Morphological Notes.

BY

SIR W. T. THISELTON-DYER, K.C.M.G., C.I.E., F.R.S.,

Late Director, Royal Botanic Gardens, Kew.

XII. GERMINATION OF THE DOUBLE COCO-NUT.

With Plates XIX and XX, and a Figure in the Text.

THE palm (*Lodoicea sechellarum*, Labill.) is remarkable in the vegetable kingdom for producing the largest seed of any known plant. Its native country was long unknown. But the seeds which were thrown up on the shores of the Indian Ocean, most frequently on the Maldivé Islands, though occasionally on Ceylon and S. India, and as far as Zanzibar in one direction and Sumatra in the other, were held in great repute by the Eastern peoples for their supposed medicinal virtues. Though there is every reason to suppose that this repute was very ancient, it did not reach Europe till the sixteenth century. The general belief was that they were the produce of some marine plant, and this was accepted by even so capable a botanist as Rumphius as late as 1680. He says: 'non est fructus terrestris qui casu in mare procidit . . . sed fructus est in ipso crescens mari' (xii. 8). Although the seeds were capable of a wide oceanic dispersal which must have continued over a long period of time, I am aware of no case of their having spontaneously established themselves in any new territory. This is in striking contrast with the ordinary coco-nut, which, probably originally a native of S. America, is now widely distributed throughout the tropics.

It was not till the middle of the eighteenth century that the mystery was cleared up. I take the account given by Sonnerat (*Voyage à la Nouvelle-Guinée*, pp. 3, 4): 'Parmi les Isles de cet archipel [Séchelles], il y en a une que M. de la Bourdonnais désigna sous le nom de l'*Isle des Palmes*, lorsqu'il en fit la découverte en 1743 ou 1744. Cette Isle, examinée de plus près en 1767, a été nommée l'*Isle Praslin*, nom que l'usage, qui prévaut en tout, a changé depuis en cela d'*Isle des Palmiers*. C'est sur cette Isle qu'on trouva le palmier qui produit ce fruit si recherché, qu'on n'avoit connu jusqu'alors que sous les noms de coco de Mer. . . .' Sonnerat visited the island in 1771, and in his 'Voyage' published in 1776 he gives five plates which represent the

superficial characters of the palm with tolerable accuracy. He adds in a note that the description was communicated to the Académie des Sciences in 1773. Since Sonnerat's time *Lodoicea* has been known to also grow in the neighbouring islands, Curieuse and Round.

Gmelin in the thirteenth edition of the *Systema* (p. 569), 1791, named it *Cocos maldivica*. But Giseke (*Prael.* 1792, p. 88) correctly divined its affinities, naming it *Borassus Sonnerati*. Labillardière created for it the genus *Lodoicea*. But this, though maintained, is only distinguished technically from *Borassus* by the numerous stamens and large fruit.

It is not a little remarkable that our detailed knowledge of the morphology of a plant with so singular a history and such striking characteristics should still be very imperfect. But that this is the case is evident from the description given by Bentham and Hooker in the *Genera Plantarum*, iii. 939. I had hoped to do something to remedy this, and had collected some material for the purpose. The necessary leisure to accomplish the task has, however, always been wanting, and I must content myself with some detached notes which may be useful to some one more fortunate.

As long as the Coco-de-mer was only known from sea-borne specimens it was of course assumed that the Double coco-nut, as it was called, was the entire fruit. As soon as the palm producing it was discovered, it was at once obvious that this was not the case. The Coco-de-mer is in fact the stone of a gigantic drupe with a fibrous mesocarp. The complete fruit is rarely to be seen in Museums; but Kew possesses one, as well as a plaster model which the late General Gordon had made in the Seychelles and presented to it. The fruit is poorly figured by Sonnerat, but the best representations are in the fine series of pictures (Nos. 474-7 and 479) in the North Gallery at Kew, which Miss North visited the Seychelles in 1883 for the purpose of painting. According to Sir William Hooker, it is 'often a foot and a half in length, weighing twenty or twenty-five pounds'.

Sonnerat figures the drupe as ellipsoidal. This, if it ever occurs, except in the youngest stage, must be exceptional. The *Genera Plantarum*, no doubt correctly, describes it as 'oblique obovoideus'. Miss North, quoted by Sir Henry Yule (Hobson-Jobson, p. 178), says: 'the outer husk is shaped like a mango.' It is clearly therefore usually unsymmetrical; one side is somewhat flattened, and the other rounded. This arises from the fact that in the maturing ovary one carpel only usually develops.

One point which seems to require further investigation is the number of primary component carpels, or at any rate of cells in the ovary. The *Genera Plantarum* says it is '3- rarius 2-4- locale'. The whole symmetry of the flower is ternary, with three stigmas in the female. This would imply three component carpels, and therefore a three-celled ovary. It is possible, though the point requires further investigation, that the discrepancy has been produced by the misinterpretation of sections containing

the bilobed seed. Sir William Hooker figures in the *Botanical Magazine* (tab. 2737, fig. 1) a transverse section of an ovary which clearly points to a normal tricarpellary structure.

The stone, or nut as it is sometimes called, is, as is well known, deeply bilobed. As shown in Plate XIX the outline of the putamen in a longitudinal section is roughly that of an exaggerated dumb-bell. The cavities of the two lobes communicate in the middle. The upper parts of the lobes are separated by an open sinus, but the lower are more or less united, and if a cross section be made at this point, the nut would show, as in one of Sonnerat's figures, a bilocular structure.

Another point which has not been ascertained is the number of ovules in each ovarian cell. Analogy and such evidence as is available suggest there being only one. The 'nut' therefore, if developed from one carpel, would be only one-seeded. W. B. Hemsley, in the *Catalogue to the North Gallery* (p. 74), refers to 'the two-lobed nut, which usually contains only one seed'. But I am not aware of any proof of its ever containing more. It seems probable that the bilobed form of the nut has suggested that it might consist of two coalescing carpels, but there is no evidence for this.

Fuglans affords a familiar instance of ingrowths from the pericarp into the seed cavity. The purpose of such spurious dissepiments, especially when they intrude on the developing seed and modify its form, is difficult to account for. The separation of the cavities at the base of the seed of *Lodoicea* is apparently due to such an ingrowth. But this can only be ascertained by following the development. The free lobes themselves are only lateral inflations in order to provide space for the enormous endosperm. They are much more distended on the dorsal than on the ventral surface, which is somewhat flattened; this produces the corresponding difference in the two surfaces of the fruit which has already been mentioned. In this case, which seems the most usual, the fruit contains only one nut and one seed. The *Genera Plantarum* describes the fruit as '1-v. imperfecte 2-3-locularis'. The latter condition can be only due to the more or less complete development of one or both of the other carpels.

The endosperm is voluminous. According to the *Genera Plantarum* it is hollow, 'late cavo.' My recollection of a specimen examined at Kew, though unfortunately I made no note at the time, is that it was solid. The account given by Sir William Hooker seems to confirm this. He says: 'The cavity is filled by the *almond*, which is very hard, white, and corneous, so that it may be rasped with a file, but is with difficulty cut with a knife.' I can only conjecture that this must have been described from an old and desiccated nut. A fresh one which afforded Dr. Walter Gardiner material for a study of the histology of the endosperm must have been immature, for sections were easily cut with a razor, and the consistence was not much harder than that of a turnip.

Apparently in an earlier stage of development the endosperm is unconsolidated and gelatinous. Sir William Hooker says: 'Before the fruit has attained its perfect maturity, the interior . . . contains a substance like a white jelly, firm, transparent and sweet to the taste. A single Coconut holds, perhaps, three pints of this substance; but if kept a few days, it turns sour, thick and unpalatable, giving out a very disagreeable smell.' Miss North gives a more graphic description: 'The outer shell was green and heart-shaped; only the inner shell was double, and full of white jelly, enough to fill the largest soup tureen.'¹ And elsewhere, as quoted by Sir Henry Yule: 'I ate some of the jelly from inside . . . of the purest white and not bad.'² The late General Gordon, who, as is well known, was deeply interested in the palm, on somewhat mystical grounds, informed me in a note: 'The nut when ripe is black and falls from the tree; the gelatinous jelly is then hard like ivory.' It would be extremely interesting to trace the histological changes which accompany that of texture.

Widely different statements have been made as to the time which the fruit takes to reach maturity. According to Sir William Hooker: 'Twelve months elapse, from the time of the appearance of the *germen*, before the fruits are fully ripe; and they have been known to hang three years on the tree before falling on the ground.' Mr. C. Button, who was at the time Conservator of Crown Lands and Forests, informed me in a letter that the period was much longer: 'It remains seven years before arriving to its perfect maturity and falls to the ground. This experience has been several times made by me personally; but the proprietors of Coco-de-mer trees generally break the fruit at about four years of age for commercial purposes, as the shell at that time is sufficiently hard.' General Gordon also informed me that the 'fruit attains maturity in seven years'. It looks as if the discrepancy had arisen from a confusion between the time at which the fruits are gathered and that at which they are really mature.

Frequent attempts have been made to cultivate the Coco-de-mer in European botanic gardens, but with little success. For some years a plant, which I think was imported, existed in the Liverpool Botanic Garden. And a young plant was raised and perhaps still exists in the Jardin des Plantes. In 1889 I began a prolonged attempt to add it to the rich collection of palms at Kew. I was energetically assisted by Mr. C. Button, who sent us repeated consignments of mature nuts. Many failed to germinate at all: others did so, but only imperfectly; others again sprouted satisfactorily, but only to end their existence by disaster almost suicidal.

According to the *Genera Plantarum*, *Lodoicea* has the 'embryo basilaris, sinum spectans'. But unless I am mistaken the sinus is the apex of the nut, and the embryo is therefore apical. In any case the sinus being open affords the embryo a free path for emergence.

¹ Recollections of a happy life, ii. 289.

² Hobson-Jobson, 178.

Everything connected with *Lodoicea* is on a gigantic scale, and the germination is no exception. According to Sir William Hooker: 'From the period of its falling from the tree, a year elapses before the nut begins to germinate.' Mr. Button, however, put the period at 'four or five months before germinating and sometimes less'. The germination morphologically is of an ordinary monocotyledonous type. The apex of the cotyledon remains immersed in the endosperm and develops into a vast suctorial organ, while its petiole, which is about an inch in diameter, emerges from the nut carrying with it the plumule and 'radicle'. The petiole, which acts as a sort of umbilical cord, according to Mr. Button, 'enters the ground to the depth of about one or two feet, then continues underground nearly parallel to the surface for a distance of four, five, six feet, sometimes more.' A note of General Gordon's is that it 'comes to sprout out of the ground twelve feet from nut'. Mr. Button subsequently informed me that it 'runs in the ground, sometimes to a distance of several yards before coming to the surface'.

The difficulties of successful germination under artificial conditions will now be apparent. At Kew the nuts were buried in coco-nut fibre in a hotbed. Germination, once commenced, proceeded rapidly. Unfortunately in at least one instance it proved abortive. Before the proceeding could be detected the growing apex managed to insinuate itself in some crevice, with the result that it was irretrievably injured. In a subsequent attempt the petiole did not grow to so great a length, and it was possible to guide its course and finally establish the young plant in a pot. This grew pretty rapidly, and in 1892 was exhibited in the Victoria Regia House at Kew, still drawing nutriment from the parent seed, a process which may apparently continue for some years.

The cultural failures were at any rate available for anatomical purposes. One of them supplied the material for the accompanying plates. These represent a structure which, as far as size is concerned, is amongst the most remarkable, if not the most so, in the vegetable kingdom. They are somewhat smaller than life-size. Plate XIX represents a longitudinal section through a germinating nut. The actual specimen (which may be seen with its companion in Museum No. II at Kew) is two and a half inches wider than in the figure, and the other dimensions are of course diminished in proportion. It shows a section of the foot-like suctorial apex of the cotyledon. This has developed at the expense of the endosperm, which it has completely broken down and absorbed. Nothing remains of it but mere exhausted flakes which adhere to the internal walls of the nut. The petiole of the cotyledon will be noticed passing outwards through the sinus. Plate XX represents the external surface of the other half of the suctorial structure. The position is reversed as compared with Plate XIX, and the attachment of the petiole is below. It again is reduced and the

actual specimen is an inch and a half wider. It is impossible not to be struck with the general resemblance of the whole preparation to that of

Germination of *Phoenix dactylifera*. I, transverse section of the dormant seed; III—IV, different stages of germination (IV the natural size); A transverse section of the seed at *xx* in IV; B transverse section at *xy*, C at *zz*; *e* the horny endosperm, *s* the sheath of the cotyledon, *st* its stalk, *c* its apex developed into an organ of absorption which gradually consumes the endosperm and at length occupies its place, *w* the primary root, *w'* secondary roots, *b'* *bb''* the leaves which succeed the cotyledon, *b''* becomes the first foliage-leaf: in B and C its folded lamina is seen cut across.

brought about by an extension of the cotyledon, which very gradually encroaches upon the endosperm. The surface of this advancing portion of the cotyledon is covered with a well-marked epithelium, which, according to Sachs, probably emits some special substance which provokes the absorption

a human brain with the hemispheres drawn apart. The general form, the bilateral symmetry, the lobing and convolutions might deceive the anthropologist. It would be interesting to trace the gradual stages by which such a structure has been reached. There must have been a wild proliferation of botryoidal growths pressing on and compressed by their prey as it succumbed to absorption. One can only find a parallel to the process in the ravages produced by a tumour in an animal economy. It is obvious that at an earlier stage it must have completely filled the cavity of the nut previously occupied by the endosperm which it has replaced. As it has been in turn drained by the growing plant it has shrunk, and this has probably produced the lobulation of the surface. Except in scale the whole process in no way differs from that which takes place in *Phoenix* as admirably described by Sachs in 1862. This is at once apparent on comparing the figure reproduced from his *Lectures on the Physiology of Plants* (p. 344). As I have not the opportunity of consulting the original paper I borrow the following account from Brown and Morris:—

‘The absorption of the reserve-cellulose during germination is

of the cellulose, but he does not appear to have made any direct experiments in support of this view. . . . The epithelial cells increase in number, and are gradually pushed forward as the reserve-cellulose of the endosperm is absorbed.' ¹

Green in 1887, and Brown and Morris in 1890, were unsuccessful in extracting the enzyme of the Date, which the latter suggested might be used up as fast as formed.² It was, however, accomplished by Newcombe in 1899. Brown and Morris, however, extracted a cyto-hydrolytic enzyme from the germinating seeds of the Grasses. But this had no action on the reserve-cellulose, the seeds of *Phoenix*, or of plants of other natural orders.

That at any rate a similar cytase does the work in *Lodoicea* cannot be doubted. Its precise nature and that of the final and intermediate products of its action deserve investigation. We shall probably have to wait till some one with the necessary equipment can visit the Seychelles, where the scale on which the enzymes operate in *Lodoicea* should afford unique opportunities for their study.

What other constituents besides cellulose the endosperm contains has not been ascertained. In barley, according to the classical research of Brown and Morris, the amylo-hydrolytic enzyme 'is no doubt principally due to a secretion by the columnar epithelium of the growing embryo'.

'There is a steady accumulation of starch-liquefying diastase in the endosperm, and this in the course of time permeates its whole tissue, the ready passage of the enzyme through the contents of the grain having been enormously facilitated by the previous destruction of the cell-walls by the cyto-hydrolytic enzyme.' ³

It is probable that in most cases in the absorption of an endosperm the process takes place in two stages: the thickened cell-walls are attacked by one enzyme, and the cell-contents are thus exposed to the action of others. But an enzyme might possibly get access to the cell-contents before the destruction of the cell-wall. In 1883 Gardiner was able to study its structure in a nut which I was able to place at his disposal, as it had failed to germinate. He found that the thickened cell-walls showed numerous deep pits which were closed by a membrane. But he describes them as 'affording one of the clearest examples of the perforation both of the wall and pit membrane' ⁴ by protoplasmic threads. It may be reasonably suspected that these would afford channels for the propagation of enzyme action.

¹ Researches on the Germination of some of the Gramineae. J. Chem. Soc. 57, pp. 497-8.

² l. c., p. 499.

³ l. c., p. 507.

⁴ Phil. Trans., R. S., 1883, p. 848.

PS. While this was passing through the press, Prof. Farmer, who had seen a proof, wrote to me: 'It may interest you to know that in 1890,

when I was at Peradeniya, there was a young plant [of *Lodoicea*] growing in the Gardens which Trimen [the Director] told me had been planted about five years previously. The "nut" was still in the ground and connected by the sucker with the plant. The latter bore, I think, about five leaves; the later formed ones were very large, somewhat resembling those of *Corypha umbraculifera*.'

THISELTON-DYER—LODOICEA.

THISSELTON

ER—LODOICEA

Thiselton-Dyer, William T. 1910. "Morphological notes XII. Germination of the double coco-nut." *Annals of botany* 24, 223–230.

<https://doi.org/10.1093/oxfordjournals.aob.a089257>.

View This Item Online: <https://www.biodiversitylibrary.org/item/262605>

DOI: <https://doi.org/10.1093/oxfordjournals.aob.a089257>

Permalink: <https://www.biodiversitylibrary.org/partpdf/319768>

Holding Institution

New York Botanical Garden, LuEsther T. Mertz Library

Sponsored by

BHL-SIL-FEDLINK

Copyright & Reuse

Copyright Status: Public domain. The BHL considers that this work is no longer under copyright protection.

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.