indeed, *Jubaeopsis caffra* turns out to have many more affinities with *Cocos nucifera* than has any other palm whatever among those hitherto referred by authors to the genus *Cocos*.⁽⁹⁾

⁽⁶⁾ The presence in Madagascar of a species of *Elaeis* distinct from *E. guineensis*, almost induces me to suspect that the genus *Elaeis* should be regarded as being really African, and that instead of a representative having been carried from America to Africa, precisely the contrary occurred, and that the American *Elaeis melanococca* must be considered to be of African origin.

⁽⁷⁾ Beccari, Palma del Madagascar 55, f. 46; Contributo alla conoscenza della Palma a olio (1914) 72, t. 18.

⁽⁸⁾ Webbia 4: 169.

⁽⁹⁾ After further careful study, I think it better to regard as distinct genera the subgenera *Arecastrum*, *Butia*, and *Glaziova*, proposed by me in Malpighia 5 (1888) 343. (Le Palme incluse nel genere *Cocos*). The genus *Arecastrum* is composed only of *C. Romanzoffiana* Cham., with its numerous varieties or subspecies and of the hardly specifically distinct *C. botryophora* Mart. To the genus *Butia* belong *C. capitata* Mart., and its numerous forms known by the names of *C. odorata* Barb. Rodr., *C. pulposa* Barb.-Rodr., *C. leiospatha* Barb.-Rodr., and several others cultivated in our gardens under the names of *C. australis*, *C. campestris*, etc. The following are species of *Butia* also; *C. Yatay* Mart., *C. paraguayensis* Barb.-Rodr. (probably only a variety of *C. Yatay*), *C. eriospatha* Mart. ex Drude, and probably *C. stolonifera* Barb.-Rodr. Species of *Glaziova* are: *C. Weddelliana* Wendl., *C. coronata* Mart., *C. comosa* Mart., *C. petraea* Mart., *C. campestris* Mart., *C. flexuosa* Mart., and

I have already shown elsewhere that *Cocos nucifera* is a monotypic palm, with but few affinities with the other palms included in the genus *Cocos*,⁽¹⁰⁾ whereas it has much in common with *Jubaeopsis*; namely, the general conformation of the fruit; the ample central cavity of the seed; and the male flowers with sepals entirely free and imbricated. This affinity to *Jubaeopsis* had led me to hazard a doubt as to whether *Cocos nucifera* may have originated, not in Polynesia or in some lands which have now disappeared from that part of the Pacific as I formerly supposed,⁽¹¹⁾ but rather in the islands lying in the eastern Indian Ocean or in some other lands or islands, existing in former times between Africa and India.⁽¹²⁾ According to this hypothesis, Ceylon and the Keeling Islands must lie almost in the region where *Cocos nucifera* assumed its present specific characters. The species *Eugeissonia*, belonging to a genus of palms peculiar to the Malay region, which until now have been referred to the *Lepidocarpaceae*, I have shown to have more affinity with the *Cocoinae* than with the *Lepidocarpaceae*.⁽¹³⁾ In the face of these facts the American origin of all the *Cocoinae* can no longer be considered as absolutely proved.

The Association of *Birgus* *latro* with the Coconut Palm

Birgus latro, the huge robber crab which is widely disseminated throughout Asiatic archipelagoes and Polynesia, is found also in the Palmyra Islands, and

numerous other species described by Drude in the Flora Brasiliensis and by Barbosa-Rodriguez in his Sertum palmarum. On the whole the species of *Glazivola* amount to more than forty. *Cocos schizophylla* Mart. is *Aricuriroba Capanemae* Barb.-Rodr. (*Aricuri schizophylla* Becc.).

⁽¹⁰⁾ Ann. Bot. Gard. Buitenz. Suppl. 3 (1910) 795.

⁽¹¹⁾ Op. cit. 802.

⁽¹²⁾ Webbia, l. c.

⁽¹³⁾ Webbia 4: 190.

from Mr. Rock's account it abounds in that group along with other crustaceans. I have already made use of the association of *Birgus* with the coconut palm⁽¹⁴⁾ as an argument against the suggested American origin of *Cocos nucifera*; for it seems to me to be inadmissible that *Birgus* could have been specifically evolved independently of the coconut. Without coconuts it would have nothing to live upon; whereas, if this association did not exist, the peculiar and special formation of this crab's prehensile organs — thanks to which it is able to grasp and break open the coconuts, which are its only means of subsistence, to say nothing of its climbing the trees which bear them — would surely not have come into existence. In any case, it seems to me that this association can hardly have originated in those eastern valleys of Peru wherein Cook insists that *Cocos nucifera* had its origin. It is also a noteworthy fact that *Birgus* is found in association with the coconut palm even in places far distant from each other and to which this palm might be held to have spread in a natural way, such as the Keeling Islands in the Indian Ocean and the Palmyra group in the Pacific.

I do not know if *Birgus* has been found in the Cocos Islands, in the Pacific, where however I should not be surprised if it existed; because, although the adult *Birgus* is a creature adapted to a terrestrial life, in the larval, or "zoaea," states it has a pelagic existence and, therefore, can be carried enormous distances. Nevertheless, *Birgus* seems to be absolutely unknown on the American shores of the Pacific. This gives me the opportunity to suggest the hypothesis that the long-enduring biological connection between *Birgus* and the coconut palm, which in the course of time has had the power of modifying certain or-

⁽¹⁴⁾ Ann. Bot. Gard. Buitenz. Suppl. 3 (1910) 804.

gans in *Birgus*, likewise has had the same influence in causing the coconut palm to assume some peculiar features. I allude to the extraordinary thickening of the pericarp, which from a teleological point of view has been attributed either to the advantage it gives to the fruit when floating, by which its dispersal is favored, or to the importance of deadening the shock when it falls from the tree. This second opinion is also shared by Hugo de Vries in the work above cited. My idea is that this great development of the pericarp may be attributed to the effect of the stimulus given by the crabs during the plasmatic period to the pericarp of the young fruits, by their efforts to reach the seed, which may have caused an hypertrophy of the tissues of the pericarp itself, leading to the production of a fibrous, corklike tissue of a protective nature, such as is the bark of a tree. In consequence and by the light nature of this tissue, the fruit is made capable of floating independently of any final cause; thus some among the many fruits produced became very light, and for this cause alone their dispersal was favored in preference to that of the heavy fruits. All this, however, rests on the supposition that *Birgus* really is in the habit of climbing the coconut palm and that it does so to get at the immature fruits. In this connection I may observe that when in the Moluccas I often found imperfectly matured coconuts on the ground, which were more or less gnawed and entirely emptied of their kernels. This the natives assured me was the work of *Birgus latro*.

On the other hand Guppy⁽¹⁵⁾ writes that he never saw *Birgus* unhusk the coconuts given to them for food when kept in captivity, but that to keep them alive it was necessary that the nuts should be opened for them. Hence it is

(15) Guppy, H. B., The Solomon Islands, 320.

not perfectly certain that *Birgus* succeeds in unhusking the coconuts when these are quite ripe and have fallen in the natural course to the ground.⁽¹⁶⁾

It seems to me that if the nut were not free from the husk, at least partly, it would be very difficult for *Birgus* to get at the kernel of a ripe coconut in a dry state through the dense stratum of the fibrous cork-like tissue of the mesocarp; whereas, it could easily do so in a young immature fruit. This would explain why *Birgus* is forced to climb the trees to provide itself with fresh nuts; whereas, it might make use of the fallen fruits, if it could open them.

However, it is easy to suppose that *Birgus* may make use even of the fallen fruits by attacking those that are beginning to germinate; for in such cases it is possible that it might succeed in reaching the albumen by gnawing at the young sprout with its mandibles.

Did the Coconut Palm Exist in America Before the Discovery of that Continent by Christopher Columbus?

Admitting that the coconut palm did exist in America on the Pacific coast before the discovery of the continent by Europeans, the data, on which Cook formed his opinion that from there it was disseminated on the Atlantic side, are so few and uncertain, that they offer little that can convince one of the correctness of his thesis. On the other hand, I cannot but wonder why the first sailors

(16) The botanist who accompanied Judge Cooper on his first expedition to Palmyra Island would remark here that he has personally observed *Birgus latro* unhusking coconuts. He more than once watched it in its laborious work, tearing fiber after fiber from the nuts found on the ground. He has also found the nests of *Birgus* filled several inches thick and covering many square feet of ground with the fibers of the coconut, each fiber single. He has not observed *Birgus* climbing the trees, but on board ship a *Birgus* climbed to the top of a 100-foot mast. — J. F. Rock.

who reached that continent have not even mentioned the coconut palm, if for no other reason than because of the refreshing milk its fruit contains; whereas, there is not a sailor in the East who does not speak of the natives bringing coconuts to strangers to quench their thirst. Amerigo Vespucci, in his voyages — and he was the first who sailed along the whole length of the tropical east coast of America to the Gulf of Mexico and the Antilles — does not once tell us that the natives offered him anything of the kind. This appears very strange, since in Asia and in the Malayan islands coconuts are almost the first things offered by the natives to all new comers. I have no difficulty in admitting that Polynesians, Malayans, or Papuans may have reached and established themselves on the Pacific shore of tropical America,⁽¹⁷⁾ and that they may have carried thither the coconut palm together with the banana; but

(17) The belief, widely accredited, that natives of Asiatic, Polynesian, or Papuan origin exist on the western coasts of Central America would appear to be confirmed also by what Amerigo Vespucci writes in the account of his first voyage [Libro de viaggi di Amerigo Vespucci, di Stanislao Canovai: Firenze, Tipografia Tofani (1832)]. He relates that while sailing (as it would seem) along the coasts of the Caribbean Sea, in the neighborhood of the Isthmus of Panama, he landed on an island in that sea about 15 leagues from the mainland, in which he found the most brutish and hideous people he had ever seen; he says that these savages had their mouths so full of an herb which they continually chewed that they could hardly speak. Each wore at his neck two small dry gourds, one holding the herb they were chewing, the other containing a white powder, which looked like powdered gypsum; into this one they dipped from time to time a little stick of the shape of a spindle, previously moistened in their mouths, and therewith flavored the herb they chewed with the aforesaid powder. It seems indubitable to me that such a custom corresponds to that which generally prevails among the Malays and other Asiatic populations at this day, of chewing the leaf of the betel and other things together with powdered lime, for the last must have been the white powder of which Vespucci speaks.

I positively cannot admit that they found the coconut palm on the American shores of the Pacific, carried it back with them, and disseminated it throughout Polynesia and tropical Asia.

The difficulty brought forward by Cook, that the coconut palm could not have been introduced into America by the Spaniards or by the Portuguese, because the fruits could not have preserved their germinative faculties during so long a voyage, has no force; because, Cook's assertion to the contrary, coconuts can withstand several months' dryness, especially if kept under the influence of sea air; moreover, they can germinate while hanging in the rigging of a ship. It is exceedingly common in the Malayan islands to see a bundle of coconuts sprouting while hanging to the posts of a hut.

With respect to the origin of *Cocos nucifera* and its supposed native land among the salt-bearing regions of eastern Peru, Cook concludes by saying (II, p. 307):

"It would be reasonable to turn to these saline districts of South America if any attempts were to be made to definitely ascertain the original home of the coconut by finding it in a truly wild state." Fortunately the author hastens to add: "Such a discovery is hardly to be expected, because of the probability that localities suited to the spontaneous growth of coconuts would have attracted human inhabitants, even in very early times."

But in that case will Mr. Cook tell us why he holds that in such localities *Cocos nucifera* could have constituted itself as a specific entity, have grown, and reproduced itself, without the assistance of man, but yet not have done so on the oceanic coral islands?

And again:

"We may hope, however, to find a

series of local varieties or subspecies of the coconut palm in these interior localities, varieties that will be more hardy and vigorous than the maritime forms of the palm cultivated in the humid parts of the Tropics, and more likely to thrive under semi-tropical conditions."

Such a search can very well be carried out by some enterprising botanist; but, as a matter of fact, no one has met with such forms or varieties of *Cocos nucifera* in the regions mentioned. I do not claim, however, that such an event is absolutely improbable or that varieties and species of *Cocos* as yet unknown to botanists, possessing more affinity with *Cocos nucifera* than have any of the other *Cocoinae* known hitherto, may not be found in such localities; but such a find would be a less extraordinary thing than that the big fruits of the coconut palm should have crossed the Andes and thence have been dispersed among the islands of the Pacific.

Dissemination of the Coconut by Maritime Agency

Cook writes (I, p. 276) that the ocean currents are an effective agency for the dissemination of the coconut and that "the theory of the transfer of fruits by ocean currents has received much attention and far greater credence than the facts seem to warrant." "The poetic theory of the coconut palm dropping its fruit into the sea to float away to barren islands and prepare them for human habitation" is called a "time-honored fancy." (I, p. 276) and again he says (II, p. 297): "A palm that is unable to maintain itself on the land has nothing to gain by having its nuts drifted about by the sea." It seems to me, however, that the restocking with plants of the islands in the Sunda Strait after the explosion in 1883 contradicts all these assertions, for both in Krakatau and in the small islands in its immediate vicin-

ity that catastrophe involved the complete destruction of all organic life. This notwithstanding, Ernst⁽¹⁸⁾ informs us that at the time of his visit to those islands, only a few years after the cataclysm, "the large number of coconut palms" was "an especially remarkable feature." In the earliest visits to the devastated islands, Doctor Treub and Professor Penzig not only picked up coconuts which had been thrown up on the beaches by the waves, but also, very soon encountered coconut palms pushing their young green fronds through the soil; and in Plate IV, fig. 7, of Ernst's book a young coconut palm at the upper edge of the tide level (southeast coast of Krakatau) can be seen; in Plate VIII, fig. 11, an entire group of coconut palms is seen "towering above the other trees;" and of this group our author writes:

"To our great delight we found the coconut palms laden with fruit. The large number of ripe nuts on the ground, several of which had germinated and produced plants reaching one meter in height, showed that they must have attained the fruiting stage some years ago: a renewal of the forest is thus amply provided for. We were all refreshed by a quantity of unripe fruits which one of our Javanese companions brought down from the crowns of the palm trees." The same author on disembarking at Zwarte Hoek, likewise in Krakatau, writes: "Young coconut palms occur here and there with seedlings of *Barringtonia speciosa*, etc.;" and on page 68: "Groups of strand-plants have penetrated inland for a distance of 300-500 m." and among these are coconut palms. He adds that young coconut palms and *Pandanus* clumps are so near the edge of the sea that their stems are washed by the waves at high tide.

(18) Ernst, A., The New Flora of the Volcanic Island of Krakatau, 58.

Another observation by Cook seems to me unsustainable; namely, that (I, p. 276) "the cocoanut palm seldom grows upon the immediate strand overhanging the water, or even in reach of ordinary waves." But everyone acquainted with the coasts of Asia and of the islands of the Malayan Archipelago and Polynesia knows the contrary to be the case. Cook himself (II, facing p. 299, Plate 54, fig. 1) gives an instructive illustration of "Coconut palms overhanging the surf at high tide, Puerto Barrios, Guatemala," and another half-tone from a photograph (fig. 2) of "Coconut palms overhanging the sea, Livingston, Guatemala." Against these assertions of Cook's one may oppose Ferguson's words:⁽¹⁹⁾

"The coconut tree flourishes better near the sea coast than in an inland situation. In such a vicinity it acquires more vigour, and produces with more fecundity; it never grows so luxuriant in the interior, where the air is not charged with saline particles, and salt water always seems to nourish it more than fresh water. The sea may wash the bottom of coconut trees without injury to them." And again, quoting Bertolacci, "It flourishes so very near the sea, that its roots are in many places washed by the waters without injury to the trees, until it is actually undermined."

As a result of my personal experience, also, all the arguments brought forward by Cook have not convinced me in the least that fruits of the coconut palm cannot be disseminated by the action of ocean currents, although he maintains (II, p. 324) that after his own observations no doubt can possibly remain that the contrary is the case. In fact he writes:

"For nearly two centuries the coconut has been described in books of travel and natural history, and even in formal

scientific works, as an example of a plant widely distributed in nature through the agency of ocean currents." The following are also his words (II, p. 300): "The possibility that a coconut might be stranded on a newly formed island and multiply in the unoccupied soil, according to the fable, may not be absolutely excluded, but we know that the monopoly would not be of long duration." This, because the writer holds that young plants would be suffocated by "their forest-forming competitors."

I would observe, however, that these competitors on the sea shore would be only halophilous plants, which have never shown themselves to be incompatible with *Cocos nucifera*, especially on the sea beaches of coral islands, which are always in immediate contact with the sea. If on many continental and insular coasts of Asia the coconut palm is not met with, I would give among other reasons, which I shall state later, this one, that it is just because forest plants from the interior have found the means of forestalling or supplanting the strand plants which originate from drift seeds.

The coconut palm (always according to Cook) "cannot be disseminated by ocean currents." He says that (I, p. 277) "it is far from correct to suppose that all nuts [of the coconut palm] which reach the water are really launched for oceanic wanderings; the chances are still hundreds to one that they will be thrown back immediately upon their own coast, like other objects floating in the surf. High waves or tides, instead of floating shore debris away, merely carry it farther inland, as everybody familiar with seacoasts knows."

That there may be some coasts the surf on which has greater power of carrying away material than of bringing it thither, I admit; but that, as a general rule, the sea does not throw back floating

⁽¹⁹⁾ Ferguson, All about the Coconut Palm, 111.

objects of various kinds, including the fruits and seeds of plants, is undeniable. How could all the strand floras of the world have been formed, if the sea did not carry their seeds to the beaches by means of its currents? Furthermore, suppose it were true that the surf does carry objects inland, would not that be a favorable circumstance for the dissemination of fruits which have fallen on other beaches bathed by the same sea, or into the sea itself?

The Coconut Palm Does Not Always Stand in Need of the Assistance of Man

Cook believes (I, p. 280) that "human assistance" is necessary to the introduction and maintenance of the coconut palm, and he says (II, p. 296) that this palm "is not known to exist except as a cultivated plant;" and (II, p. 297) that "we should find old palms surrounded by flourishing young ones growing spontaneously without the aid of man." And again, "There seems to be no authentic record of coco palms establishing and maintaining themselves on any tropical coast in a wild or truly spontaneous condition." He adds that: "The complete absence of coconuts from the extensive tropical coast line of Australia until planted by European colonists" is, "a gigantic experiment showing that the coconut did not establish itself without human help, even in a place where it afterwards thrived in cultivation." Cook (II, p. 299) also quotes Pickering⁽²⁰⁾ to the effect that "throughout the Pacific the coconut occurs only on those islands to which it has been carried by the natives." From another author⁽²¹⁾ Cook quotes: "It is to be emphasized that all coconuts are planted; the idea of a wild

palm being as strange in Funafuti as that of a wild peach in England * * * I doubt whether, despite popular opinion to the contrary, a wild coconut palm can be found throughout the breadth of the Pacific."

That the assistance of man is necessary to the coconut palm is indubitable whenever it is cultivated in districts wherein there are not combined all the conditions of climate, etc., which its nature as a halophilous plant demands, and wherein it has to dispute the soil with other plants, or finds foes which injure its fruits when fallen to the ground or its young sprouting plants, or cause the death of the adult trees. But large groves of the coconut palm exist in a most flourishing condition in places where man most certainly does not contribute to their maintenance, and where they now produce themselves naturally, even supposing it were the case that the first fruits were deposited by man.

The Palmyra Islands are just such a case; there, as Darwin observed of the Keeling group, "the young and fully grown coconut trees grew intermingled with the adult plants."

It would appear that the same is the case on other coral islands of the Pacific; for examples, Palmerston Island and probably also Cocos Islands, formerly — that is, before they had been inhabited by Europeans. *Cocos nucifera* in these localities may be regarded as really wild and as a true representative of a strand flora; but admitting that the coconut palm, to establish itself on an oceanic island, has required, as a rule, the hand of man to carry its fruits thither, the case of the Palmyra Islands demonstrates that it is absolutely contrary to the truth to assert that the coconut palm can never flourish and reproduce itself spontaneously without the protection and help of man.

⁽²⁰⁾ Pickering C., Chronological History of Plants (1879) 428.

⁽²¹⁾ Hedley, Australian Mus. Memoir 3 (1896) 22.

I cannot credit that even if the Polynesians did carry the coconut to the Palmyra Islands, they ever returned thither to take care of the plants. Yet the coconuts of the Palmyras are among the largest and finest known, and their albumen is more developed than that of most varieties cultivated by man. On oceanic islands, and especially on atolls, the coconut palm can establish itself; because when once the waves have deposited the fruits the young plants do not have to fear any competition with the primitive forest for the soil, and also because their competitors can at worst be only a few halophilous plants, produced from seeds brought thither at the same time as themselves, which can not oppose any great resistance to the growth of the coconut palm. Moreover, a most essential matter, no destructive marauders can have existed in such islands; while, on account of their great isolation, not even the foes of the coconut tree that are most to be dreaded — the red and the black beetles — have been able to reach them. Still arguing to sustain his theory, Cook writes (II, p. 303): "Unless the human friends of the young coconut are at hand to keep down the other vegetation the period of infancy is not survived." But it must be observed that the special conditions, required for the coconut palm to develop and reproduce itself independently of man, are just those found either on newly emergent beaches, such as those of Krakatau, or on the oceanic islands on which grow only a few species of plants born from drift fruits, and on which there exists no animal likely to be hurtful.

But if one holds as correct Cook's assertion, that *Cocos nucifera* cannot have developed its actual qualities without man's protection except in America, we must admit that the cradle of mankind was America; for Cook is right

when he says "that the useful cultivated plants offer the best record of man's primitive existence." If this *Cocos* cannot live without man's protection and if man must necessarily have been its distributor, we must also admit, either that man was the creator of the species *Cocos nucifera*, or that man appeared on earth at least contemporaneously with *Cocos nucifera*. The fact that the coconut palm has not established itself in Australia without help, although its nuts must certainly have been carried to its shores, can be understood when we consider that Australia is one of those regions where the conditions are precisely such that the coconut could not establish itself without man's assistance; such conditions are the predominant vegetation; the too great dryness, especially during the period of germination; and the presence of animals destructive to nuts and to young and to full-grown plants.

Cook finds another argument for maintaining that the coconut palm cannot have disseminated itself in the asserted fact that its fruits, falling from such a height, must surely be injured by the cracking of the kernel, which would have the effect of reducing "materially the chances of successful germination." But even if this were true (and in the case of some very tall palms it may perhaps happen), this must also have been the case in the birthplace of the coconut palm where there was no man ready, as he says, "to let the fruits down carefully to avoid injury" to them. Setting aside the small probability of such peril, it must be remembered that the coconut palm begins to fructify when only a few meters high; therefore, there is no danger whatever that its fruits will be injured by their fall or that there will not remain a sufficient number of them to secure the reproduction of the species.

The Coral Islands are the Locality Best Adapted to the Spontaneous Reproduction of the Coconut Palm

The manner in which the volcanic island of Krakatau (whence every slightest trace of vegetation was swept away by the explosion) has been restocked with plants, under our eyes, reveals the manner by which the coral islands can have been populated with a new flora, as soon as they were in a condition to sustain a vegetation.

The transportation of seeds of plants to these coral islands may have been effected otherwise than by the usual ocean currents, by means of extraordinarily violent storms, by exceptionally high tides, and by the great waves that are occasionally produced by telluric movements, and which are of no rare occurrence in that part of the Pacific, wherein a good number of islands appear to rest on volcanic bases. It does not seem likely that other forces, such as the winds, or birds, or other fruit-eating animals, have contributed much to populate certain coral islands (the Palmyras amongst others) with flowering plants; because the seeds that might have been carried to them by these means belong almost wholly to species that do not tolerate the presence of salt in the soil and often not even in the air.

The oceanic coral islands of new formation can be populated only by plants of which the seeds, besides being able to float, possess also outer wrappings of such a nature that they can resist the action of salt water, and which, moreover, can tolerate the presence of salt during the period of germination; thus is explained the scanty number of plants found on oceanic islands, which, like the Keelings and the Palmyras, cannot be regarded as being the relics of ancient drowned lands.

The Palmyra Islands belong in fact, like the Keelings, to those islands constituted entirely of coral, of which Darwin wrote, as quoted by Hensley,⁽²²⁾ that they "at one time, must have existed as mere water-washed reefs," and to which all the terrestrial products that existed on them, before Europeans settled on them and even before any natives had reached them, "must have been transported by the waves of the sea."

It is precisely on account of this circumstance that I maintain that the coconut palm has been able to establish itself, unaided by man, both in the Palmyras and in the Keelings and, probably, in other islands, not well known to us. Indeed, it is on islands of this kind and on their scanty soil, almost level with the water, that any coconut which may have been washed up on the beach and been able to germinate, finding no hindrances nor obstacles in any pre-existing forest vegetation, would have been able to grow and prosper, because it did not find there the many enemies which would have hindered its independent development on the shores of a continent or on one of the great Asiatic islands.

Among the most dreaded foes of *Cocos nucifera*, the wild hogs must be reckoned. With respect to these we read in Ferguson⁽²³⁾ an extract from the Ceylon Examiner as follows:

"Amongst the enemies of the coconut tree the wild pig has the first place. Not only because he is the most destructive to young plantations, I suppose, but because he is about the earliest enemy that the plant has to contend against."

It is certain that on the coasts of Asia and on the shores of the Malayan and

(22) Report of the Voyage of H.M.S. Challenger, Bot. 1 (1885), The South-Eastern Moluccas, 114.

(23) All about the Coconut, 137.

Papuan islands, where the wild pig is excessively abundant, not a single coconut would succeed in producing an adult plant without the protection of man, even though all the other conditions were favorable. There are besides the pigs other mammals such as certain rodents and herbivorous marsupials, which are very injurious to the coconut; among the last I learn that in New Guinea the "little flying opossum" (*Belidens ariel*) is in the habit of completely emptying the ripe nuts. It is noteworthy, also, that whole plantations of coconut palms can be utterly ruined by the injury caused to the adult plant by two very dangerous insects, the red beetle (*Rhynchophorus ferrugineus*) and the black beetle (*Oryctes rhinoceros*).⁽²⁴⁾

That the coconut palm not only can exist, but can prosper without man's help and can even produce finer and larger fruits than in places where it is carefully cultivated, is clearly evidenced by the dimensions of the coconuts of the Palmyras which I have already described. This fact may be attributed to the very special conditions inherent in the soil of the Palmyras; for though at first sight one would be inclined to think that *Cocos nucifera*, which is so exacting a plant as to fertilizing elements, could draw very little aliment from a soil composed solely of disintegrated coralline rock, of which rock the islands are formed, it does in fact find abundant nutrition therein.

⁽²⁴⁾ How the presence of an insect can impede the acclimatization of a plant in a new region, the following fact demonstrates. For several years I cultivated *Aubrietia deltoidea*, a pretty *Cruciferae*, native to southern Italy, but unknown in Tuscany, which maintained and multiplied itself upon a rockery without any help, in my garden near Florence; until it was attacked one spring by the larva of a small beetle, *Ademonia tanacetii*, which devoured it to its last leaf, since which it has never reappeared.

The fact is that in coral islands, in addition to the detritus of various kinds, all capable of being transformed into humus, which the sea may have brought to them, the soil which forms upon them may contain fertilizing substances due to the remains of animals that have contributed to the formation of the reef; to the accumulation of guano deposited by sea birds; and finally to the remains of the innumerable mollusks and crustaceans by which coral islands are usually populated.

The Coconut Palm a Halophilous Plant Peculiarly Adapted to Tropical Sea Coasts and to Oceanic Dispersal

A chemical analysis of the ashes of the coconut palm shows that all its organs contain chloride of sodium in considerable quantity; this salt, indeed, after the salts of potassium and of lime and the phosphates, being their most abundant constituent; it is even more abundant than silica, which in the state of crystals is found to be especially abundant in the leaves.

According to the summing up of Prudhomme,⁽²⁵⁾ a plantation of 1 hectare of the coconut palm annually draws out of the soil 120 kilograms of marine salt. And from Ferguson's report⁽²⁶⁾ we learn that an adult plant requires each year 1.34 kilograms of chloride of sodium. Salt, therefore, is considered an important manure for the coconut palm — far more than the quantity found in its ashes appears to demonstrate.

From the same source I learn that Doctor Gardner, to show the value that the Brasilians attribute to salt as a fertilizer for coconuts, states that "a man would walk many miles for it, pay high for a load, and then apply it to a single tree." Elsewhere, it is stated that sea

⁽²⁵⁾ Le Cocotier, 262.

⁽²⁶⁾ Op. cit. 66.

weeds and the ashes of plants that contain much salt are used as manures for the coconut palm. Ferguson also states (p. 142) that the Singhalese "invariably throw a little salt into the holes before they place the coconut plants in them." And on page 111, speaking of a new plantation of coconuts which is being made inland and at a distance from the sea, he says: "it is customary to throw a considerable quantity, as much as half a bushel, of salt into the hole which receives the coconuts.

Prudhomme,⁽²⁷⁾ writing of the toleration of the coconut palm for marine salt, asks if marine salt should not be reckoned among the fertilizers to be administered to this palm, as it seemed to him, that instead of merely tolerating it, the coconut had a real preference for this salt. The excessive toxicity of sodium chloride for plants is well known; the coconut palm, however, is one of the few that can live on a salt soil. For that reason I am not able to understand how a plant endowed with such high hereditary halophitism — which, therefore, not only tolerates, but actually prefers, a salt soil and, moreover bears fruit so constituted as to be, as Seeman⁽²⁸⁾ writes, "often tossed about the ocean for months without losing its germinating power from the effects of salt water" — can have been plasmated or brought into existence in a region remote from the sea.

That *Cocos nucifera* is a true halophyte, that is to say, a plant capable of resisting the physiological action of mediums rich in chloride of sodium and in the other salts that are characteristic of sea water, the very presence of which is pernicious to most other types of vegetation, shows that it must have been placed in close contact with salt soils

during the period of its evolution; considering, therefore, all the other circumstances that may have been required during and for the evolution and plasmation of the species *Cocos nucifera*, we are led to conclude that it must have originated on maritime shores.

Few are the true halophytes, and for this reason the flora of maritime shores and of the coral islands is poor in species, but in compensation they are of extremely wide geographic distribution. And this is because there are few plants having seeds tolerant of salt and at the same time provided with fruits capable of floating and of enduring a long immersion in salt water and, hence, fitted for long voyages. The coconut palm is one of these few. It is true that this palm can grow and even prosper far from the sea and can exist at a certain elevation above it, but it is probable that in these localities it can always find the quantity of chloride of sodium it needs. But although it is true that the coconut palm is capable of adapting itself to non-saline soils, as other halophilous plants can do, it none the less remains true that if *Cocos nucifera* were not a plant of the sea shore, and therefore an indubitable hereditary halophyte, it would not be better suited by a soil rich in chloride of sodium than by a soil devoid of that salt. It was therefore on the shores of the sea and especially on those of the coral islands that *Cocos nucifera* must have found the conditions under which it assumed its present specific characters: because there it would have had little to fear from the competition of other large plants of the strand flora and because there, also, it had not to struggle against powerful foes. Therefore, it cannot be admitted that the coconut palm is "unable to maintain itself on the sea coasts," and "the popular idea" that the "coconut palm is a plant specially adapted to

⁽²⁷⁾ Le Cocotier, 40.

⁽²⁸⁾ Fl. Vit. 276.

tropical sea coasts" is, and remains, a true idea.

Conclusions

From the preceding study, which was chiefly suggested to me by the conditions in which the Palmyra Islands were found by their explorers, Messrs. H. E. Cooper and J. F. Rock, I conclude:

1. That the coconut palm may have been very easily disseminated by the agency of oceanic currents.
2. That the coconut palm is a halophilous plant with a predilection for the sea shore.
3. That an Asiatic or Polynesian origin of the coconut palm is more probable than an American one.
4. That the coconut palm can occasionally exist and reproduce itself in the tropics independently of man, and that the latter's protection is necessary to it only when it occurs in regions where its existence is disputed by the nature of the soil, by other pre-existing vegetation, or by foes of various kinds.

THE EDITOR'S CORNER

The present issue of *PRINCIPES* contains an article by Beccari which several persons have suggested be reprinted. The original intent was to divide it between two issues, but upon thought such a division seemed inadvisable. Thus it is reprinted in its entirety, together with the summary of O. F. Cook's arguments about the origin of the coconut, at the risk of an overdue emphasis on the coconut in one issue.

It should be noted that some of Beccari's observations concerning the classification of palms related to *Cocos*, and particularly *Eugeissona*, would perhaps be modified by contemporary writers.

The Editor also wishes to note that the authorship of "What's in a Name?" should have been credited to Bruce H. Beeler in the January issue page 34.

USES OF COCO-DE-MER TREE

The stem does not find any use as the wood is rather soft and is liable to rot easily. It is therefore useless as a source of timber.

The leaves provide a first class material for thatching purposes. They are so large that only a few are sufficient to cover a native hut completely.

The young leaves are used on a large scale for making the beautiful straw hats which are worn by a large fraction of the population. They enter also in the composition of the coco-de-mer mats and baskets which are turned out in large numbers by expert hands.

The fruit is eaten at an early stage during its development.

The nuts are exported and sold in the East, where the endosperm is reputed for its medicinal properties. Arabs and Indians use it as a tonic, an aphrodisiac, and a poison antidote.

It is a pity that attempts to use the endosperm as vegetable ivory failed on account of the ease with which it cracks. Professor Pieraets of Brussels tried his best to overcome this difficulty but unfortunately his attempts to produce a commercial product from the endosperm failed.

The shell of the nut is put to various uses: water bottles, fruit bowls, bowls for baling, plates, etc., etc.

The plates and dishes of coco-de-mer are well known objects in the Praslin crockery. Bowls for baling form the equipment of every boat and "pirogue."

The bowls produced when the lobes of the nut are cut parallel to the sinus are well known in Mauritius where shopkeepers use them for measuring out rice or sugar.

At one time the bowls were quite useful in Mauritius sugar factories where