

XIV. *On new Species of Balanophora and Thonningia, with a note on Brugmansia Lowi, Becc.* By WILLIAM FAWCETT, B.Sc., F.L.S., Assistant in the Botanical Department, British Museum.

(Plates XXXIII.-XXXVI.)

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I. ON BALANOPHORÆ.

BALANOPHORA HILDEBRANDTII, Reichb. fil.—During the 2nd voyage of Capt. Cook, Forster discovered in Tanna, one of the New Hebrides, a singular plant, which he called *Balanophora fungosa*. Dr. Anderson, the surgeon to the Expedition, made drawings of several rare plants which were met with, and among them there is one of *B. fungosa*, dated 9 Aug., 1774. The genus was established by Forster in his 'Characteres Generum Plantarum,' published in 1776. Anderson's specimen and drawing are preserved in the British Museum.

During the first voyage, however, Banks and Solander had discovered a species of *Balanophora* in Tahiti, in 1769, which was figured by S. Parkinson at the time. It was described by Solander in his MSS. as *Acroblastum pallens*, and placed by Seemann, in his 'Flora Vitiensis,' under *B. fungosa*, Forst., where Solander's description is given in full. I have examined both specimen and drawing of this plant in the Museum, and have identified it with a *Balanophora* discovered in Comoro Isles by Hildebrandt in 1875, and described by Reichenbach, fil., in the 'Journal of Botany,' 1876, as *B. Hildebrandtii*. Hildebrandt's specimen only differs in being much larger, but we have lately received other specimens of about the same size as the Tahiti plant, collected also in the Comoro Isles, by Humblot.

It seems strange that the same species should only have been found in such widely separated spots as Tahiti and the Comoro Isles, but when we consider that *Cynomorium coccineum* occurs in isolated spots from the Canary Islands to the Levant, we may hope that this *Balanophora* will be found in places intermediate between the habitats at present known. The geographical distribution need not be considered impossible; we may adduce the case of the Orchid, *Cirrhopetalum Thouarsii*, Lindl., which is found in Madagascar and Tahiti, and also in the intermediate stations, Mauritius, Java, and Manilla.

The anthers have hexagonal thecæ, and this species is the only one which is similar in this respect to the Indian *B. polyandra*, Griff., from which it is readily distinguished by the capitula being bi-sexual.

Reichenbach has given a very short description, and I therefore subjoin one, giving more details.

B. Hildebrandtii, Reichb. f.; rhizomate tuberoso pustulato, squamis pedunculi imbricatis, capitulis bisexualibus, florum masculorum bracteis liberis nec in favum

combinatis, antherarum thecis numerosis (12–15) hexagonis in capitulum coalitis, singulatim poro dehiscentibus; floribus femineis in receptaculo inter spadicellos obovato-truncatos dispositis.—*B. fungosa*, Seemann (non Forster), *Flora Vitiensis*, p. 99. *Acroblastum pallens*, Solander, MSS., “Primitiæ Floræ Insularum Oceani Pacifici,” pp. 310, 311; S. Parkinson’s *Drawings of Tahiti Plants*, t. 91 (ined.); “‘Ea-owa’ Tahitensibus,” Solander. Spec. in herb. Mus. Brit.

Hab. Tahiti (*Banks & Solander*): Comoro Is. (*Hildebrandt, Humboldt*).

Rhizoma magnitudine nucis juglandis, “albidum” (Sol.), tuberosum, minute papillosum, stellato-pustulatum. Volva brevis irregulariter lobata. Spadices, pedunculo incluso, 9–14½ cm. longi; squamæ haud numerosæ, oblongo-ovatæ, 1½–3 cm. longæ, apicibus capitula haud attingentibus. Capitulum bisexuale, floribus masculis infra capitulum ut in *B. fungosa*, ovato-cylindricum. Bractæ florum masculorum semilunatæ liberæ nec in favum combinatæ. Flores ♂ sessiles, lobis perianthii 4, lateralibus lanceolatis, medianis 2–3-plo latioribus. Antherarum capitulum in receptaculo ut in *B. polyandra* insertum, thecis numerosis (12–15) hexagonis.

B. ZOLLINGERII (nov. sp.).—This is a plant found in the island of Salayer by Zollinger, and distributed by him under the number 3323. No doubt, as often happens, more than one species may have been distributed under this number, for Eichler determines the plant to be *B. abbreviata*. The Brit. Mus. specimen, however, differs from it (1) in the ♂ flowers having anthers with hippocrepiform thecæ, and (2) in the capitula being small, sessile, and globose. From *B. fungosa* it differs in habit, the ♀ flowers, the sessile capitula, and the pustulate rhizome.

B. Zollingerii; rhizomate pustulato, capitulo bisexuali sessili squamis fere ocluso, antherarum thecis hippocrepiformibus; floribus ♀ in receptaculo dispositis.

Hab. Ins. Salayer (*Zollinger*, 3323, partim.). Herb. Mus. Brit.

Rhizoma lobatum, nucis Avellanæ magnitudine, minute verrucosum, pustulatum. Volva irregulariter lobata. Capitulum parvum, sessile, globosum, squamis suborbicularibus 4–6 mm. longis imbricatis fere oclusum. Flores ♂ ad basim capituli, perigonii phyllis 4–5, antherarum thecis in capitulum subglobosum coalitis, hippocrepiformibus, rimis 2 hippocrepicis parallelis dehiscentibus. Flores ♀ in receptaculo nec ad spadicellos elongato-obovatos dispositi.

B. DECURRENS (nov. sp.).—This species is founded on a plant sent by Don J. G. Azaola, from Luzon, in 1846. It might at first sight be taken for a variety of *B. dioica*, R. Br., but differs in the ♀ flowers being on the receptacle only, in the capitula of anthers being oblong, and the scales of the peduncle decurrent. The very long floral peduncle reminds one of *B. elongata*, but the hippocrepiform shape of the anthers at once distinguishes it.

B. decurrens; rhizomate lobato, minute verruculoso, epustulato, squamis imbricatis decurrentibus, capitulis dioicis, antherarum thecis 4 hippocrepiformibus, rimis hippocrepiformibus dehiscentibus; floribus femineis in receptaculo dispositis.

Hab. Luzon, Philippine Is. (*Don J. G. Azaola*, 1846). Herb. Mus. Brit.

Rhizoma lobatum, ovi gallinacei-pugni magnitudine, minute verruculosum, epustulatum. Volva irregulariter repando-dentata. Stipites florales 6-18 cm. longi, pedunculo cylindrico elongato, squamis imbricatis, 1-3 cm. longis, a basi ad apicem gradatim accrescentibus lato-oblongis longe decurrentibus totum pedunculum obtegentibus. Capitula ♂ obovata, 3-4 cm. longa. Bracteae margine ad apicem truncato crasso in favi speciem basi connatae. Flores ♂ 7-8 mm. longi; perigonium 4-5-phyllum phyllis ovatis subaequalibus intus laevibus. Antherarum capitulum ovoideo-oblongum, 3 mm. longum, thecis 4 hippocrepiformibus, rimis hippocrepiformibus dehiscentibus. Capitula ♀ oblonga-ovoidea, floribus in receptaculo nec ad spadicellos sessiles oblongo-obovatos dispositis.

B. TYPHINA, Wall. no. 7248.—Mr. J. J. Bennett in a note to Griffith's paper "On the Indian species of *Balanophora*" (Trans. Linn. Soc. xx. p. 95) says that "*B. typhina*, Wall. List. no. 7248, appears to be identical with *B. picta*, Griff." a species which was afterwards placed under *B. dioica*, R. Br. There are several specimens on the sheet marked 7248 in the Wallichian Herbarium of the Linnean Society, but none of them is *B. dioica*. Those marked A and B are *B. polyandra*, Griff., and no. 3 appears to be *B. indica*, Wall.

B. GIGANTEA, Wall.—In the same note, Mr. Bennett identifies, though doubtfully, *B. gigantea*, Wall., with *B. globosa*, Jungh. There are very fine specimens of *B. gigantea*, Wall., in the British Museum Herbarium sent from Wallich to Robert Brown, which show that it differs from Junghuhn's species in the ♀ flowers being both on the spadicels and receptacle, and in the form of the spadicels. The form of the thecae of the anthers is like that in *B. indica*, Wall., to which species it has a great resemblance, and may be a variety of it; it differs in the rhizome, which has no pustules, and is tessellated rather than warty. The following is a full description.

B. gigantea, Wall. List. n. 7249; rhizomate composito-lobato hexagono-tesselato haud pustulato, squamis pedunculi laxis imbricatis, capitulis dioicis, antherarum thecis 4-6 hippocrepiformibus, rimis hippocrepiformibus dehiscentibus, floribus femineis ad spadicellos et in receptaculo dispositis.

Hab. Taong Dong, Burmah (*Dr. Wallich*). Herb. Mus. Brit.

Rhizoma ut in *B. abbreviata*, sed tessellatum haud pustulatum. Spadices masculi, pedunculo incluso, 6-9 cm. longi; pedunculus 2-3 cm. longus; squamæ laxæ late oblongo-ovatae 1-5 cm. longæ, superioribus maximis capitulum involuerantibus. Capitulum ♂ ovatum vel cylindricum, 3-6 cm. longum, bracteis liberis semilunatis 5-7 mm. longis, floribus pedicellatis patentibus, 1½ cm. longis, lobis perianthii 4-5 omnibus oblongis. Antherarum capitulum compressum, thecis 4-6 hippocrepiformibus, rimis hippocrepiformibus dehiscentibus. Spadices feminei, pedunculo incluso, 7-13 cm. longi; pedunculus 4-10 cm. longus; squamæ numerosæ late ovatae laxæ patentēs. Capitulum ♀ subglobosum 2-3 cm. longum. Flores ♀ longe pedicellati in receptaculo et ad stipites spadicellorum oblongo-truncatorum dispositi.

B. RAMOSA (nov. sp.).—This species comes near *B. globosa*, Jungh., but differs in the branching rhizome, and the ♀ flowers being on both the receptacle and the stalked spadiceles. It was found in S.E. Java by Mr. H. O. Forbes, and is the same as a specimen sent from Java by De Vriese.

B. ramosa; rhizomate ramoso tessellato haud pustulato, squamis pedunculi numerosis confertis imbricatis, capitulis dioicis, femineis sub-globosis, floribus femineis ad spadicellos et in receptaculo dispositis.

Hab. Java (*De Vriese*); S.E. Java (*H. O. Forbes*, no. 1140, A.). Herb. Mus. Brit.

Rhizoma pomi magnitudine, e centro communi ramosum, totum tessellatum. Spadices feminei, incluso pedunculo, 3–7 cm. longi, pedunculus $\frac{1}{2}$ – $4\frac{1}{2}$ cm. longus, squamis confertis appressis late oblongo-ovatis, $\frac{1}{2}$ – $2\frac{1}{2}$ cm. longis. Capitulum femineum subglobosum vel oblongum, 2–3 cm. longum. Flores ♀ in receptaculo et ad stipites spadicellorum ovato-truncatorum dispositi, sessiles vel breviter pedicellati. Flores ♂ adhuc incogniti sunt.

B. MULTIBRACHIATA (nov. sp.).—This species differs from *B. globosa*, Jungh., and *B. elongata*, Blume, in the rhizome, the thecae of the anthers, and the spadiceles. It was brought from Sumatra by Mr. H. O. Forbes, and appears to be the same as one of the plants distributed by Zollinger under the no. 2948.

B. multibrachiata; rhizomate ramoso verruculoso pustulato, squamis confertis imbricatis, capitulis dioicis, antherarum thecis numerosissimis, longitudinalibus rimis longitrorsis dehiscentibus; floribus femineis in receptaculo dispositis.

Hab. Sumatra (*H. O. Forbes*, no. 2545, B; *Zollinger*, 2948). Herb. Mus. Brit.

Rhizoma pomi majoris circuitu, e centro communi ramosum, ramis dichotomis lobatis, verruculosum, pustulatum. Volva brevis 4–6-lobata. Spadices solum juveniles cogniti brevissimi, 3 cm. longi; pedunculus subobsoletus, squamis confertis late ovatis capitulum juvenile velantibus. Capitulum ♂ cylindricum $1\frac{1}{2}$ –2 cm. longum, bracteis liberis, floribus juvenilibus in alveolos immersis, lobis perianthii 4 inapertis, lateralibus lanceolatis, medianis 3–4-plo latioribus. Antherarum capitulum valde compressum, thecis 23–25, coalitis, linearibus, longitudinalibus, nunc confluentibus. Capitulum ♀ cylindricum 1– $1\frac{1}{2}$ cm. longum. Flores in receptaculo inter spadicellos sessiles oblongos dispositi.

B. FORBESII (nov. sp.).—This species comes near *B. Lowii*, Hook. f., but differs in the branching rhizome, which is without pustules.

B. Forbesii; rhizomate composito-lobato, minute verruculoso, haud pustulato, squamis confertis imbricatis, capitulis dioicis, antherarum thecis numerosis, longitudinalibus rimis longitrorsis dehiscentibus; floribus femineis in receptaculo dispositis.

Hab. S.E. Java (*H. O. Forbes*, no. 1140, A.). Herb. Mus. Brit.

Rhizoma pomi magnitudine, e lobis numerosis compositum, lobis obovoideis, totum minute verruculosum, haud pustulatum. Volva irregulariter lobata. Spadices masculi, pedunculo incluso, $2\frac{1}{2}$ –7 cm. longi; pedunculus 0–3 cm. longus, squamis confertis ovatis

oblongisve 1-2 cm. longis, capitulum subvelantibus. Capitulum ♂ cylindricum $2\frac{1}{2}$ -4 cm. longum, bracteis liberis semilunatis, 2 mm. longis, floribus pedicellatis patentibus, 7 mm. longis, lobis perianthii 4, omnibus oblongis obtusis, anthesi reflexis. Antherarum capitulum valde compressum, pedicellatum obovoideum, thecis numerosis (9-10), linearibus, longitudinalibus. Spadices feminei, pedunculo incluso, $2\frac{1}{2}$ -8 cm. longi; pedunculus 1-6 cm. longus, squamis confertis ovatis oblongisve 1-2 cm. longis, his ad apicem majoribus et latoribus capitulum subvelantibus. Capitulum ♀ cylindricum, $1\frac{1}{2}$ -2 cm. longum. Flores in receptaculo inter spadicellos sessiles oblongos dispositi.

The following Key shows the relation of the new species of *Balanophora* to those already described:—

I. Anthers equal in number to leaves of perianth, dehiscing by a transverse chink.

1. *B. involucrata*, Hook. f.

Scales verticillate in middle of peduncle.

2. *B. Harlandi*, Hook. f.

Scales free, crowded at base.

II. Anthers equal in number to perianth-leaves, hippocrepiform, dehiscing by two hippocrepiform chinks.

(a) Capitula unisexual.

3. *B. dioica*, R. Br.

Capitula cylindrical; rhizome pustulate; ♂ perianth-lobes ovate, patent; ♀ fls. on spadice and recept.

4. *B. decurrens* (n. sp.).

Capitula cylindrical; rhizome without pustules; ♂ perianth-lobes ovate, patent; ♀ fls. on recept.; scales decurrent.

5. *B. indica*, Wall.

Capitula obovoid; rhizome pustulate; ♂ perianth-lobes long linear, reflexed; ♀ fls. on spadice and recept.

6. *B. gigantea*, Wall.

Capitula obovoid; rhizome without pustules, tessellated; ♀ fls. on spadice and recept.

(b) Capitula bisexual.

7. *B. fungosa*, Forst.

Capitula pedunculate; rhizome without pustules.

8. *B. Zollingerii* (n. sp.).

Capitula sessile; rhizome pustulate.

III. Thecae of anthers more numerous (8-25) than the perianth-leaves, linear longitudinal.

(a) Rhizome tessellated, without pustules.

9. *B. globosa*, Jungh.

♀ fls. on recept., not on the sessile spadice; rhizome lobed.

10. *B. ramosa* (n. sp.).

♀ fls. on recept., and on the stalked spadice; rhizome branching.

(b) Rhizome tessellated, with few pustules.

11. *B. reflexa*, Becc.

♀ fls. on recept., not on the sessile spadix; rhizome simple.

(c) Rhizome warty, with pustules; ♀ fls. on recept. only.

12. *B. elongata*, Blume.

Capitula 1-sexual; thecae 8-12; rhizome branching irregularly.

13. *B. abbreviata*, Blume.

Capitula 2-sexual; thecae 8-12; rhizome with small roundish lobes.

14. *B. multibrachiata* (n. sp.).

Capitula 1-sexual; thecae 23-25; rhizome branching, with dichotomous lobes.

(d) Rhizome minutely warty.

15. *B. Lowii*, Hook. f.

Rhizome simple, pustulate.

16. *B. Forbesii* (n. sp.).

Rhizome branching, without pustules.

IV. Thecae of anthers hexagonal.

17. *B. polyandra*, Griff.

Capitula 1-sexual; ♀ fls. on recept. and spadix.

18. *B. Hildebrandtii*, Reichb. fil.

Capitula 2-sexual; ♀ fls. on recept. only.

II. ON THONNINGIA MALAGASICA.

In 1884 the Herbarium of the British Museum received specimens, preserved in spirit, of a Balanophoraceous plant sent from Madagascar by the Rev. W. Deans Cowan. These specimens, consisting of female capitula in flower, appeared to be a new species of *Thonningia*. The MSS. in which I described it were submitted to Sir J. D. Hooker, who had at the time just completed a paper on a male plant and fruiting capitula sent by Messrs. Humblot and Parker respectively from Madagascar. Suspecting that our plants were the same, he at once, with rare generosity, offered me his MSS. and drawings to add to my paper, and I am thus enabled to lay before the Society a full description of this interesting plant. Passages taken direct from Sir J. D. Hooker's MSS. I have placed between inverted commas.

"The discovery of a Balanophoraceous plant in Madagascar extends our knowledge of the geographical range of that curious family, and adds something to that of its morphology, and hence of the affinities of its genera. Hitherto only one Tropical-African species had been known, the monotypic *Thonningia* of Vahl, a native of Guinea, the original specimens of which, gathered in 1804, and preserved in the Royal Herbarium of Copenhagen, were sent to me for examination, and are figured in the Society's

Transactions *. The other African genera of Balanophoreæ are extra-tropical, consisting of *Cynomorium*, Micheli, in the north of the continent, and, in the south, *Sarcophyte*, Sparrm., and *Mystropetalon*, Harv. † These all belong to different tribes from *Thonningia*, which, as I have shown, is closely related to the American genus *Langsdorffia*."

The two species of *Thonningia* may readily be distinguished, for in *T. sanguinea*, Vahl, the peduncle is long, the scales acuminate, and the male perianth consists of a few scales placed at different heights on the pedicel; whereas in *T. malagastica* the peduncle is very short, the scales obtuse, and the male flower has a regular perianth. The following is a fuller description:—

T. MALAGASTICA; "*rhizomate* elongato, flexuoso, cylindraceo, rigido, $\frac{1}{4}$ – $\frac{1}{8}$ poll. diam.," volvis irregulariter lobatis, lobis 1–5 mm. longis; *capitulis* brevissime pedunculatis, "sparsis v. confertis, 1–1 $\frac{1}{2}$ poll. diametro, squamis 60–80, obtusis, exterioribus v. inferioribus brevibus rotundatis, intimis $\frac{1}{2}$ – $\frac{2}{3}$ poll. longis obovato-oblongis, scarioso-coriaceis apice laceris: *floribus masculis* $\frac{1}{2}$ – $\frac{3}{4}$ poll. longis, erectis confertis, squamis obtectis, perianthis regulari, lobis 3 ovato-oblongis valvatis demum reflexis; antheris 3 (?), elongatis, confluentibus, filamentis in columnam connatis; *floribus femineis* stratum tenuissimum vix $\frac{1}{10}$ poll. crassum efformantibus," ovario cum vicinis coalito, margine ovarii tubuloso, 2 $\frac{1}{2}$ –3 mm. longo, obscure 3–4-dentato.

Hab. In sylvis Madagascariæ (*Humblot*, fl. ♂; *Deans Cowan*, fl. ♀ anth.; *Parker*, fl. ♀ fruct.).

The following is a detailed description of the anatomy of *T. malagastica*, in the preparation of which I owe very much to the exceedingly elaborate monograph of the Brazilian Balanophoreæ by Dr. A. W. Eichler ‡, and also, of course, to Sir J. D. Hooker's monograph *;—

The parts of the rhizome which we possess are cylindrical; the point of insertion on the host is not known; but the rhizome probably becomes tuberous there, as in *Langsdorffia* and *Helosis*.

The rhizome does not branch, but gives off flowering stems laterally. The epidermis is normally clothed with hairs, but frequently both epidermis and hairs are rubbed off, except immediately round the base of the flowering stem, where they are under the shelter of the capitulum.

The anatomical structure of the rhizome shows more points of resemblance with *Helosis* than with *Langsdorffia*. The greater portion of the tissue is parenchyma, through which several fibro-vascular bundles run longitudinally. There are four large bundles arranged in a circle near the centre, with the xylem inwards and phloëm outwards. Outside these, there is an irregular ring of several small bundles, which are remarkable for having the position of the xylem and phloëm reversed, that is, the phloëm faces inwards and the xylem outwards. Schimper, in his paper on "Die Vegetationsorgane von *Prosopanche*

* Trans. Linn. Soc. xxii, pp. 29 & 42, tab. 3.

† To which is now added *Balanophora* (see above, *Hildebrandtii*).

‡ Mart. Fl. Bras. fasc. 47, Balanophoreæ.

Burmeisteri"*, has shown that in its 4- or 5-sided rhizome there are four or five central bundles with normal orientation, and that near each angle in a transverse section there are several small bundles arranged on each side of an imaginary line joining the angle with the centre, in such a way that the bundles are placed sideways as regards the centre, with the xylem facing the imaginary line. But an opposite orientation, even more pronounced than in *Thonningia*, because repeated, occurs in the rhizome of *Nelumbium speciosum*, in which there are several concentric circles of bundles, the first and second of which nearest the centre are normal; the third is opposite, the fourth is normal, and the fifth is again opposite. Another example occurs in the cortical bundles of *Calycanthus occidentalis*.

The parenchyma of the rhizome is composed of cells which are twice or thrice longer than wide. Towards the periphery the cells become smaller, and are of the same diameter longitudinally as transversely. The epidermis is composed of irregular projecting cells, as in *Langsdorffia*. The hairs are a millimetre or more in length, composed of two cells, the basal one short and somewhat bulbous, the other long and slender. The cell-wall of the hairs is covered with very minute granular warts.

Several of the cells have their walls so much thickened that the central cavity has the appearance of a long pore from which very numerous branching pores pass off to the periphery. These sclerenchymatous cells ("stone-cells," as the Germans call them) are longer and somewhat broader than the ordinary cells; they occur in masses, running in longitudinal strands parallel with the fibro-vascular bundles. In *Langsdorffia* the part of the cell-wall which is in contact with the soft-walled parenchymatous cells remains unchanged; this is not so evident in *Thonningia*, since the cavity of the cell is extremely narrow, but it also occurs, and then the pores appear almost as if they originated on the cell-wall.

The axis of the rhizome is occupied by one of these sclerenchymatous strands of an elliptical outline in transverse section, and of so great a diameter that it is easily recognized by the naked eye. The cambium-layer of the four internal fibro-vascular bundles is fairly parallel with the long axis of the elliptical outline, which is vertical, the shorter axis being horizontal. Sometimes the cells in the centre of this axial strand have walls which are only half the thickness of those that occur elsewhere; sometimes the upper and lower parts of the strand are entirely separated by a band of the ordinary parenchymatous cells. The outer cells are occasionally compressed in a radial direction. It is interesting to trace the resemblance with *Helosis*, which has a greater differentiation of this axial strand, so much so that Eichler† speaks of the medulla and the rays. It is in this respect very much nearer *Helosis* than *Langsdorffia*.

There are no sclerenchymatous strands corresponding in position to those which in *Helosis* are situated outside each fibro-vascular bundle, with a cup-like form in transverse section. They occur arranged somewhat concentrically, but still irregularly, gradually decreasing in diameter and in the number of cells to the periphery.

* A. F. W. Schimper in Abh. der Natur. Gesell. zu Halle, 1880.

† Mart. Fl. Bras. fasc. 47, Balanophoræ, p. 25.

The four fibro-vascular bundles nearest the centre are large, more or less elliptical in transverse section, with the long axis, which is vertical, occupied by the cambium. The xylem, facing inwards, consists of narrow vessels, the ends of one vessel being often bent over to join another; the longitudinal walls have reticulate-porose markings; the transverse walls are oblique, and also have porose markings. There is neither wood-parenchyma, nor spiral nor annular vessels. The phloëm consists of soft bast, narrow prosenchymatous cells, with an occasional sieve-tube occurring amongst them. The elements of the whole bundle, including the cambium, resemble those of *Helosis*, as described and figured by Eichler *: There are also three or four wood-vessels above and below the central strand.

The smaller bundles are like the larger bundles, except, as above stated, in the opposite orientation of the xylem and phloëm.

In *T. sanguinea*, Vahl, the bast of the four internal bundles is continuous round the central sclerenchymatous strand, with occasional wood-vessels here and there.

The *floral peduncle* is situated laterally on the rhizome, and its origin is first indicated by a swelling. When the bud breaks through, the ruptured cortical parenchyma forms a ring, with two to six irregular short lobes—the “volva.” The successive transverse sections which I have made through the bud appear to show that it is adventitious, and formed in the cortical parenchyma. In the adult state the fibro-vascular bundles run up from the rhizome towards the peduncle, but I have not seen them actually pass from the one to the other.

The peduncle is very short, so that the capitula are almost sessile on the rhizome. It is smaller at the base than above, and is clothed with numerous imbricating scales. There are several scattered fibro-vascular bundles, some of which are arranged in an irregular ring midway between the centre and the periphery.

At the very base of the peduncle, and between the insertion of the scales, an epidermis exists, clothed with hairs of the same kind as those on the rhizome, and with a layer of sclerenchymatous cells beneath it. No other sclerenchymatous cells are to be found in the peduncle.

The obtuse *scales* are persistent, imbricate, and increase in size from the volva upwards, the lowest being 5–6 mm. broad and 6–8 mm. long, while the large upper scales are 8 mm. broad and 20 mm. long. These large upper scales are linear, and distinct in outline from the series just below, which are rotundate, the lower scales gradually becoming lanceolate. The margins of the upper scales have a torn appearance.

The scales have a single fibro-vascular bundle running up the centre through the soft-walled parenchyma. There is an epidermal layer of small dark-coloured cells, beneath which is a continuous layer of sclerenchymatous cells with walls thickened to such a degree as to leave only a small cavity in the centre. Several of the subjacent cells are also sclerenchymatous; they occur in masses 2-, 3-, or 4-deep, forming an almost continuous layer; frequently the wall on the inner side of such masses, adjacent to the soft-walled parenchyma, is also soft-walled, just as occurs in the rhizome of *Langsdorffia*.

* Mart. Fl. Bras. fasc. 47. Balanophoræ, p. 26, t. vi. fig. 13.

There are no stomata present on the scales, or, in fact, on any part of the plant.

The flattened receptacle of the *male capitulum* contains few flowers as compared with the female capitulum. Round the circumference there are a few scales shorter than the flowers. Surrounding the base of the male flowers there are scale-like bodies of fleshy character, with the surface of the upper part papillose, which possibly correspond to the bodies on the male capitulum of *Langsdorffia*, considered by Hooker* and Eichler† to be abortive ovaries.

In the *female capitulum* the flowers are exceedingly numerous, probably as many as 4000. As they are slightly connected together, they form a continuous layer, completely covering the receptacle, which is convex. The inflorescence is centripetal. At the circumference there are scales, sometimes as long as the flowers, but generally shorter; they are probably true bracts, but none occur amongst the flowers themselves.

The tissue of the *male flower* and its pedicel is very like that of *Langsdorffia*, the cells being very thin-walled, and longer than broad. The pedicel contains a single fibro-vascular bundle, and therefore cannot be regarded as a staminal column with the tube of the perianth adnate, as Eichler has remarked for *Langsdorffia*‡. The lobes of the perianth are reflexed in flowering. There is a distinct layer of epidermal cells with rugose markings on their outer walls; there is no fibro-vascular bundle nor any sclerenchymatous cells. The staminal column is solid, with three fibro-vascular bundles, which indicate three anthers. I have not been able to determine exactly the number of cells in each anther, as the flowers are too far advanced, but there appear to be 4, and it is evident that they dehisce by longitudinal chinks, as in *T. sanguinea*, Vahl. The pollen is subglobose.

The *female flowers* agree in appearance with those of *T. sanguinea*, Vahl, as described by Hooker§. I have not been able to trace the development of the flower, but have little doubt that the so-called "perianth" is really a prolongation of the ovary, as Eichler has shown to be the case in *Lophophytum* and *Helosis*||. Even after the flower has become fully developed, the perianth-like limb increases in width, especially at the base, the mouth becomes contracted and covers up the persistent lower portion of the style. This does not appear to be the result of fertilization, for in flowers which never produce fruit the same thickening occurs, so that finally they have a very different appearance from those in the flowering condition; for, instead of being cylindrical with the styles protruding, they become clavate. The flowers of the three or four rows nearest the circumference are fleshy and thicker than the rest. In proportion as the fruit ripens, the receptacle grows more convex, thus providing a greater surface for the enlargement of the fruit, while the hardened limb forms a protecting cap. The ripe fruit is similar in most respects to that of *Langsdorffia*, as described by Eichler¶. The

* Trans. Linn. Soc. xxii. p. 41, tab. 2, fig. 4.

† Mart. Fl. Bras. fasc. 47. Balanophoræ, p. 18, tab. 3, fig. 14.

‡ Ibid. p. 17 (note).

§ Trans. Linn. Soc. xxii. p. 43, tab. 3, figs. 10-15.

|| A. W. Eichler, "Sur la structure de la fleur femelle de quelques Balanophorées," Actes du Congrès International de Botanique, Paris, 1867.

¶ Mart. Fl. Bras. fasc. 47. Balanophoræ, p. 20, tab. 3, figs. 15-21.

layer of cells surrounding the ovule is converted into an oblong thin putamen, consisting of sclerenchymatous cells, elongated at the sides, short at the apex and base, differing from those in the putamen of *Langsdorffia* in having the outer wall of the same thickness as the inner. The seed fills the cavity of the putamen; the greater part of it consists of soft-walled parenchymatous cells.

"The well-developed embryo is a noteworthy character; it is a nearly globose body, minutely cellular, with no distinction of parts. It is situated in the upper end of the seed, close to what may be assumed to be the position of the hilum, and is wholly immersed in the albumen. The only other genera of the order in which a similarly developed embryo has been detected are *Cynomorium*, *Mystropetalon*, and *Corynæa*. In all the rest, in so far as at present described, the embryo is of a character wholly different from the above, and is most inconspicuous, composed of a few very large, loose, transparent cells attached to a suspensor, only to be discovered by making most delicate sections, whereas in the genera named above, though minute, there is no difficulty in discovering the embryo, when present, by tearing open the albumen, when it can be turned out entire by the point of a needle. I have said 'when present,' because Weddell found the fully-formed embryo to be of rare occurrence in *Sarcophyte**, and I have only twice seen it in *Corynæa*, after dissecting a multitude of fruits. Eichler, indeed, states that the fruit of *Corynæa* is unknown†, probably by oversight, as I have fully described it."

The structure of the ovule agrees with Eichler's description and figure of *Langsdorffia*‡. The embryo-sac is long, with a large oosphere just below the apex, and a protoplasmic mass sometimes filling up the space between the apex and the oosphere, probably representing the synergidæ. In some instances a very large nucleus was seen at some distance below the apex, which is doubtless the first cell of the endosperm. Between the apex of the embryo-sac and the base of the style there are many long narrow cells, forming a conducting tissue. There are two or three layers of small cells immediately surrounding the embryo sac, corresponding in form and position with those which Eichler considers to belong to the ovule, while the cells of the ovary lying outside are long and narrow.

The description of *T. malagastica*, as given above, modifies the character of the genus, as described by Bentham and Hooker§, bringing it very close to *Langsdorffia*. The following is the revised character:—

THONNINGIA, Vahl. Spadices unisexuales. Flores dioici. Fl. ♂: Perianthium e squamulis 2-3 minutis lineari-subulatis, pedicello sparsis; aut regulare triphyllum, phyllis 3 lanceolatis; antheræ 3-(5?), lineari-elongatæ, in columnam pedicello continuam connatæ, 2-loculares, loculis 2-locellatis extrorsum dehiscentibus; pollen subglobosum. Fl. ♀: Ovarium elongatum, anguste cylindraceum, basi interdum tumidum, cum vicinis totum coalitum aut liberum, vertice in marginem tubulosum

* Trans. Linn. Soc. p. 54 (in nota).

† Eichler in DC. Prodr. xvii. p. 137.

‡ Fl. Bras. fasc. 47. Balanophoræ, p. 19, tab. 3. fig. 14.

§ Benth. & Hook. f. Genera Plantarum, iii. p. 236.

2-4-lobatum v. dentatum; stylus 1, terminalis, crasse filiformis, elongatus, dimidio superiore stigmatosus; ovulum in axe ovarii consitum, erectum atropum toto ambitu ovario coalitum.

Fructus flore femineo tumidior, styli inferiore parte intra ovarii tubulosum marginem persistenti, margine apicali in pilei duri speciem connivente; endocarpium in putamen tenue induratum; epicarpium carnosum. Semen endospermio copioso oleoso; embryo subglobosus, axilis interdum excentricus, ad trientem endospermii superiorem consitus.

Herba carnosa cerigera; rhizoma cylindraceum, esquamatum, tomentosum vel glabratum; volva lobato-dentata. Pedunculi brevissimi v. elongati, squamis imbricatis tecti; squamæ superiores spadice involucentes, persistentes. Spadices ♂ depresso-hemisphærici; ♀ hemisphærici v. subglobosi. Flores ebracteati v. bracteolis ad basim fl. ♂ minutis, ♀ stratum continuum efformantes.

III. ON BRUGMANSIA LOWI, *Beccari*.

Blume, in 1827, described a parasitic plant from Java, a near ally of *Rafflesia*, under the name of *Brugmansia Zippelii* *. For his new genus he revived a generic name given by Persoon, in honour of S. J. Brugmans, to plants afterwards placed under *Datura*. In 1829 he published an elaborate description of it, accompanied by coloured plates, in the 'Flora Javæ' †. The genus is quite distinct from *Rafflesia* in the absence of the corona of the perianth, the induplicate aestivation, the capitate genital column, and the two-celled anthers.

Beccari, in 1868, published a diagnosis ‡ of a new species (*B. Lowi*), and, in 1869, a detailed description with plates §. These plants were in bud only; and, in Hooker's monograph of the Cytinaceæ in De Candolle's 'Prodromus,' he evidently did not consider Beccari's new species quite satisfactory, and therefore placed it as a variety only of *B. Zippelii*, Blume. || In 1874, in a paper "Osservazioni sopra alcune Rafflesiacee," Beccari refers to the question of its being a good species ¶, mentions that he has since had opportunities of examining *B. Zippelii*, Bl., and quotes from his former paper the following passage, in which he had stated the differences:—" *Brugmansia Zippelii*, according to the figure and description given by Blume, seems somewhat smaller than *B. Lowi*, has the interior of the perigone uniformly pilose, ramentaceous, and furrowed with numerous striæ (instead of fourteen to sixteen ribs), which disappear in the ventricose part of the unopened flower; at the throat, in place of the tufts of hairs, it

* 'Bijdragen tot de natuurskundige wetenschappen,' Amsterdam, ii. (1827), p. 422.

† Vol. ii. Rhizanthæ, p. 13, tt. 4-6.

‡ Atti Soc. Ital. Sc. Nat. xi. p. 197 (1868).

§ "Illustrazione di nuove specie di piante Bornensi," Nuovo Giorn. Bot. Ital. i. p. 84, t. 5.

|| DC. Prodr. xvii. p. 113, 1873.

¶ Nuovo Giorn. Bot. Ital. vii. p. 74.

has fifteen linear oblong callosities, glabrous, colourless, equidistant, furrowed in the middle, concealed by the rammenta. The limb is 5-partite (6-partite in the figure), with laciniae which have two or three furrows or fissures; the genital column is globose and less depressed, the upper part is marked with various furrows, which perhaps correspond to the number of the anthers, which moreover correspond to the number of the furrows of the tube of the perigone on which they must press in the bud; the stalk or neck of the column is more elongated; the anthers are thirty-eight to fifty. Finally *B. Zippelii* is hermaphrodite."

The question is now finally settled by a coloured drawing and an expanded flower together with buds, sent to the British Museum by Mr. H. O. Forbes. These plants he collected on the slopes of Mt. Dempo, Sumatra, at an elevation of 4000 feet.

The expanded flower is not perfect, as the ovary is wanting. It is, however, extremely interesting, since it confirms a happy conjecture of Beccari, founded on an examination of the bud, namely, that the perianth in opening splits up into "fourteen to sixteen laciniae," instead of into five or six, as in *B. Zippelii*, Bl. Mr. Forbes's fully-opened specimen shows that the perianth splits up into sixteen lobes, and therefore as a species it is quite distinct. A transverse section of the inflexed parts in the bud shows that eight of them form a central mass, while the remaining eight alternate with them on the outside; an indication of this double series is afforded by the alternate lobes in the bud dipping beneath the others at a short distance below the apex of the bud. The lobes are connected below the bud apex by a membranous extension of the inner surface, which is reduced in the inflected portion to a narrow wing. When the flower opens, the web is split more or less between each lobe. The apical portions, which have been inflexed, are always free.

The fissures extend downwards to about the level of the top of the genital column, and this is therefore the limit of the tubular portion of the perianth. The flower opens wide and flat at this point, though the web may not be ruptured between all the lobes.

From the existence of the web between the lobes it would seem as if a tube were formed by the inflexed parts on the first expansion of the bud, leading from the exterior to the depression in the genital column. If it be so, it may possibly be connected with cross fertilization by insects. The strong fetid odour which Mr. Forbes noticed in this plant may also have some relation to the action of insects.

Beccari figures the cells of the anthers as directly superposed; in Mr. Forbes's specimens there is an appearance of alternation.

DESCRIPTION OF THE PLATES.

PLATE XXXIII.

Balanophora, species of.

- Fig. 1. Male plant of *Balanophora decurrens*. Natural size.
 Fig. 2. Female flowers and spadiceles on the receptacle of ditto. Magnified.
 Fig. 3. Bud of male flower of ditto, seen from above. Magnified.
 Fig. 4. Capitulum of anthers of ditto, seen slightly from above. Magnified.
 Fig. 5. Male plant of *B. gigantea*, Wall. Natural size.
 Fig. 6. Female flowers of ditto on the stalk of the spadicele. Magnified.
 Fig. 7. Male flower of ditto, seen slightly from above. Magnified.
 Fig. 8. Female plant of *B. Forbesii*. Natural size.
 Fig. 9. Female flowers and spadiceles on receptacle of ditto. Magnified.
 Fig. 10. Male flower of ditto. Magnified.

PLATE XXXIV.

Balanophora, species of.

- Fig. 1. *Balanophora Zollingerii*, attached to the root of its host. Natural size.
 Fig. 2. Female flowers and spadiceles of ditto on receptacle. Magnified.
 Fig. 3. Bud of male flower of ditto, seen from above. Magnified.
 Fig. 4. Capitulum of anthers of ditto, seen slightly from above. Magnified.
 Fig. 5. *B. multibrachiata*, attached to the root of its host. Natural size.
 Fig. 6. Very young female flowers of ditto on receptacle, with sessile spadiceles. Magnified.
 Fig. 7. Bud of male flower of ditto, seen from above. Magnified.
 Fig. 8. Capitulum of anthers of ditto. Magnified.
 Fig. 9. Female plant of *B. ramosa*. Natural size.
 Fig. 10. Female flowers of ditto on stalk of spadicele. Magnified.

PLATE XXXV.

Thonningia malagasica.

- Fig. 1. Female capitulum during flowering, on rhizome (*r*), showing at (*a*) the swelling where a bud is about to break out, and at (*b*) a young bud.
 Fig. 2. A transverse section of the rhizome; *s*, the sclerenchymatous strands; *f*, the fibro-vascular bundles, the shaded portion being the xylem.
 Fig. 3. The central portion of fig. 2, enlarged; *s*, sclerenchyma; *x*, xylem; *ph*, phloëm; *p*, parenchyma.
 Fig. 4. A longitudinal section through the central sclerenchymatous strand and one of the fibro-vascular bundles; *t*, thick-walled cells of the circumference of the sclerenchymatous strand; *c*, thinner walled cells in the centre of the sclerenchymatous strand; *p*, parenchyma; *fv*, fibro-vascular bundle; *x*, xylem; *ph*, phloëm.
 Fig. 5. Sclerenchymatous cells from fig. 4.
 Fig. 6. Transverse section of portion of a scale; *f*, the solitary fibro-vascular bundle; *p*, the parenchyma; *s*, sclerenchymatous cells.
 Fig. 7. Portion of female flower, showing embryo sac (*s*), conducting tissue (*c*), walls of ovule (*ov*), base of style (*st*).

- Fig. 8. Transverse section of the pedicel of male flower, with one fibro-vascular bundle in the centre.
 Fig. 9. Transverse section of a portion of the staminal column, with three fibro-vascular bundles.
 Fig. 10. Ditto, higher up, when dehiscence has taken place.
 Fig. 11. Pollen.
 Fig. 12. Transverse section of one of the leaves of the perianth of the male flower.
 Fig. 13. One of the fleshy scales surrounding the male flowers.

PLATE XXXVI.

Thonningia malagastica (figs. 1–11); *Brugmansia Lowi*, Becc. (fig. 12).

Fig. 1. Fruit, showing the persistent base of the style (*s*), embryo (*e*), endosperm (*en*), putamen (*p*).

Fig. 2. Unfertilized flower.

Fig. 3. Rhizome with two male capitula.

Fig. 4. Male capitulum in section.

Fig. 5. Male flower.

Fig. 6. Two female capitula in fruit.

Fig. 7. Female capitulum in fruit, in longitudinal vertical section.

Fig. 8. Single fruit.

Fig. 9. Unfertilized flower.

Fig. 10. Unfertilized flower.

Fig. 11. Endosperm with embryo.

Fig. 12. *Brugmansia Lowi* (natural size), after a coloured drawing from the living plant by Mr. H. O. Forbes.

} From original drawings by Sir J. D. Hooker.







