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A Morphological and Systematic Review of the *Apostasiæ*. By R. ALLEN ROLFE, A.L.S., Assistant in the Herbarium of the Royal Gardens, Kew.

[Read 21st June, 1888.]

(PLATE XLVIII.)

THE *Apostasiæ* form a highly interesting little group, placed at the very end of the large order Orchideæ, and as no general revision has ever been published, and the literature relating to the subject is extremely scattered, I have attempted to remedy the deficiency in the following paper. I have also discussed somewhat fully the morphology, affinities, and geographical distribution of the group. The annexed Plate I have prepared to illustrate the more important points of structural detail.

HISTORICAL INTRODUCTION.

The genus *Apostasia* was founded in 1825 by Blume* for a plant discovered by him in Western Java, and which he termed *Apostasia odorata*. It was considered simply a genus of Orchideæ, for Blume divided the Order into three tribes, viz. *Cereaceæ*, *Granulosæ*, and *Pulvereæ*, the latter tribe being again subdivided into *Monantheræ* and *Diantheræ*, the last-named division comprising only the genus *Apostasia*. *Cypripedium* is not mentioned in the text, but is bracketed with *Apostasia* in a separate table of genera. Blume's description of the genus is sufficiently correct, except as to the pollen, which he describes as "Massæ pollinis pulverulentæ;" while of the tribe he remarks, "Pollinis massæ in pulverem facile solvenda." So far as *Apostasia* is concerned, it is incorrect to speak of pollen-masses, for the grains are quite free, not aggregated in masses at all. The three-celled ovary and axile placentation he appears to have quite overlooked, for he makes no mention of them whatever.

In 1830 two other species, which had been sent from India by Wallich, were described by Robert Brown†. All the structural details were accurately described by Brown, the position of the stamens with regard to the perianth-segments clearly set forth, the affinities ably discussed, and the genus raised to the rank of a distinct, though somewhat anomalous, tribe of Orchideæ, bearing

* Bijdr. Fl. Nederl. Ind. p. 423, t. i. fig. 5.

† Wall. Pl. Asiat. Rar. i. pp. 74-76, tt. 84, 85.

a certain analogy in the staminal arrangement, and perhaps in the economy of fertilization, to *Cypripedium*. Both the species are admirably illustrated.

In 1833 * Lindley raised *Apostasiæ* to the rank of a distinct natural order, another group of *Orchideæ* being also so separated under the name *Vanillaceæ*. This latter group was abandoned in a later work †, though *Apostasiæ* was retained, on account of the three-celled ovary and the style being free for the greater part of its length. Here Lindley remarks, "the Order seems as if connecting Orchids with Hypoxids."

Between 1830 and 1838 Bauer's 'Illustrations of Orchidaceous Plants' appeared, in which *Apostasia* is admirably figured ‡, with the single exception of the pollen. That of *Apostasia nuda* is here represented as cohering in tetrads, a point in which no subsequent author agrees, and which is quite at variance with my own observations.

Attention was called to this very point by Griffith § in describing *Apostasia Brunonis*, in the following note:—"With respect to the pollen, in this species at least, it has no affinity with that of *Orchideæ*; Mr. Bauer, however, has figured that of *A. nuda*, which has a manifest and close resemblance to that of *Orchideæ*." He then describes the pollen from his own observations as "pulvereous" and differing "only from the common form of pollen in having but one tegument. It appears to be lanceolate-ovate, with one or three elevated lines of a whiter colour than the remaining part. Immersed in water, the lines generally disappear, and it appears like an oval or roundish vesicle, very transparent, containing very minute granules and a viscid fluid. There is no ternary or quaternary cohesion." But on examining Griffith's specimens I find them to be identical with *A. nuda*, B. Br., so that the error must be simply one of observation, and perhaps arose from Bauer not clearly seeing all the details and trying to make the pollen fit with that of other *Orchideous* genera.

In 1834 a second genus of *Apostasiæ* was described by Blume ||, under the name *Neuwiedia*, differing from *Apostasia* in its sub-

* *Nixus Plantarum*, p. 188.

† *Veg. Kingd.*, ed. 1 (1847), p. 184.

‡ *Fructification*, t. 15.

§ *Posthumous Papers*; *Notulæ ad Plantas Asiaticas*, iii. p. 243, *Icones*, t. 282 (published in 1851).

|| *Ann. Sc. Nat. sér. 2*, ii. p. 93.

ringent perianth, three perfect stamens, and other minor characters, which were all very accurately set forth. This plant, also from Java, was called *Neuwiedia veratrifolia*. Here Blume also ranked the group as a distinct natural order, closely allied to Orchideæ.

A third genus was afterwards doubtfully added to the *Apostasieæ* by Lindley. In his 'Vegetable Kingdom' * “? *Rhynchanthera*, Blume” †, is enumerated under this Order, with the following remark:—“If *Rhynchanthera* is correctly represented by Blume, its 3-locular ovary will refer it here, while the structure of its column would keep it in Orchids. The essential character [i. e. of *Apostasieæ*] is, however, framed without reference to it.”

In 1837 Endlicher ‡ (who also retained *Apostasieæ* as a distinct Order) divided *Apostasia* into two sections—*Mesodactylus*, with the rudimentary third stamen present, and the anthers unequal at the base, and *Adactylus*, with no vestige whatever of a third stamen, and the anthers equal at the base—characters which had been pointed out by Robert Brown.

In 1846 Lindley described *Uropedium* §, remarking, “*Omnia Cypripedii*, sed labellum planum et petala longissime caudata. Anthera sterilis trilobo-hastata.” No mention is made of the structure of the ovary.

Three years later, the plant meantime having flowered in cultivation, Brongniart published an elaborate memoir on *Uropedium Lindenii*, Lindl. ||, illustrated with a plate, showing, among other

* Ed. 1, p. 184.

† This genus is at present a mystery to me. Blume himself (Coll. des Orch. Archip. Ind. (1858) p. 125) cites “*Rhynchanthera*, Bl. Bydr. (1825–1826), fig. lxxviii,” as a synonym of *Corymborchis*, Thouars; and on the following page he cites “*Rhynchanthera paniculata*, Bl. Bydr. fig. lxxviii,” as a synonym of *Corymborchis veratrifolia*, Blume; and yet no such figure appears in either of the two sets of plates at Kew. Figure 73 is the highest number on tab. 15, which, according to Pritzel, is the number issued with the work. Neither in plates, text, nor index, can I find any trace of the name or the figure in question; and yet, from Lindley's remark, it is clear he had seen this figure. I can only surmise that some copies of the work may have been issued incomplete, yet this would not account for its absence in the index, and hardly in the text. With regard to the other question, I have examined the ovary of a species of *Corymborchis*, which is synonymous according to Blume, and find it one-celled with parietal placentation, as in the rest of the *Monandraceæ*. Other authors appear to have found, or assumed, the same.

‡ Gen. Plant. i. p. 221.

§ Orch. Linden. p. 28.

|| Ann. Sc. Nat. sér. 3, vol. xiii. p. 113, t. 2. figs. 1–8.

things, that it differed from *Cypripedium* in having a trilocular ovary and three perfect stamens, in addition to a barren one or staminode; and that, while in characters it more nearly approached the small family *Apostasiæ*, still it might possibly prove to be a monstrous state of the plant then known as *Cypripedium caudatum*, Lindl., now *Selenipedium caudatum*, Reichb. f.

In 1854 Prof. Reichenbach described *Selenipedium**, basing it on the Tropical-American species then called *Cypripedium*, but differing in having a trilocular ovary (a point previously apparently unsuspected). He remarks of it, "Omnia *Cypripedii*, sed ovarium *Apostasiæ Uropedii*que," and briefly adds, "*Apostasiæ sunt Orchideæ*."

A little later the same author figured and described *Uropedium Lindenii*, Lindl.†, contending that as the three stamens of the inner whorl were all perfect, *Uropedium* should be regarded as a good genus and not a monstrous condition of something else. Notwithstanding this, it is now certain that the plant is simply a pelorioid state of *Selenipedium caudatum*, in which this peculiar character has become fixed or permanent. Excepting in the altered parts, no difference whatever can be detected between the two,—colour, texture, and similar characters are as absolutely identical as if the two kinds of flower were produced by the same plant; and Dr. Masters has recorded an instance where a plant of the normal character produced a flower with all the stamens of the inner whorl perfect; and the lip quite intermediate between the normal condition of that organ and an ordinary petal (or the lip of *Uropedium*)‡.

Dr. Pfitzer also retains *Uropedium*§ (spelling it "*Uropedilum*"), adding, however, a "?"; he also defines his group *Cypripeditinæ* as sometimes having all the stamens of the inner whorl perfect, a character obviously drawn from *Uropedium*.

In 1867–8 Baron Ferdinand von Müller described *Niemeyera*|| as a new genus of *Hypoxidaceæ*, but it has proved to be simply an Australian species of *Apostasia*.

In 1881 Bentham published his "*Notes on Orchideæ*," in which he united *Apostasiæ* with *Cypripediæ*¶ under the latter

* *Selenipedium Bonplandia*, ii. p. 116.

† *Xen. Orch.* i. p. 32, t. 15.

‡ *Gard. Chron.* n. s. xxvi. p. 268, fig. 54; also *Journ. Linn. Soc.* xxii. p. 419, t. 20.

§ *Nat. Anordn. Orch.* (1887) p. 95.

¶ *Fragm. Phyt. Austral.* vi. p. 96.

¶ *Journ. Linn. Soc.* xviii. p. 358.

name. He remarks:—"The four genera constituting this tribe differ so strikingly from the rest of the Order in their andrœcium, that they have been proposed as forming one or two distinct natural orders. Now, however, that they are better known, they are found to be too closely connected together not to be united in a single tribe; and the importance of the single character which separates them from Orchideæ generally has fallen so much in estimated value, that they have by common consent been reunited with that order as a distinct tribe only." This arrangement was also adopted in the 'Genera Plantarum.'

In 1886 Ridley*, in describing a new species of *Neuwiedia* from New Guinea, again placed *Apostasiæ* as a distinct natural order.

Lastly comes Dr. Pfitzer's arrangement of the group†, which is as follows:—

Ordo ARRHIZOGONÆ (Gynandræ).

Fam. BURMANNIACEÆ.

Fam. ORCHIDACEÆ.

A. DIANDRÆ.

1. Apostasiinæ.

Gen. *Apostasia*, *Neuwiedia*.

2. Cypripedilinæ.

Gen. *Cypripedilum*, *Selenipedilum*, *Paphiopedilum*‡, *Uropedilum*? §.

B. MONANDRÆ.

(Including the remainder of the Orchideæ.)

In the present paper I have treated *Apostasiæ* as forming a distinct tribe of Orchideæ allied to *Cypripedieæ*, but differing

* Journ. of Bot. 1886, p. 355.

† Nat. Anordn. Orch. p. 95.

‡ Pfitzer, Morph. Stud. Orchideenbl. p. 11. This so-called genus is based on Reichenbach's section *Acaulia Coriifolia* of *Selenipedium* (Xen. Orch. i. p. 3), and the section *Coriaceæ* of *Cypripedium* (Benth. and Hook. f. Gen. Plant. iii. p. 634), the character relied on being the connivent leaves. It is a strictly artificial group, as there is nothing in floral structure to separate it; moreover, it contains species with a three-celled, and others with a one-celled ovary, beyond which there is nothing to keep these two genera, *Cypripedium* and *Selenipedium*, apart. The species of *Paphiopedilum* are tropical, and the difference in leaf-character is probably due to the evergreen habit, most of the other species being temperate and deciduous.

§ *Uropedilum* has already been shown to be simply a monster of *Selenipedium caudatum*, and not a genus. And surely in this, as in other cases above given, there is no sufficient reason for the (orthographical) change of name.

therefrom in several important points. These two tribes I have regarded as forming one diverging branch of the Order, not very far removed in structure from what may be considered the ancestral Orchideous prototype, and worthy to be looked upon as a distinct suborder,—*Diandra*. The other diverging branch comprises the remainder of the Order, the suborder *Monandra* more highly specialized than the *Diandra*, and divisible into several distinct tribes; too intimately connected, however, to be considered Suborders. Certain it is that there is no other gap anywhere in the Order of anything like such importance as that which separates *Monandra* from *Diandra*. Lastly, I do not think *Apostasiæ* can be maintained as even a Suborder (much less a distinct Order) apart from *Cypripediæ*. On the other hand, I think these two groups are too distinct to be merged together in a single homogeneous tribe, and far better regarded as forming two distinct tribes of the Suborder *Diandra*.

MORPHOLOGY.

General habit.—The species of *Apostasiæ* are terrestrial plants, from about one to three feet in height, generally growing in shady woods and thickets. They produce underground creeping rhizomes, shortly jointed, and clothed with numerous sheathing bracts. These appear to push out for some distance, and then throw up an erect leafy shoot, from near the base of which is produced a tuft of several thickish, hard, wiry roots. These stems in *Apostasia* are nearly, and in some cases over, a foot high, clothed with numerous, more or less recurved, narrow, grass-like leaves, and bearing at the apex a more or less spreading or recurved, simple or branched raceme of small yellow flowers. In *Neuwiedia* the leaf-bearing portion of the stem is generally shorter, and thus the tuft of leaves is formed near the ground. The leaves are fewer and larger, suberect, and somewhat like those of *Curculigo* or *Veratrum* in appearance. On reaching the flowering stage the stems lengthen above the leaves, sometimes but little, at others very considerably, the apex of the raceme of *N. Lindleyi* apparently being at least three feet from the ground. The flowering portion of the stem bears a number of much smaller leaves, which pass gradually into the bracts, the inflorescence itself being a strictly erect, spike-like, many-flowered raceme of medium-sized flowers, also yellow in colour.

The Stem.—In all the species the stem is erect and simple,

produced, as already remarked, from an underground creeping rhizome. Thus it is probably herbaceous and of annual duration, dying down after maturing the seeds.

Leaves.—The leaves differ somewhat in the two genera, but are remarkably uniform through the different species of each genus. In *Neuwiedia* they are narrowly or broadly lanceolate, varying from half a foot to about two feet long; few in number, suberect, and strongly plicate. In *Apostasia* they are narrowly lanceolate-linear, about half as long as in *Neuwiedia*, much more numerous, generally somewhat recurved, and less strongly plicate.

Inflorescence.—In *Neuwiedia* the inflorescence is an erect, spike-like, many-flowered raceme, varying from about three or four inches to occasionally over a foot in length, as in *N. Lindleyi*. In *Apostasia* it consists of a more or less recurved, subsessile raceme, occasionally simple, but more frequently branched, and measuring from two to about four inches in length, or as much as six inches when in fruit.

Bracts.—The bracts are lanceolate or subulate-linear, invariably acute; much shorter than the ovary in *Apostasia*, generally longer in *Neuwiedia*, in which genus they gradually pass, at the base of the racemes, into the reduced leaves of the flowering-stem.

Flowers.—The flowers are generally shortly pedicelled or subsessile, in the axils of the bracts, and apparently always yellow; very small in *Apostasia* (Pl. XLVIII. fig. 15), but larger in *Neuwiedia* (figs. 2, 3, and 10). The segments in *Apostasia* range from about $1\frac{1}{2}$ lines in the section *Adactylus* to about $2\frac{1}{2}$ lines in *A. Wallichii*, or, according to Blume, a little larger still in *A. odorata*, the other species of the section *Mesodactylus*. In *Neuwiedia* the same organs range from about 3 lines in *N. Griffithii* (figs. 2 to 6) to 6 lines in *N. Curtisii*, or even 9 lines in *N. Lindleyi* (fig. 10). They are more or less widely spreading in *Apostasia*, but subconnivent in *Neuwiedia* (fig. 3).

Ovary.—The ovary in *Neuwiedia* (figs. 2, 3, and 13) is ovoid-oblong, tapering into the short pedicel, narrowed above, strongly triquetrous and grooved down each face opposite the dissepiment, and from two lines long in *N. Griffithii* (figs. 2 and 3) to quite four lines in *N. Lindleyi*. In *Apostasia* (fig. 15) it is narrowly linear, less distinctly triquetrous, with more rounded angles, and measures from three to six lines long in the different species. In both genera it is trilocular, with three, polyspermous, axile placentas, running throughout the length of each cell. It is nearly

or quite glabrous in *Apostasia* (fig. 15) and *Neuwiedia Zollingeri*, but more or less puberulous in other species of the latter genus.

Perianth-segments.—The perianth-segments in both genera are lanceolate or lanceolate-linear, and more or less distinctly cuspidate (see numerous figures); in *Apostasia* (fig. 15), also in *Neuwiedia Zollingeri*, nearly or quite glabrous; but in other species of *Neuwiedia* (see figs. 2 and 3) the three outer segments, or sepals, as well as the central keel of the three inner ones (the only part exterior in the bud), are puberulous or shortly pubescent. In *Apostasia* the six segments are subsimilar and subequal, no real difference in the petals and no differentiation of the median one into a lip being perceptible. All the segments are strongly, but obtusely, keeled, and shortly cuspidate. In *Neuwiedia*, however, the petals are a little broader than the sepals, very slightly oblique, while the lip, in other respects similar to the petals, is a little broader, quite equal-sided, and with a slightly thickened, linear, fleshy keel inside, in addition to the outer one, both of course being simply thickenings of the central nerve (see figs. 4 to 6, also 10). The sepals are also keeled, perhaps not quite so strongly as are those of the inner segments, especially in *N. Griffithii* (fig. 4); and all the segments are shortly cuspidate. The margins of the petals and lip, which are interior in the bud, are glabrous.

Column.—The column, which is altogether homologous with that of other Orchids, is extremely short in *Apostasia* (figs. 18, 21, 23, and 28), and in *Neuwiedia Griffithii* (fig. 7), but half a line long and sometimes over in other species of the genus (see fig. 11). It is flattened from front to back, the angles being somewhat acute.

Stamens.—Three perfect stamens are present in *Neuwiedia* (figs. 7, 10, 11, and 13), but only two in *Apostasia* (figs. 17, 21, 23, and 28); the third one, homologous with the staminode of *Cypripedium*, is present in the section *Mesodactylus* as a barren filament-like organ, always more or less adnate to the back of the style (figs. 23 and 28), while in the section *Adactylus* it is entirely absent (figs. 17, 18, and 21). Two of these stamens are opposite the petals, being the lateral stamens of the inner staminal whorl (see fig. 1), while the third one is opposite the dorsal sepal, and is the median or dorsal stamen of the exterior staminal whorl (see fig. 1). The lateral stamens of the outer whorl and the median one of the inner whorl are entirely wanting, while in the

section *Adactylus* the whole outer series is altogether suppressed (figs. 18 and 21). The free portions of the filaments about equal the column in *Apostasia* (figs. 18, 21, 23, and 28) and in *Neuwiedia Griffithii* (fig. 7); but in other species of the latter genus they somewhat exceed it, sometimes reaching double this length (see fig. 11).

The anthers are linear or oblong in *Neuwiedia* (figs. 7 and 11), ovate or linear-oblong in *Apostasia* (figs. 19, 21, 24, &c.); in both genera the base being more or less distinctly cordate. In *Neuwiedia* the insertion of the filament is distinctly versatile (see fig. 11), also in the *Mesodactylus* section of *Apostasia* (see fig. 24), though, from the erect position of the anther, it is not so perceptible unless carefully examined. In the section *Adactylus*, however, the stamens appear to be truly basifixed (see figs. 19 and 21). In this section, too, the two cells are quite equal at the base, and narrowing upwards to an acute point; while in *Mesodactylus* (see fig. 24) one cell is distinctly longer than the other, making the anther unequal at the base. In this section the anthers are not so perceptibly narrowed above and the apex less acute. These differences are evidently correlated with the presence or absence of the staminode, and make the division of the genus into two sections a most marked and absolute character. In *A. stylidioides*, where the character was supposed to break down, I have shown, under that species, that this is not the case, the supposition arising from an error of observation (see fig. 28).

The anther-cells are quite parallel in *Neuwiedia* (see fig. 11), and nearly so in *Apostasia* (see figs. 19, 21, and 24), the difference alone arising from the shape of the anther in the latter genus, and more especially in the section *Adactylus* (figs. 19 and 21). The dehiscence is introrse by a pair of longitudinal grooves (see figs. 11, 19, and 24). In the section *Adactylus*, more especially in *A. Lobbian*, the anthers are strongly connate by their margins round the style (fig. 17); but I am not sure whether they remain so after the flowers open. Expanded flowers are wanting to settle this point.

Staminode.—The staminode is only present in *Apostasia*, section *Mesodactylus*. It is continuous with the back of the column, and adnate to the style except at the extreme apex. In *A. Wallichii* (fig. 23) it is distinctly broader below, the lateral angles acute, narrowing upwards to an acute point, the minute apex alone being free. Here it is shorter than the style. In *A. stylidioides*

it is a little narrower at the extreme base, and perhaps a little longer relatively to the style, but otherwise very similar (fig. 28).

Pollen.—The pollen-grains are ellipsoidal in shape, invariably simple, dry, and quite free from each other (figs. 14 and 25). Griffith speaks of that of *Apostasia* as grooved; but I was unable to satisfy myself on this point, although I examined *A. Wallichii* under a $\frac{1}{2}$ objective both dry and in water. Fig. 25 represents approximately the shape. The pollen of *Neuwiedia Curtisii* was examined in the same way (fig. 14), and beyond a slight tendency to be more acute at the ends, I could not observe much difference between the two.

Style and Stigma.—The free portion of the style is invariably slender, arising from the apex of the column between the filaments. In *Neuwiedia* it is slightly flattened laterally, distinctly grooved along the face, and terminated by a somewhat enlarged, rounded, but distinctly oblique and somewhat bilateral stigma (see fig. 11). In *Apostasia* the bilaterality is also distinctly marked (figs. 21 and 23); and although it is invariably described as very minutely three-lobed at the apex, I am inclined to think it bilobed, as in *Neuwiedia*. This is the result of my observations; but I have not had time to make sections of this minute organ to settle the point.

Capsule.—The capsule corresponds very closely to the characters given of the ovary. In *Neuwiedia Griffithii* it is strongly triquetrous-ovoid, strongly keeled along the back of the carpels, but grooved along the face opposite each dissepiment (fig. 8). The surface is strongly hispidulous. This is the only species of which I have seen mature capsules; but the somewhat immature ones of *N. Lindleyi* are more strongly triquetrous, longer, and nearly glabrous. In *Apostasia* the capsule is narrowly linear, subterete, with three strong rounded keels. The texture is stouter, the walls and dissepiments much stouter than in *Neuwiedia*—(see fig. 26). In both genera the capsule is narrowed above, and crowned with the remains of the withered perianth-segments; but in *Neuwiedia* it is more distinctly rostrate (fig. 8). It is three-celled, with axile placentas and numerous minute seeds (figs. 8 and 26).

Seeds.—The seeds are minute, with reticulated testa, corresponding in structure to those of the order generally. In *Neuwiedia Griffithii* they are narrowly oblong in shape, almost truncate at the ends, the roundish embryo, by reason of its darker

colour, showing very prominently through the thin testa (fig. 9). The reticulations of the testa are small and very numerous. In *Apostasia Wallichii* the shape is more nearly ellipsoidal, or rhomboid-ellipsoidal, the embryo apparently filling the entire testa, except a small narrow portion at the base, which is of a paler colour than the rest. The reticulations of the testa are also much fewer and larger (fig. 27). Other species of *Apostasia* seem substantially identical in this respect.

Fertilization.—Notwithstanding the comparatively simple structure as compared with other Orchids, and the dry simple pollen, the group is certainly entomophilous, both the genera showing decided adaptations for insect-fertilization. Whether they secrete nectar it is impossible, from dried specimens, to say; but, according to Wallich, *Apostasia* exhales a fragrant perfume. In *Neuwiedia* the segments are subconnivent (fig. 3), and therefore an insect must enter from the mouth of the flower. It would alight on the lip and, on crawling into the flower, its back would invariably come into contact with the three versatile anthers, and thus become dusted with the pollen. On subsequently visiting another flower it would as surely brush against the oblique slightly down-curved stigma and leave some of the pollen behind. In *Apostasia* the arrangement is quite different; the segments are spreading or recurved, and the anthers stand suberect in the centre of the flower. It seems equally certain that the genus is insect-fertilized, though in what way does not seem so clear as in the preceding case. The differences between the two sections of the genus seem to be in some way connected with the fertilization; though the use of the staminode seems an obscure point, unless it be to prevent the insect from alighting on that side of the flower towards the back of the anthers. This and other points yet remain to be settled—whether the anthers are mature before the stigma, whether any nectar is secreted, also some points of structural detail which I have found it impossible to determine from dried specimens or from the scanty materials at command. I regret that none of the species are in cultivation, a fact probably arising from their not being sufficiently showy for introduction as garden plants.

AFFINITIES.

This comparatively simple organization is highly instructive, and stands in the strongest contrast with that of so many of our

familiar garden Orchids. It is here that the affinities of the Orchideæ can best be traced, because here ancestral characters are less masked by later adaptations. In discussing the affinities of any group there is one very important point to be carefully borne in mind, viz. the necessity of distinguishing between truly ancestral characters (which alone afford evidences of consanguinity or real affinity) and adaptive or developmental characters (which may present strong analogies in groups very far separated by lineal descent).

Two extreme cases may be mentioned to illustrate this point. *Ranunculaceæ* presents a number of the strongest analogies with *Alismaceæ*, and yet the two groups might be traced backwards through their various ramifications to the point of divergence of the two great branches of the Angiospermeæ—Monocotyledones and Dicotyledones—before the point of contact was reached; and this alone represents the degree of affinity between the two. In the same way *Asclepiadeæ* and *Orchideæ* present certain similarities in their economy of fertilization, yet their affinities are equally remote. It is therefore clear that organisms, or groups of organisms, standing far apart by ties of consanguinity may yet tend to approach each other in their adaptive or developmental characters if placed for sufficiently long periods under substantially similar conditions. Thus adaptations for securing plants against long periods of drought take the form of succulence; or adaptations for securing the visits of insects frequently take the form of irregularity or unequal suppression or development of parts of the flower; both producing analogies of structure in very diverse groups, *i. e.* groups far separated by ties of consanguinity. These points are here emphasized because they have not been sufficiently recognized by some systematic botanists in discussing affinities, and until quite recently were scarcely recognized at all.

A difficulty may be here supposed to present itself, as to what are ancestral and what adaptive characters; but as the two have been shown to be so essentially distinct, it is sufficient to establish the general principle, premising, however, that, from the very nature of the case, no general rule can possibly ever be applied to it. Ancestral characters will sometimes be of one kind, sometimes of another, but always easily recognized as those extending with the greatest uniformity throughout a group and subject to the smallest amount of variability. Moreover, they are invariably most apparent in embryonic structures, becoming most masked

or obscured in those stages where the greatest amount of specialization is developed. Adaptive characters may (and do) become ancestral ones if sufficiently beneficial to give rise to a dominant group of organisms, the adaptive characters being handed down to all the descendants in common. But when once a group becomes dominant, and therefore widely diffused, some of its members invariably come under new conditions of environment; still newer adaptations arise; the group begins again to diverge in various directions; and the non-variable characters are now easily recognized as the ancestral ones.

We now proceed to apply these principles in discussing the affinities of the *Apostasieæ*, and by the aid of the two accompanying diagrams (figs. 1 and 2, page 224) to show their relationship with surrounding groups.

It is very probable that the ancestral Monocotyledonous prototype was an apocarpous plant of very simple structure, destitute of perianth, and probably more nearly allied to *Pandanaceæ* than to any other existing order—a conclusion based upon structural grounds and supported by palæontological evidence. Commencing from this common starting-point, the broad features of the evolution of existing Monocotyledones may be pretty closely traced; though the exact point of divergence of many of the branches from the primary Monocotyledonous stem, and from each other, is a point on which much difference of opinion exists, and the real affinities of a few Orders are not yet at all conclusively settled. At the base of the series occurs the *Nudifloræ*, a comparatively simple group which has not departed far in its essential characteristics from the primary Monocotyledonous type, and which, together with the *Apocarpæ* and the natural orders they comprise, probably represent diverging ramifications of the same early branch. From a point somewhere near the angle of divergence of the previous group may be traced another branch which afterwards separated into three ramifications, the *Glumales* on the one hand, the *Calycineæ* and *Coronarieæ* on the other. The passage between these groups, and their subsequent ramifications into Orders, is, for the most part, so gradual that it seems tolerably clear they had one common origin, afterwards diverging in various directions. Lastly may be mentioned the *Epigynæ*, though it is doubtful if this group had one common origin. The *Amaryllidæ* and Bromeliads at least appear to have arisen from the same branch which produced the *Liliaceæ*, and it seems probable

Fig. 1.

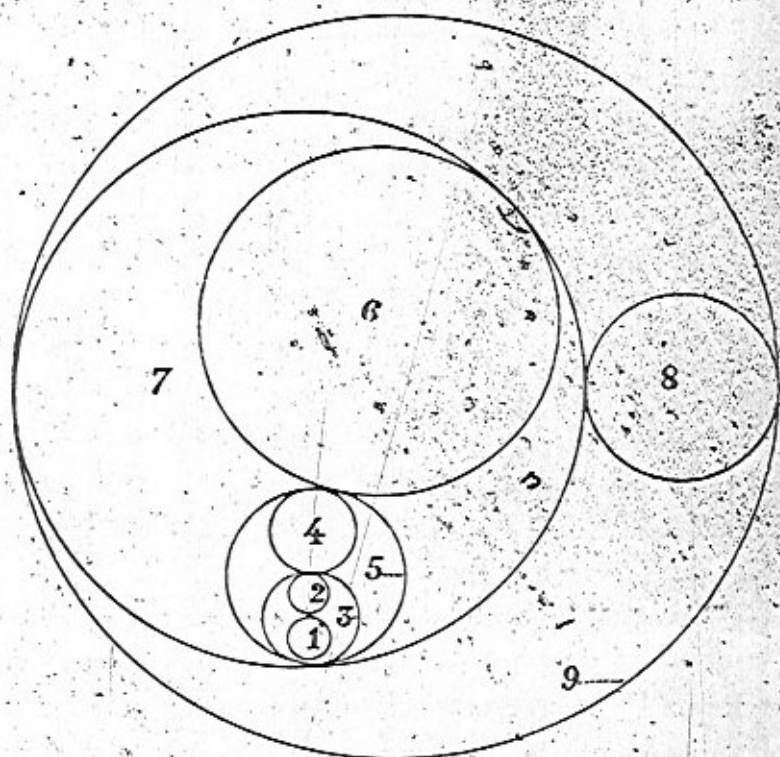


Diagram to show the affinities of *Apostasiæ* with surrounding groups.
(Plan.) Numbers as in Fig. 2.

Fig. 2.

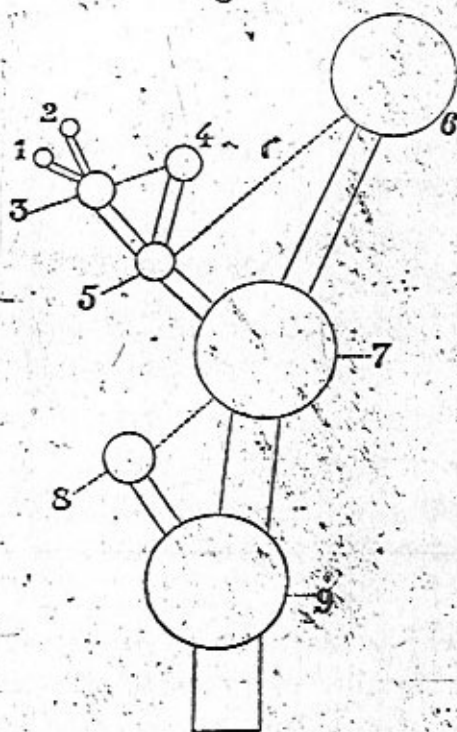


Diagram to show the affinities of *Apostasiæ* with surrounding groups.
(See also Fig. 1.)

1. *Neuwiedia*, 2. *Apostasia*, 3. *Apostasiæ*, 4. *Cypripediæ*, 5. *Diandra*,
6. *Monandra*, 7. *Orchidæ*, 8. *Burmanniaceæ*, and 9. *Arrhizogoneæ*.

that most of the epigynal alliance, arose from some point along the branch which produced the *Coronariæ*, and that, at some point of the Epigynal branch the *Arrhizogoneæ* (n. 9, figs. 1 and 2) were developed.

The *Arrhizogoneæ**, in which the culminating point of development of the Monocotyledones is reached, is separated from the remainder of the *Epigynæ* by the minute exalbuminous seeds, with reticulated testa and apparently homogeneous embryo. *Hydrocharidæ* has been artificially grouped together with the two Orders which the above group comprises, on account of its minute exalbuminous seeds; but in other respects it presents so many important differences, that it is tolerably certain its affinities are more remote.

The Arrhizogonal branch now bifurcates, giving rise, on the one hand to *Burmanniaceæ* (n. 8), on the other to *Orchidææ* (n. 7)—the former with the andrœcium quite regular, adnate to the perianth, and free from the gynœcium; the latter with the andrœcium highly irregular, adnate to the gynœcium but free from the perianth.

The Orchideous branch now bifurcates into *Diandriæ* (n. 5) and *Monandriæ* (n. 6)—the former with the two lateral stamens of the inner whorl perfect, the median stamen of the outer whorl either perfect or modified into a barren staminode, or occasionally quite absent, and the pollen-grains simple; the latter with the median stamen of the outer whorl alone developed, and the pollen-grains either united in tetrads; or still further aggregated in masses.

The Diandrous branch bifurcates into *Apostasiææ* (n. 3) and *Cypripediææ* (n. 4)—the former with the perianth nearly regular, the column very short, being equalled or exceeded by the free portions of the filaments, the anthers always distinctly elongated, generally versatile, the pollen dry, and the style very slender and much elongated; the latter with the perianth highly irregular, the column more elongated, the anthers very short and basifixed, the pollen-grains connected together by a viscid fluid exudation, and the style short and terminated by an enlarged stigma.

The *Apostasiææ* diverge into two genera, *Néuwiedia* (n. 1) and *Apostasia* (n. 2); the former with three perfect anthers, the

* Pfitzer, Nat. Anordn. Orch. p. 95.

latter with but two, together with other important differences pointed out elsewhere. *Neuwiedia* at once breaks up into about half a dozen species; but *Apostasia* first bifurcates into two marked sections:—*Mesodactylus*, with the third stamen represented as a narrow staminode, adnate to the back of the style, and the anthers versatile, with their bases unequal; and *Adactylus*, with the third stamen entirely suppressed, the anthers basifixed, with their bases quite equal. These groups then break up; the former into three, the latter into two (known) species. Notwithstanding the marked difference between the two sections of *Apostasia*, still in habit and general appearance they are so thoroughly identical, that I do not think it advisable to consider them as genera; though they are at least as distinct as some others so separated, and had each given rise to a large number of species, they might perhaps have been so distinguished. The one negative character correlated with the floral differences above mentioned is, that in both the known species of the section *Adactylus* the peduncle is a little elongated and covered with a series of lanceolate imbricating bracts, which are not present on the more sessile one of the other section.

Returning now to the *Apostasiæ*, the point in dispute with the different botanists who have treated of the group is not so much their characters (though some of these have been somewhat misunderstood), as the particular rank in the system of classification to which those characters entitle them. Those who treat the group as a distinct Order, at the same time uniting *Cypripediæ* with *Orchideæ*, take a view which, in my opinion, is wholly at variance with the structural peculiarities of the respective groups; while, on the other hand, to regard both as distinct Orders would at least render a similar subdivision of the *Monandriæ* necessary. In fact the difference between *Apostasiæ* and *Cypripediæ* is simply a developmental one, the latter group being a more highly specialized form, or development, of the same structural plan. Nor do I think *Diandriæ* and *Monandriæ* should be considered as more than distinct Suborders, for the amount of agreement between them is far closer than that between *Orchideæ* and *Burmanniaceæ*, the latter itself by no means a homogeneous group, though not so markedly subdivided as is the *Orchideæ* *.

* In *Burmanniaceæ* the perianth-segments are united at their bases into a tube, the upper part being free and divided into six segments. The inner whorl of three is generally smaller than the outer (or rarely quite suppressed), both

The *Diandra* and *Monandra* evidently represent the two great diverging branches along which the Order has been evolved, the more ancestral *Diandra* having developed but two marked tribes, while the highly specialized *Monandra* has multiplied enormously, and given rise to several well-marked tribes and a large number of genera; all connected together by a very strong thread of affinity, and many of them separated from each other by very slight differences.

With regard to the *Cypripediæ*, a very curious point presents itself. The genus *Selenipedium* has retained the ovarian characters of the more ancestral *Apostasiæ*, while *Cypripedium* has a unilocular ovary with parietal placentation as in the *Monandra*. This cannot of course be held to constitute any affinity with the *Monandra*, as *Cypripedium* clearly represents the culminating point of development of the *Diandra*. The trilocular ovary with axile placentation obviously represents the ancestral condition of the Order, and the development of a unilocular ovary with parietal placentation in each of the two diverging branches may possibly be an adaptation for saving room to accommodate the enormous number of seeds produced. In floral characters *Selenipedium* so clearly agrees with *Cypripedium*, that horticulturists generally treat the two as constituting a single genus, though from the above-named important difference, correlated with a few minor ones, I am convinced that *Selenipedium* should be regarded as a sufficiently distinct genus*.

Affinities with *Hypoxideæ* have been pointed out in the *Apostasiæ*; but these are nothing but developmental analogies, for

being regular, except that in the tribe *Corsiciæ* the median segment of the outer whorl (not the inner one, the lip, as in *Orchids*) is larger than the rest. The stamens are situated on the perianth-tube, six in number, both whorls being present, or the outer whorl suppressed in the tribe *Euburmanniæ*, when the stamens are but three, opposite the inner perianth-segments. The ovary is unilocular with parietal placentation, except in two genera of *Euburmanniæ*, where it is trilocular with axile placentation. In this respect the Order is in a transition state; for in some genera the placentæ intrude considerably, the ovary being three-celled at the extreme base, but only one-celled above. So that here a considerable range of variation is seen.

* There are other genera which, neglecting some constant and important character, are equally difficult to separate. For instance *Eria* and *Dendrobium*, the one with eight, the other with but four pollen-masses; also *Octomeria* and *Plectrothallis*, the one with eight, the other with but two, cannot be absolutely separated without reference to these highly important characters; yet every one considers these as good and sufficiently distinct genera.

the structure of the seeds is quite different. Even the supposed analogies are not very close; for the andrœcium in *Hypoxideæ* is regular. In fact this group so thoroughly agrees with *Amaryllidaceæ*, that it is clearly only a tribe of that order. The similarities in certain characters between *Orchideæ* and *Scitamineæ*, which have been pointed out as tending to justify the ordinal separation of *Apostasieæ*, are in a like manner simply developmental analogies; for the seeds are altogether different, and the line of ancestry of *Scitamineæ* would have to be traced back to the diverging-point of at least one or two other Orders before the point of contact or common ancestry with *Orchideæ* was reached. In short, the lines of bifurcation, if rightly interpreted, are as (in ideal) shown in the annexed diagram (fig. 2, p. 224, shown in plan in fig. 1), and all other affinities are necessarily more remote, and therefore outside the scope of the present paper. The exact point of contact of the *Arrhizogoneæ* with its parent branch, I believe, yet remains to be solved.

GEOGRAPHICAL DISTRIBUTION.

The (known) geographical distribution of the *Apostasieæ* is set forth in the following table; but I believe on this point very much yet remains to be done, and I can only hope that those

	India.	Ceylon.	Indo-Malaya.						New Guinea.	Queensland.
			Malacca.	Penang.	Java.	Sumatra.	Borneo.	Philippines.		
<i>Neuwiedia</i>										
<i>veratrifolia</i>	×	×	...	?	?		
<i>Lindleyi</i>	×	×	...	×	
<i>calanthoides</i>	×	...	×		
<i>Curtisii</i>	×	×	×	...	?		
<i>Zollingeri</i>	×	×	?		
<i>Griffithii</i>	×							
<i>Apostasia</i>										
§ <i>Mesodactylus</i>										
<i>odorata</i>	×	×	...	?	?		
<i>Wallichii</i>	×	×	...	×	?	×	
<i>stylidioides</i>	×		×
§ <i>Adactylus</i>										
<i>Lobbii</i>	×	×	...	×			
<i>nuda</i>	×	...	×	×	×	...	×			

who have the opportunity will turn their attention to it and collect more materials.

There are one or two points of interest about the distribution of the group, though in the present imperfect state of our knowledge they cannot be particularly emphasized. Thus, *Newwiedia* is not represented in India proper or in Ceylon, but only in Indo-Malaya, including the Peninsula, with a single species in New Guinea. Two species occur in the little island of Penang; and as two *Apostasias* also occur there, it is clear that this island has been better worked than many others. Again, *Newwiedia Lindleyi* being common to Penang and Borneo, and *N. Curtisii* to Penang and Sumatra, both should also occur elsewhere if looked for. The Philippine species of *Newwiedia*, also the *Apostasia* so marked, are reported in the "Novissima Appendix" of the third edition of Blanco's 'Flora de Filipinas,' but I have not seen specimens; and the species may not prove identical with the Java ones with which they have been identified. If correct, however, each is common to Java and the Philippines, and therefore should also occur elsewhere. *Apostasia Wallichii* occurs in Ceylon, in a limited district in India proper (*vide infra*), in Penang, and fully in Java, and apparently again in New Guinea; so that here also much yet remains to be done. *A. Lobbii* is only known from Borneo (here also another undetermined species occurs, *vide infra*); while *A. stylidioides* is interesting as occurring beyond the range of any other species of the group, namely in Tropical Australia.

ENUMERATION OF SPECIES.

Subordo I. DIANDRÆ*.—Stamina 2 vel 3, antheræ laterales semper perfectæ, anthera postica (in Subordine *Monandra* solum perfecta) sæpius sterilis, varie difformis, rarius perfecta lateralibus similis, rarissime omnino deficiens. Pollen semper simplex, siccum vel viscosum. Ovarium 3-loculare placentis axilibus, vel, in *Cypripedii*, 1-loculare placentis parietalibus.

* Although in *Newwiedia* three perfect stamens are present, it seems best to retain the old nomenclature, which represents at once one of the earliest and best characters for naturally subdividing the Orchideæ. The terms *Monandra* and *Diandra* appear to have been first used by Salisbury, in 1796, in his 'Prodromus Stirpium in horto ad Chapel Allerton vigentium,' though of course in a far more restricted sense than at the present time.

In the Suborder *Monandra* the median stamen of the outer whorl is alone normally perfect (though others are occasionally developed in monstrous flowers); and the pollen-grains are united together in tetrads, or variously aggregated in masses*. And correlated with this greater complexity in the staminal characters is very frequently a high degree of specialization in the other parts of the flower.

Tribus 1. APOSTASIEÆ, R. Br. in Wall. Pl. Asiat. Rar. i. (1830), p. 74. —Ovarium perfecte triloculare placentis axilibus. Perianthium subregulare. Columna brevissima. Antheræ breviter vel plus minus stipitatae, lineares vel angusti-oblongae; pollen siccum. Stylus plus minus elongatus.

In the remaining tribe, the *Cypripediæ*, the perianth is very irregular; the lateral sepals, with one solitary exception (*Cypripedium arietinum*, Ait.), being united into one body, which is thus placed exactly opposite the dorsal sepal; and behind the median petal or lip. This latter organ is modified into a pouch or slipper-like organ, quite different from the lateral petals, which again are always more or less dissimilar to the sepals. The column is more elongated and curved; the two perfect anthers globose, while the third is invariably transformed into a shield-shaped staminode, which partially closes the mouth of the lip. The pollen-grains are held together by a glutinous fluid exudation, which causes it to adhere to the bodies of insects, by which means it is carried from flower to flower. Lastly, the free portion of the style is very short, and terminated by the enlarged oblique stigma. The two genera agree in these respects; but while the Tropical American *Selenipedium* has retained the ovarian characters of the *Apostasiæ*, the remaining genus, *Cypripedium*, agrees with the *Monandra* in possessing a one-celled ovary with parietal placentation.

CONSPECTUS GENERUM.

Perianthium subconnivens. Stamina 3, omnia perfecta. Racemi erecti, simplices. Flores mediocres. . 1. *Neuwiedia*, Blume.

* To this *Cephalanthera* forms a solitary exception, having single pollen-grains; but as the genus is obviously a degraded representative of the *Neottieæ*, with which in every other respect it entirely corresponds, it cannot be held to invalidate the general correctness of the above classification.

Perianthium patens vel recurvum. Stamina 2 laterales solum perfecta, staminum posticum castratum vel omnino deficiens. Racemi patentes vel recurvi, sæpe ramosi. Flores parvi.

2. *Apostasia*, Blume.

1. NEUWIEDIA, *Blume*.

NEUWIEDIA, *Blume in Ann. Sc. Nat. sér. 2, ii. (1834), p. 93.*

—Perianthium subconnivens, segmentis subæqualibus. Sepala lanceolata. Petala extus carinata, cæterum sepalis similis. Labellum petalis paullo latius, cæterum simile. Columna brevis. Antheræ perfectæ 3, stipitatæ, angustæ, versatiles, loculis parallelis contiguis, 2 ad latera styli, tertium posticum; pollen granulosum. Stylus ad apice columnæ erectus, elongatus, apice in discum parvum antrorsum obliquum stigmatosum dilatatum. Ovarium perfecte 3-loculare. Capsula ovoideo-triquetra, breviter rostrata.—Herbæ terrestres rhizomati brevi, caule erecto simplici foliato. Folia longa in petiolum contracta, venis elevatis percursa. Racemus terminalis, densus, simplex, sæpe elongatus. Flores mediocres, breviter pedicellati. Bractæ angustæ, flores interdum superantes.—*Blume in Hœv. et De Vr. Tijdschr. i. (1834), 140**; *Schnizl. Iconogr. i. t. 67. figs. 15-18*; *Benth. in Journ. Linn. Soc. xviii. 360*; *Benth. & Hook. f. Gen. Plant. iii. 635.*

Species 6, ranging from Penang and Malacca through the Malayan Archipelago to the Philippines and New Guinea.

1. N. VERATRIFOLIA, *Blume in Ann. Sc. Nat. sér. 2, ii. (1834), 94.*—"Planta caule simplici inferne radicante, omnino habitus ejusdem ac quædam *Calanthe*, foliis lato-lanceolatis nervoso plicatis, racemo terminali puberulenti, floribus breviter pedicellatis unibracteatis flavescentibus."—*Blume*. "Racemo elongato sparsifloro, bracteis herbaceis acutis, ovariis fusiformibus velutinis, labello ligulato per axin linea carnosio carinato."—*Reichb. f.*—*Blume in Hœv. et De Vr. Tijdschr. i. (1834), 142*; *Reichb. f. in Bonpl. v. 58*; *Miq. Fl. Ind. Bat. iii. 748.*

Hab. Java: "in sylvis montorum altiorum Javæ occidentalis, licet rarissime; ego certe semel tantum mense Julio plantam

* The paper here cited is the same as the one at the head of the genus. Both appeared in the same year, but I am not certain which of them has priority. The same remark also applies to *N. veratrifolia*, Blume.

florentem et alteram eodem tempore fructiferam indagavi" (*Blume*).

This, the original species of the genus, I have not seen; and have therefore reproduced *Blume's* short description, adding also that of *Prof. Reichenbach*, who has seen *Blume's* specimen.

2. *N. LINDLEYI*, n. sp.—Folia anguste lanceolata, acuminata, petiolata. Scapus bipedalis v. altior. Racemus elongatus, puberulis, multiflorus. Bracteæ anguste lanceolatæ, puberulæ. Ovarium puberulum, triquetro-oblongum. Sepala lineari-lanceolata, minute puberula, cum petalis et labellum cuspidatis. Petala sublatis, extus carinata. Labellum petalis subsimile, callo medio lineare paullo incrassato. Filamenta ultra dimidium libera. Capsula ovoideo-oblonga, triquetra, subglabra.

Hab. Borneo; *Low!* Island of Penang; *Curtis*, n. 469!

A tall plant, reaching to 3 or 3½ feet high. Leaves 1-2 feet long by 1½-2 in. broad. Racemes 10-15 in. long, with numerous flowers. Bracts ¾-2½ in. long by 1½-3 lin. broad. Pedicels 1-2 lin. long. Ovary 4-5 lin. long. Segments 7-9 lin. long. Column 1 lin., free portion of filaments 1½ lin. long, anthers 3½ lin. long. Free portion of style 3 lin. long. Capsule ½ in. long.

Evidently allied to the preceding, but with narrower leaves, less pubescence, and other differences. *Lindley* appears to have considered it identical with *N. Zollingeri*, but, as I think, quite wrongly. Likewise *Reichenbach*, who (*Bonpl.* v. p. 58) remarks:—"In herbario *Lindleyano* adest planta quæ omnino *N. Zollingeri* bene evoluta. Inflorescentia prope *Cæliæ macrostachyæ* seu *Calanthidis* ejusdam. Ovarium abrupte turbinatum; apice recurrens in rostrum. Sepala linearia, elongata (ovario incluso callo longiora) apicibus apiculata, apiculis in carinulis exeuntibus. Tepala subbrevia. Labellum prope ejusdem rationis, convexum, pagina inferiori carinatum.—Sepala oblique inserta. Stylus apice retusus; filamenta lateralibus extus decurrentia. Antheræ lineares apice obtuse acutæ basi cordatæ; versatiles. Borneo, *Lowe*." But the sheet referred to in *Lindley's* Herbarium contains a single specimen of *N. Zollingeri*, *Reichb. f.* (collected by *Zollinger* himself, in Java), and an enlarged drawing of a single flower, labelled by *Lindley* himself—"Borneo, *Lowe*, in *Hb. Hooker*." This drawing, so fully described by *Reichenbach*, is from the very specimen

now described by me as *N. Lindleyi*, a quite distinct plant from *N. Zollingeri*, Reichb. f., as remarks under that species will show. The Penang plant seems identical in every respect with the Bornean one; and being in much more perfect condition, I have made use of it in drawing up the description wherever the other was insufficient.

3. *N. CALANTHOIDES*, Ridley! in *Brit. Journ. of Bot.* 1886, 355, t. 271.—Folia anguste lineari-lanceolata, acuminata, petiolata. Scapus pubescens, vaginis dissitis tectus, validulus, bipedalis. Racemus multiflorus, comosus. Bractee virides, pubescentes. Flores majores, carnosuli, ochraceo-flavi. Ovarium pubescens, breviter rostratum. Sepala angusta, lanceolato-linearia, pubescentia. Petala latiora, lanceolata, extus carina depressa pubescente, cum sepalis cuspidata. Labellum angustum, lanceolatum, medio incrassato subtus pubescente, marginibus tenuibus glabris. Antherae angustae, lineares, brunneae. Filamenta complanata, ultra dimidio libera. Stylus cylindricus, filiformis, versus apicem attenuatus, antheris brevior. Stigma parvum, rotundatum.

Hab. New Guinea; Mt. Meroka, at 2000 feet elevation, under shade; flowers yellow; *H. O. Forbes*, n. 777!

A little smaller than the preceding. Leaves 2 ft. long by $1\frac{1}{2}$ in. broad. Racemes 8 in. or more long. Bracts, the lower ones $1\frac{1}{2}$ in. long, decreasing upwards. Sepals $\frac{1}{2}$ in. long, petals and lip a little broader than sepals. Ovary $\frac{1}{2}$ in. long.

I have seen the type specimen in the British Museum; but the description is, for the most part, drawn up from that of Mr. Ridley. The flowers are a little smaller than in *N. Lindleyi*, also more pubescent, and the leaves a little narrower.

4. *N. CURTISII*, n. sp.—Folia lanceolata, acuminata, petiolata. Scapus brevis. Racemus brevis, multiflorus, pubescens. Bractee anguste lanceolatae, pubescentes. Ovarium pubescens, triquetrum, ovoideum. Sepala lineari-lanceolata, pubescens, cum petalis et labellum cuspidatis. Petala paullo latiora, extus carinata. Labellum petalis subsimile, callo medio lineare paullo incrassato.

Hab. Sumatra; *Curtis*, n. 55! Island of Penang; West Hill, at 2000-ft. elevation; *Curtis*, n. 1185!

Leaves 8-18 in. long by $1\frac{1}{2}$ - $2\frac{3}{4}$ in. broad. Scape much shorter than the leaves. Racemes 4-5 in. long. Bracts 9-12 lin. long by $1\frac{1}{2}$ - $2\frac{3}{4}$ lin. broad. Pedicels 2 lin. long. Ovary $2\frac{1}{2}$ lin. long. Segments 5-6 lin. long. Column and free portion of filaments each about 1 lin. long. Style 2 lin. long.

The leaves are broader and the racemes shorter than in any of the preceding species, while the pubescence is also very marked. The Penang plant seems quite identical with the Sumatran one. In this latter two or three of the flowers I have examined are monstrous, while others are in the normal condition. In one the two lateral sepals and the lip occur in their normal position, the dorsal sepal and the two petals being carried at least a line higher by a pedicel-like growth formed of their united bases together with the column. After elongating for another line the style becomes free, while the filaments remain further united for over half a line more, when they branch in the ordinary way, the central filament being, as usual, a little longer than the lateral ones. This condition is represented on Pl. XLVIII. fig. 13. It appears to result from a remarkable lengthening of the floral axis. All the organs appear to be quite perfect. In a second flower, however, the petals are united to the lateral sepals, while the filaments are wholly connate. In other respects the flower is unaltered.

5. N. ZOLLINGERI, *Reichb. f.!* in *Seem. Bonpl.* v. (1857), 58.—Folia lanceolata, acuminata, petiolata. Scapus brevis. Racemus brevis, multiflorus, minutissime puberulis. Bracteæ angustæ lanceolatæ, subglabræ. Ovarium glabrum, triquetrum, ovoideum. Sepala lineari-lanceolata, subglabra, cum petalis et labellum cuspidatis. Petala paullo latiora, extus carinata. Labellum petalis subsimile, callo medio lineare paullo incrassato.—*Reichb. f. Xen. Orch.* ii. 13, t. 106.

Hab.—Java; Mt. Idjeng, 2000-4000 ft. alt., in bambusetis; *Zollinger*, n. 2808!

Leaves 8-18 in. long by $1\frac{1}{2}$ - $2\frac{1}{2}$ in. broad. Scapes much shorter than the leaves. Racemes 4-6 in. long. Bracts 6-12 lin. long by 1-2 lin. broad. Ovary 2 lin. long. Sepals 4-5 lin. long. Filaments $1\frac{1}{2}$ lin. long; anthers 2 lin. long. Style a little exceeding the stamens.

Readily distinguished from all the preceding species by its nearly, if not quite, glabrous ovary, sepals, and bracts. *N. Lind-*

leyi, with which it has been confounded, is quite distinct, as pointed out under that species. The only specimen of *N. Zollingeri* I have seen is in Lindley's Herbarium, the lower flowers of the raceme only being expanded.

6. *N. GRIFFITHII*, Reichb. f. ! *Xen. Orch.* ii. (1874); 215.—
Folia lanceolata, acuminata, petiolata. Scapus brevis. Racemus brevis, multiflorus, hispidus. Bracteæ anguste lanceolatae, hispidopubescentes. Ovarium hispidum, triquetrum, ovoideum. Sepala lanceolata, hispidopubescentes, cum petalis et labellum breviter cuspidatis. Petala subsimiles, extus carinata. Labellum petalis subsimile, callo medio lineare paullo incrassato. Filamenta brevis; antheræ oblongæ. Capsula triquetro-ovoidea, rostrata; hispida.

Hab. Malacca; *Griffith! Maingay*, n. 1682!

Leaves 4–10 in. long by 1–1½ in. broad. Scapes shorter than the leaves. Racemes 3–4 in. long. Bracts 6–9 lin. long by 1 lin. broad. Ovary 2 lin. long. Sepals 3 lin. long. Filaments shorter than column; anthers 1 lin. long. Style exceeding anthers. Capsule, including the beak, 4 lin. long.

Much smaller in all its parts than any other species; also readily distinguished by the very hispid pubescence. This is the only species of which I have seen quite mature capsules.

Doubtful Species.

F. Villar, in *Blanco, Fl. Filip.* ed. 3, *Nov. App.* 251, enumerates the following:—

N. veratrifolia, Blume, from San Mateo, Island of Luzon.

N. Zollingeri, Reichb. f., from the same locality.

These determinations may be correct; but as I have not seen specimens, and as these species with the above exceptions have only been recorded from Java, I prefer to consider the determinations as requiring confirmation. I should feel extremely obliged to any one who would forward specimens, not only from this locality, but also from any other. A good series of the genus is much wanted, for, with the exception of the last species, the material is not sufficient for complete description. The best characters for determination of the species appear to rest in the relative size of the flowers, the nature of the pubescence, and, I am inclined to think, in the character of the mature capsule.

In the leaves and general habit there is a considerable amount of uniformity between the species.

2. APOSTASIA, Blume.

APOSTASIA, *Blume, Bijdr.* (1825). 423, t. 1. fig. 5.—Perianthii segmenta consimilia, æqualia, libera, patentia v. recurva. Columna brevis. Antheræ perfectæ 2, ad latera styli brevissime stipitatae, erectæ, versatiles v. basifixæ, angustæ, loculis subparallelis contiguis; pollen granulosum. Stylus ad apicem columnæ erectum, elongatum, apice in discum parvum stigmatosum integrum v. 3-dentatum dilatatum. Ovarium perfecte 3-loculare. Capsula anguste linearis.—Herbæ terrestres rhizomate brevi, caule erecto simplici undique foliato. Folia angusta, venis prominentibus percursa. Racemi in apice caulis sessiles, simplices vel ramosæ, sæpissimæ patentēs vel recurvæ. Flores parvi, brevissime pedicellati. Bractæ angustæ, acutæ.—*R. Br. in Wall. Pl. Asiat. Rar.* i. 74; *Bauer, Ill. Orch. Pl., Fruct.* t. 15; *Schnizl. Iconogr.* i. t. 67. figs. 1-14; *Griff. Notul.* iii. 243; *Icones*, t. 282; *Blume in Ann. Sc. Nat.* sér. 2, ii. 93; *Endl. Gen. Pl.* i. 221; *Benth. in Journ. Linn. Soc.* xviii. 360; *Benth. & Hook. f. Gen. Pl.* iii. 635. *Niemeyera, F. Muell. Fragm. Phyt. Austral.* vi. (1867-8), 96. Species 5 or 6, ranging from subtropical India, at low elevations, to Ceylon, and through the Malayan Archipelago to the Philippines and Tropical Australia.

Sect. 1. MESODACTYLUS, *Wall. ex Endl. Gen. Plant.* i. 221.—Staminis tertii filamentum anantherum. Antheræ versatiles; antherarum loculi basi inæquales.

1. A. ODORATA, *Blume, Bijdr.* (1825), 423, t. 1. fig. 5.—“Foliis lineari-lanceolatis, racemis, deflexis antherarum loculis basi inæqualibus, filamentis tertio castrato.”—*Blume in Ann. Sc. Nat.* sér. 2, ii. 93; *id. in Hœv. et De Vr. Tijdschr.* i. 139; *Miq. Fl. Ind. Bat.* iii. 748.

Hab. Java; in sylvis primævis montis Salak; *Blume.*

This, the original species of the genus, I have not seen, and have therefore reproduced Blume's very short description. It has, however, larger flowers than *A. Wallichii*, *R. Br.*, for in the *Ann. Sc. Nat.*, above cited, Blume under that species remarks:—“Iterata *A. odorata* inspectis me docuit, antherarum structuram esse eandem atque in *A. Wallichii*, *R. Br.* Facile autem

ambæ interse dignoscuntur indicata foliaturæ diversitate: hujus etiam flores sunt minores ac filamenta breviora, quam in specie priore."

2. *A. WALLICHII*, *R. Br. in Wall. Pl. Asiat. Rar.* i. (1830), 75, t. 84 ("*A. odorata*", on plate).—Folia ensiformi-lanceolata in acumen gracillimum attenuata, recurvato-patentia. Racemus ramosus, decurvato-nutantis, multifloris. Flores parvi, flavi, admodum fragrantés. Bracteæ lanceolatae, subcarinatae. Perianthii segmenta lanceolato-lineares, cuspidata, subsimilia, apice patentia. Filamenta brevissima; antheræ oblongæ, basi inæquales. Staminodium styli supra medium adnatum. Stylus staminodio longior.—*Blume in Ann. Sc. Nat. sér. 2*, ii. 93; *Miq. Fl. Ind. Bat.* iii. 748; *Wall. Cat. n.* 4448; *Thwaites, Enum. Ceyl. Pl.* 315.

Mesodactylus deflexa, *Wall. ex R. Br. in Wall. Pl. Asiat. Rar.* i. (1830), 74, in nota.

Hab. India; in valle Nāpalicæ minore Noakote; *Wallich!* Assam; *Griffith*, n. 5603! Khasia Mts., in the tropical region; *Hooker & Thomson*, n. 2398! Penang, at 2500 ft. elevation; *Curtis*, n. 925! Ceylon, banks of streams in the Saffragan district, at no great elevation; *Thwaites*, n. 2744! N. Guinea, in the south-eastern district; *Rev. J. Chalmers!*—Blume also mentions a fruiting specimen from New Guinea, and a specimen from Java without flowers.

Plant 1–2 ft. high. Leaves 6–10 in. long by 3–5 lin. broad. Racemes 2–3 in. long, somewhat longer in fruit. Ovary 6–8 lin. long. Perianth-segments $2\frac{1}{2}$ lin. long. Capsules 1 in. long.

Distinguished from the preceding, according to Blume, by the smaller flowers. The New-Guinea plant cited is in the British Museum. The leaves are a little narrower than usual, still it appears to belong to the same species. The Javan locality requires confirmation.

3. *A. STYLIDIOIDES*, *Reichb. f. in Flora*, v. (1872), 278, in nota.—Planta humilis. Folia lanceolato-linearia, acuminata, suberectis. Racemus ramosus, laxiflorus. Bracteæ lanceolati-triangulares, acutæ. Perianthii segmenta lanceolato-linearia, cuspidata. Filamenta brevis; antheræ basi inæquales. Staminodium fere omnino adnatum.—*Reichb. f. Xen. Orch.* ii. 215, t. 196. fig. 1; *Benth. Fl. Austral.* vi. 396.

Nieymera stylidioides, *F. Muell. Fragm. Phyt. Austral.* vi. (1867-8), 96.

Hab. N.E. Australia: Rockingham Bay; *F. Mueller!*

Plant 6-8 in. high. Leaves 3-6 in. long by $1\frac{1}{2}$ -3 lin. broad. Racemes 1-2 in. long. Bracts 1-2 lin. long. Ovary 4 lin. long, elongating somewhat in fruit. Perianth-segments $1\frac{1}{2}$ lin. long.

A much smaller plant than the preceding, with shorter and narrower leaves and smaller and narrower perianth-segments.

Both Reichenbach and Bentham, while describing the anther-bases as unequal, say that the staminode is absent, the former also so figuring it. Bentham, however, while saying that it agrees with *A. nuda* in the absence of the barren stamen, adds, "except that in some flowers I find the style abortive, or nearly so, and replaced, as it were, by a staminode." My observations, however, do not agree with those of these two authors, and, as all worked with the same materials, there should be no discrepancy on this point. I have very carefully examined four flowers, one, at least, having probably been examined by Bentham, as it was placed in a small capsule. In all four the staminode was undoubtedly present, but almost entirely adnate to the style, and hence perhaps previously overlooked. The apex, however, is free, or like a minute tooth, and down either side between the staminode and the style is a most distinct groove; while at the base the insertion of the staminode is precisely as in *A. Wallichii*, R. Br. (see Pl. XLVIII. fig. 23). Nor did I observe any difference in the flowers examined, all seemed quite normal, and unmistakably those of the section *Mesodactylus*.

Sect. 2. *ADACTYLUS*, *Endl. Gen. Plant.* i. 221.—*Staminis tertii vestigium nullum. Antheræ basifixæ; antherarum loculi basi æquales.*

4. *A. LOBBII*, *Reichb. f. in Flora*, lv. (1872), 278.—*Folia linearilanceolata, acuminata, subpatentia. Racemus breve pedunculatus, basi multibracteatus, ramosus, recurvo-nutantis. Bractæ subulato-lineares, acutæ. Ovarium sessile. Perianthii segmenta linearis, cuspidata. Filamenta brevia; antheræ sagittato-lineares, acutæ, vulgo coherentiæ.*

Hab. Borneo; *Lobb (ex Reichb. f.)*; Forests of Labuan; *Lobb (in Herb. Kew)!* Bangarmassing, Borneo; *Motley*, n. 840!

Plant $1\frac{1}{2}$ ft. high. Racemes 2 in. long, elongating in fruit.

Ovary 4 lin. long. Perianth-segments $1\frac{1}{2}$ lin. long. Capsule $\frac{3}{4}$ in. long.

Readily distinguished from the following species by its broader leaves and more robust habit, also by the more linear perianth-segments and narrower anthers. The ovary is more sessile than in any other species.

5. *A. NUDA*, R. Br. in Wall. Pl. Asiat. Rar. i. (1830), 76, t. 85.—Folia erecto-patentia, linearia, attenuato-acuminata. Racemus breve pedunculatus, recurvato-patentis, basi multibracteatus. Bracteæ lineari-lanceolatae, acuminatae. Flores minimi, flavi. Perianthii segmenta lanceolata, breve cuspidata. Filamenta breviora; antheræ lineari-subcordatae, acutae.—Blume in Ann. Sc. Nat. sér. 2, ii. 93; Miq. Fl. Ind. Bat. iii. 748; Wall. Cat. n. 4449.

A. Brunonis, Griff.! Notul. iii. (1851), 243; Icones, t. 282.

Hab. India; in montosis Penang; Wallich! Khasia Mts., in the tropical region, Hooker & Thomson! Chittagong, below 1000 ft. elevation, Hooker & Thomson, n. 444! Mergui; Griffith, n. 5604! Malacca, Maingay, n. 1680! Singapore, Lobb! Without locality, Falconer!

Plant 2–3 ft. high. Racemes 2 in. long, elongating in fruit. Ovary 4 lin. long. Perianth-segments $1\frac{1}{4}$ lin. long. Capsule $\frac{1}{2}$ in. long.

A more slender plant than the preceding, with narrower leaves, more lanceolate perianth-segments, and broader anthers. In fruit it may be readily distinguished from *A. Wallichii*, R. Br., by the narrower leaves, and racemes with numerous imbricating bracts at the base.

Doubtful Species.

F. Villar, in Blanco, Fl. Filip. ed. 3, Nov. App. p. 251, enumerates:—

A. odorata, Blume, from San Mateo, Island of Luzon; but as I have seen no specimen, and as the species is otherwise only recorded from Java, I prefer to consider the determination as requiring confirmation.

A., sp.—A plant in the Kew Herbarium, from "Deep shady jungle, Labuan, Motley, n. 95," very closely resembles *A. stylioides*, Reichb. f., in general appearance, though I believe it to be a distinct species. It is, however, just passing out of flower, and much too imperfect for description. The material is not sufficient to show even to which section it belongs.

A good series, especially of flowering specimens, of this genus is much wanted, many of those which I have seen being very imperfect in this respect. Of all the specimens of *A. Wallichii* cited only one bears examinable flowers. I should be extremely obliged to any one who would send specimens, especially from localities not here enumerated, for it is clear that the range of the species is at present very imperfectly known.

DESCRIPTION OF PLATE XLVIII.

- Fig. 1. Diagram showing the arrangement of the flower in *Apostasia*.
 2. A bud of *Neuwiedia Griffithii*, Reichb. f., $\times 2$ diam.
 3. Expanded flower
 4. Lateral sepal
 5. Petal
 6. Lip
 7. Column, with stamens and style,
 8. Capsule, and in section,
 9. Seed of same, highly magnified. } of same, $\times 2$ diam.
 10. Flower of *N. Lindleyi*, Rolfe, all the segments, except the dorsal sepal, being thrown back to show the position of the stamens and style, $\times 2$ diam.
 11. Column with stamens and style of same, the anther on the right bent down to show its versatile insertion, $\times 3$ diam.
 12. Section of ovary of same, showing axile placentation, $\times 3$ diam.
 13. Monstrous flower of *N. Curtisii*, Rolfe (fully described on page 234), showing abnormal elongation of the floral axis, the parts being carried up out of their normal position, $\times 2$ diam. Note the union of the filaments, the darker central nerves, and the insertion of the style, which is only an exaggerated development of their normal arrangement.
 14. Pollen of same, highly magnified.
 15. Bud of *Apostasia Lobbii*, Reichb. f., $\times 2$ diam.
 16. Segment
 17. Column with stamens (back view) and style
 18. Ditto (side view, one stamen removed)
 19. Stamen (front view), showing introrse dehiscence,
 20. Segment of *A. nuda*, R. Br., $\times 4$ diam. } of same, $\times 4$ diam.
 21. Column with stamens (back view on right hand, front view on left) and style of same, showing the equal basifixed anthers, as in *A. Lobbii*, $\times 4$ diam.
 22. Segment of *A. Wallichii*, R. Br., $\times 4$ diam.
 23. Column with stamens (back view) and style of same, showing the staminode adnate to the back of the style, $\times 4$ diam.
 24. A stamen of same removed (front view), showing the versatile arrangement, the unequal base of the anther, and the longitudinal dehiscence, $\times 4$ diam.

Fig. 25. Pollen of same, highly magnified.

26. Capsule, with section, of same, the former $\times 2$, the latter 4 diam.

27. Seed of same, highly magnified.

28. Column, with staminode, style, and anthers, of *A. stylidioides*, Reichb.f., showing that it really belongs to the section *Mesodactylus* (see remarks on page 238), $\times 4$ diam.

SUPPLEMENTARY NOTE.

Since the foregoing was written some additional materials have come into my hands, which it seems desirable to append as a supplementary note. These are:—(1) specimens received at Kew in the ordinary way, and (2) Blume's types of the two genera *Neuwiedia* and *Apostasia*, together with other specimens for determination, kindly lent by the authorities of the Botanic Garden at Leyden. These are distinguished by the words "*Hb. Kew.*," or "*Hb. Lugd. Batav.*," respectively.

1. *NEUWIEDIA VERATRIFOLIA*, Blume.—The type specimen received is in fruit, and has the raceme a little more compact than in *N. Lindleyi*, Rolfe, the bracts proportionately broader, and the young fruits are more pubescent. A second specimen has two or three narrower bracts, but no flowers, the upper portion of the raceme being missing. An erect portion of the rhizome, six inches long and supported by stout aerial roots, has the nodes half an inch distant, each marked by a very prominent annular scar. The two species are not strictly comparable without better material of the former; but I should not be surprised if *N. Lindleyi* yet proves specifically identical with Blume's plant.

2. *N. LINDLEYI*, Rolfe.—(Probably; there being no flowers.) Borneo; Coll. —? *Hb. Lugd. Batav.*

4. *N. CURTISII*, Rolfe.—A specimen in young fruit. Sumatra; Coll. —? *Hb. Lugd. Batav.*

6. *N. GRIFFITHII*, Reichb. f.—Perak, in dense old jungle at 400 to 600 feet elevation, "rare, flower very white, hanging downwards, bell-shaped;" King, n. 10128. *Hb. Kew.*

1. *APOSTASIA ODORATA*, Blume.—The type specimen is a little over a foot high, the leaves 3-5 in. long by 4-5 lin. broad, the

raceme unbranched, and the segments 3-3½ lin. long. The short lanceolate leaves readily distinguish it.

2. *A. WALLICHII*, *R. Br.*—Perak, in dense bamboo-forest, at 400-600 ft. elevation; *King*, n. 10629; *Scortechini*, n. 714. *Hb. Kew.* Sumatra, *Prætorius*. *Hb. Lugd. Batav.*

3 *a.* *A. (§ MESODACTYLUS) GRACILIS*, *Rolfe*, n. sp.—Planta 6-9 poll. alta. Folia linearia, attenuata, 3-6 poll. longa, 2-3 lin. lata. Racemus ramosus, diffusus, 2-2½ poll. longus. Bracteæ lanceolatae, acutæ, 1½-2 lin. longæ. Ovarium 6-7 lin. longum. Perianthii segmenta angustissima, 1½-2 poll. longa. Antheræ lineares, obliquæ, basi inæqualibus. Staminodium ut in sectione.

Hab. Borneo; Coll. —? *Herb. Lugd. Batav.*

Differs from *A. styliidioides*, Reichb. f., of which it has much of the general appearance, in its more diffuse panicle, with more slender branches, its more slender ovaries and narrower segments. The stamens, staminode, and style are very similar in the two species.

Motley's Bornean specimens, mentioned at p. 239 as probably belonging to an undescribed species (which I have since discovered in his MSS. to have flowers "white"), is remarkably similar in general appearance; but as the fruits are only two thirds as long as the undeveloped ovaries of *A. gracilis*, I hardly think they can belong to the same species.

4. *A. LOBBII*, *Reichb. f.*—Borneo; Coll. —? *Hb. Lugd. Batav.*

5. *A. NUDA*, *R. Br.*—Perak; *Wray*, n. 1114, "flowers white;" also n. 866. Malacca, top of Mt. Ophir; *Hullett*, n. 866. *Hb. Kew.* Sumatra; *Korthals*; *Prætorius*. Java; Coll. —? *Hb. Lugd. Batav.* Wray's specimen, marked "flower white," seems quite identical with yellow-flowered ones in other respects.

6. *A. (§ ADACTYLUS) LATIFOLIA*, *Rolfe*, n. sp.—Planta 1½-3 ped. alta. Folia lanceolata, acuta, petiolata, 3-6 poll. longa, 1 poll. lata. Racemi ramosi, nutantes, 3-5 poll. longi. Bracteæ subulato-lanceolatae, subcarinatae, 2 lin. longæ. Ovarium sessile, angustum, 3 lin. longum. Perianthii segmenta lineari-oblonga, cuspidata, 1 lin. longa. Antheræ lineari-cordatae, obtusæ, basi æqualibus. Staminodium nullum. Stylus gracilis, antheras æqualis. Fructus 6 lin. longus.

Hab. Perak, at Ulu Batang Padang; *Wray*, n. 1605; *Scortechini*, n. 868. *Hb. Kew.*

A most distinct species. The leaves are much broader than in any other, also fewer and more distant, while the bracts at the base of the inflorescence are not so distinctly developed. *Wray* notes the plant as "3 ft. high," but his specimen (with roots attached) is but little over half this height. His specimen is in fruit only, but *Scortechini's* has both flowers and fruit.

On *Boodlea*, a new Genus of Siphonocladaceæ.

By GEORGE MURRAY, F.L.S.

[Read 21st February, 1889.]

(PLATE XLIX.)

A FEW weeks ago Dr. G. B. De Toni, on receiving a paper on *Struvea* recently published by Mr. Boodle and myself ('Annals of Botany,' vol. ii.), suggested to me in a letter that a species of *Cladophora* collected by the 'Challenger' Expedition on the coast of Japan, and described in our Journal (vol. xv. p. 451) by Professor Dickie as a new species, viz. *C. coacta*, Dickie, would be worth examination, since, so far as he could judge from the reference to "anastomosing filaments" in the description, it appeared to be a *Struvea*. The type is in the British Museum—both Prof. Dickie's own specimens and the distributed 'Challenger' series. It was therefore hardly likely that it could have escaped us in our recent work at the genus; but the allusion to its "anastomosing" filaments certainly excited curiosity. The specimens had not been long under examination when it appeared that the so-called "anastomosing" was in a double sense like that of *Struvea*—first, it was not true anastomosis, but adhesion without open communication; and, secondly, this adhesion was effected by tenacula remarkably like those of *Struvea* (compare 'Annals of Botany,' vol. ii. pl. xvi. figs. 1f, 3d, 3e, 3f, with figs. 2 and 3 of the Plate accompanying this paper). At the same time it became apparent that this alga possessed no regular frond or stalk like a *Struvea*, but resembled *Microdictyon* more strongly in this respect. The tenacula, however, are very different from those of *Microdictyon*, and, more important still, the branching also. In *Microdictyon* the filaments spread out in one plane and form a definite net; in this organism they run in all directions (Pl. XLIX. fig. 1),