XVIII. *On Myostoma, a new genus of the Burmanniaceæ.*
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(Plate LVII.)

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IN April 1847, I communicated to the Linnean Society the account of a new Brazilian genus of the *Burmanniaceæ*, which was published in the Twentieth Volume of the Society's Transactions, under the name of *Ophiomeris*. I showed that in its more essential characters it accorded with the Indian genus *Thismia*; and in order to include these two genera in the family, I proposed to form a third tribe, *Thismieæ*, distinguished from *Burmannieæ* and *Dictyostegieæ* by having an apterous perianth with a 6-lobed border (each alternate lobe being contracted into a long subulate spur), and a succulent capsule which opens by a circumscissile line. I have now to describe a third genus of the *Thismieæ*, which is also of Brazilian origin, its chief peculiarity consisting in the shape and condition of the three inner segments of the border of the perianth, which do not open in the usual manner, but remain constantly closed, for which reason the name of *Myostoma* is given to it*.

In the regular form of the perianth it resembles *Thismia*: the tube is not gibbous; and its contracted mouth is in the vertex, not excentrically placed on one side as in *Ophiomeris*. The perianth is succulent, infundibuliform, regularly ventricose towards the summit, where it is suddenly contracted into a short cylindrical mouth, which is terminated by three short erect teeth; these teeth, or rather claws, belonging to the segments, have the same breadth as their sinuated intervals, and they suddenly become expanded into three orbicular very convex segments three times the breadth of the claws, each being cordately expanded below into two rounded connivent auricular lobes which embrace the claws; these segments, arching over the centre, remain imbricately closed, and thus entirely conceal the mouth. The other three alternate segments are fleshy, extremely narrow, with their margins revolutely coiled back, so that they assume a subulate form; they are external, as in *Thismia*, not spirally coiled within the tube in æstivation as in *Ophiomeris*; they arise immediately below the contracted portion of the tubular mouth, beneath each sinus, thus alternating on a lower level with the auriculately lobed segments; they are nearly the length of the tube of the perianth, at first spreading horizontally, then curving downwards. The six equal stamens are quite free from each other, and not united into a broad free annular ring as in *Thismia* and *Ophiomeris*; the filaments, opposite the segments, and pendently attached immediately below the contracted mouth of the perianth, are short, somewhat filamentous, and widely separated; each connective is a cuneiform plate, about the length of the filament, with two long

* From *μύω*, *occludo*, and *στόμα*, *os*.

sides narrowing into an obtuse point, and truncated at the opposite end, the angles of which are prolonged into two erect horn-like appendages of equal length; and from a point between these it is attached to and suspended from the end of the filament. These stamens at first converge towards the axis, over the stigma, but ultimately they collapse into a pendent position, the anthers being fixed extrorsely, and turned towards the face of the perianth. The anther consists of two distinct, oblong, parallel or slightly converging lobes, each bilocellate, dorsally adnate to the connective, and opening bivalvately by a median longitudinal suture, the margins of which detach themselves from the septum. In the flowers examined, the anther-cells had discharged their pollen; but some few of the granules still remained in the cells, while others were distributed over the surface of the perianth. These pollen-grains are somewhat large (0·003 in. in diam.), globular, extremely transparent, and of a very pale hue, with a minutely reticulated surface, and three slight hyaline protuberances on the margin; but these protuberances are not lengthened into boyaux as in *Dictyostega*; the pollen is therefore quite of the ordinary structure.

The ovarium is wholly inferior, turbinate in form, 1-celled, with three parietal placentæ, as in *Ophiomeris*; it is crowned by a convex fleshy epigynous disk, from the centre of which the somewhat short cylindrical style rises, bearing the stigma, which is equal to it in length, suddenly incrassated, and cleft almost to its base into three nearly erect lobes with minutely papillose surfaces, their summit scarcely reaching the middle of the tube.

The fleshy hyaline capsule grows to a size four times that of the ovary, and in consequence of the fall of the perianth at the period of maturity, by a circumscissile line of separation along the margin of the epigynous disk, it remains like an open-mouthed truncated turbinate cup; it has three short parietal placentæ, which do not meet in the base, and rise to the height of one-fourth of the length of the cup; they are as broad as the intervening spaces, and are densely covered with very numerous minute seeds upon long funicles, all forming a crowded mass in the bottom of the cell.

These minute seeds, though similar in form, are somewhat larger than those of *Ophiomeris*, being 0·05 in. long and 0·02 in. broad; they are suspended by a rather long funicle: the outer tunic is very lax and transparent, as in *Burmattia*, with about twelve longitudinal carinated ribs, which are parallel and uninterrupted, arcuately conjoined at the apex, where they terminate in a wide, open, truncated mouth; below they are connected with the somewhat narrower hemispherical reticulated and translucent base of the integument: the spaces between the longitudinal ribs consist each of a single narrow areole, filled with a pellicular membrane which, under a powerful microscope, is seen marked by numerous closely parallel, very diagonal lines, slanting obliquely downwards from left to right; and the ribs themselves are fissile down their middle through their entire length. The funicle by which the seed is suspended is 0·04 in. long, with a diameter of 0·0055 in.; it is transparently hyaline, forming an extremely thin pellicular hollow cylinder, marked by six or eight very delicate lines, which extend in an uninterruptedly parallel direction from one extremity to the other, the interspaces being streaked by close transverse lines so extremely minute that they can be discerned only under a very powerful microscope: thus magnified, these interspaces assume the appearance of

muriform tissue. The extremity of the funicle, where it is attached to the seed, is not decurrent along the outer surface of the integument, as usually occurs, but enters its broad open mouth, within which it is attached on one side, and where its further progress is lost; and it should be especially noticed that there is no indication of the presence of a raphe, or of spiral vessels, or ducts of any kind, either in the integument or in the funicle. Besides the lines above described, we see within the pellicular tube of the funicle, when viewed under a high power, as well as beneath the cuticle of all parts of the plant, more especially on the inner surface of the perianth, a number of rounded yellow glands, irregularly scattered, which might be mistaken for pollen-grains; but they are very different, less than half their size, yellow and granulated, and apparently fixed upon the cuticle.

In analyzing the seed, the readiest method of separating the outer seminal integument from the body which it encloses is to place one of them on a sheet of paper, covering it with a glass slide; then moving the latter by a gyratory motion under moderate pressure, the outer integument will be seen to split, not along the delicate pellicular interspaces, but through the middle of its more solid carinated nervures; and it thus opens valvately from the mouth downwards into segments united at their base, after the manner of dehiscence of an ordinary capsule. The oval body thus liberated from the pulvinate base of the outer integument, is about two-thirds of the length of that tunic; it seems to contain a torulose yellowish nucleus, apparently formed of three or four series of aggregated nodules, just as was formerly described in the seed of *Ophiomeris*, and figured in the Linnean Transactions, vol. xx. pl. 15. figs. 18 & 19.

When the integument of the oval body thus liberated is ruptured by the point of a needle, under water, about eighteen loose spherules become disengaged, which are irregular in size, somewhat angular in shape, of a dark-brown or blackish colour when fully matured, more or less opaque, and appear to consist of numerous very minute oily cells, aggregated together somewhat loosely around a larger central globule, seemingly transparent and of an oily nature. When these spherules are placed under a compressor, the central oily globule escapes, the more minute cells are separated, and with them a number of black extremely diminutive atoms, which look like the sporidia of *Acrogens*. It should be mentioned that the spherules first mentioned show no vestige of any reticular covering; so that they cannot be compared with the spore-cases of Ferns; and after the most careful search nothing like an embryo could be perceived. The seeds examined had never become dry, having been preserved in spirits from the time the specimens were collected to the period of their examination, when they were placed in distilled water, lest any extraneous earthy particles might interfere with the results. The investing integument, when cleared of its contents, is found to be a simply reticulated membrane, cancellated, with rather large areoles, and has no appearance of any chalaza, raphe, or vessels of any kind. Such are the only results I have been able to obtain after numerous attempts, carefully repeated, to analyze the seed of *Myostoma*.

I have omitted, in the previous details, one circumstance which appears to me worthy of notice. Although, as before stated, no tracheal or other vessels usually found in seeds can be seen in the funicle, or in either of the integuments of the seed of *Myostoma*,

they are distinctly observable in other parts of the plant: the stem, composed entirely of transparent hexagonal cells, has a medullary cord running up its centre, formed of a bundle of spiral vessels, which on reaching the base of the ovary, divides itself into six portions, severally following the course of its sulcated furrows, three of them thus passing by in close proximity to the placentæ, but without communicating with them; and all are continued along the grooves of the tubular perianth, thus touching the stamens, and they extend to the extremities of the six segments of the border: no spiral vessels are found in any other parts of the plant. Prof. Henfrey (Linn. Trans. xxi. tab. 2) shows the funicle and integument of the ovule of *Orchis* as being quite cellular and destitute of vessels; but I have found spiral threads abundantly in the longitudinal placentæ of many Orchidaceous plants; I could find no trace of them in the placentæ of *Myostoma*. The tissues of most of the Rhizogens are said to be deficient of tracheal vessels; but they have been detected in some of the *Balanophoreæ*.

The resemblance of the apparently torulose body contained within the seed of *Myostoma* to the nucleus delineated by Mr. Robert Brown in the seed of *Rafflesia*, in the Linnean Transactions (vol. xix. plate 25, R. B.), is too remarkable to pass over without notice. Bauer, who repeated Mr. Brown's analysis, and prepared the drawings for that memorable memoir, figures the nucleus as he saw it under the most powerful microscope, considering it to be a simple cylindrical embryo of homogeneous texture; but under the more penetrating observation of Mr. Brown, it was resolved otherwise and as he drew it separately in the figure marked R. B. in the same plate: according to his view (*l. c.* p. 228), this "embryo consists of large cells disposed nearly, but not with absolute regularity, in two longitudinal series, and so transparent that it may be safely affirmed that there is no included body, nor any perceptible difference in the contents of any of the component cells." It was in this manner that I regarded and described, nineteen years ago, the nucleus or supposed embryo of *Ophiomeris* (Linn. Trans. xx. 376, pl. 15. figs. 18, 19).

Griffiths defined the seed of *Thismia* (Linn. Trans. xix. 342) as consisting of two integuments, the outer one being "celluloso-areolate, fragile and easily separable, the inner one extremely slender, membranaceous, scarcely separable, and containing a cellulose waxy mass (embryo) composed of cells filled with grumous molecules and oily matter," but he gave no figure to explain any further meaning.

Dr. Lindley, founding his views principally upon the evidence of Brown in regard to *Rafflesia* and *Hydnora*, and the details he had obtained from Griffiths concerning the *Balanophoreæ*, separated these and all analogous plants from Exogens, on account of their "homogeneous or anembryous sporuliferous seeds;" and in his 'Elements of Botany,' p. 226, he defines the Rhizogens, or *Rhizanthæ*, as "wholly or nearly destitute of vascular tissue; and when their seed is fertilized, instead of an embryo being formed, the issue is a mass of sporules or reproductive bodies analogous to those which *Acrogens* have instead of seeds."

This definition was considered by Mr. Griffiths (*l. c.* p. 306), "to be open to the gravest objections." He did not oppose the use of the term "homogeneous," which he considered correct, but the case was very different when that term was connected with the want of an embryo and with a sporuliferous mass: he did not find the appearances

presented by the seeds to be uniform; and the only cases that support "the hypothesis of their being composed of a sporuliferous mass are *Mystropetalum* and *Sarcophyte*" (p. 307). This opinion, as we shall presently see, is opposed to the views of Dr. Hooker, who considers that among the *Balanophoreæ* "the only known embryonate and albuminous genera are *Cynomorium*, *Sarcophyte*, and *Mystropetalum*" (Linn. Trans. xxii. 18). Mr. Griffiths regarded all the other genera of that family, including *Thismia*, as having seeds enclosing "a densely cellular homogeneous body, each cell containing granules and globules of an apparently oleaginous fluid, the appearance being that of some forms of albumen" (*l. c.* p. 307). He was convinced that these bodies were the embryos described by Mr. Brown as being homogeneous and acotyledonous, and which exist in a marked degree in *Thismia*, also in *Orchidaceæ* and many plants parasitic on roots.

Dr. Hooker, in his excellent memoir on *Balanophoreæ* (Linn. Trans. xxii. 17), attributed to the seeds of many genera of that family a similar structure, and his observations serve to throw much additional light upon this interesting inquiry. The ovule of *Balanophora involucrata*, as shown in Pl. V. figs. 11 and 12, at an early stage of its growth "consists of a delicate hyaline sac, suspended almost immediately below the insertion of the style, and containing two free spherical cells, each full of fluid and covered with opaque spots, which are probably cytotlasts. The formation of cells proceeds with great rapidity within the sac;" but he was unable to trace their further evolution. If it could be proved, as Dr. Hooker was inclined to believe, that these cells are analogous to the ordinary embryo-sac of phanerogamous plants, it would be a very important fact; but we must yet regard this as a mere supposition; for although he perceived within the style a filament, like a pollen-tube (as shown in figs. 16 and 17), he could not trace it into the cavity of the ovary, there was no indication of its having been fertilized, nor was he able to observe any vestige of chalaza, raphe, or foramen by which impregnation could be effected: the ovule gradually swells till it is matured, and then consists of a dense opaque mass of cohering hexagonal cells.

In regard to the nature of the seed in *Balanophoreæ*, Dr. Hooker infers (*l. c.* p. 18), as Griffiths in a somewhat different manner had conjectured before him, that there are two types of seminal structure in that family:—1st. The embryonate, found only in *Cynomorium*, *Sarcophyte*, and *Mystropetalum*; 2nd, the exembryonate, which includes all the other genera, whose seeds consist of a homogeneous or sporuliferous mass as above described. But if we regard the facts established by these botanists, the conclusion seems irresistible that the three genera whose seeds have a distinct nucleus (perhaps miscalled an embryo), imbedded in a fleshy, more or less solid, albumen, should be considered ordinarily distinct from all the others, which have no albumen and no embryo; for under such contrary conditions, if we regard consistency, they ought not to be retained in the same natural family. By the separation of the former as the *Cynomoriaceæ*, consisting of the three tribes already established, the *Cynomoriæ*, *Mystropetaleæ*, and *Sarcophyteæ*, we have the *Balanophoraceæ* remaining, whose genera are all uniformly marked by similar essential characters. Holding in view therefore the extreme difference in the organization of its seeds, the *Cynomoriaceæ* would stand further separated from *Balanophoraceæ* than *Triuridaceæ* or even *Burmanniaceæ*. The chief reasons which

induced Dr. Hooker to include *Mystroptalum* in *Balanophoraceæ* were its habit, its valvate tripartite perianth, its stamens placed opposite the lobes of its border, and its extrorse anthers, in all which characters that genus equally resembles *Triuris* and *Soridium*: these, however, differ in their dioecious flowers and numerous ovaries. Were the *Cynomoriaceæ* separated from *Balanophoraceæ*, as above indicated, they need not on that account be excluded from the Rhizogens, or merely because of the presence of albumen in their seeds, especially as our present knowledge seems to show that the organ which has been called their embryo consists of an aggregation of sporule-like granules similar to those which we find in all the other orders of this class of plants.

In order to know the limits of the Rhizogens as a peculiar class, it is desirable to investigate the circumstances which give rise to the reproductive power of their seeds (in which no trace of a cotyledonary embryo can be detected), and to inquire into the manner of the fertilization of their ovules. In the ordinary embryo, as is well known, its radicle, under conditions favourable to its development, extends into a root, while the rising stem and its first leaves are produced by the expansion of the plumule and cotyledons; in that exceptional condition of the embryo, such as in *Cuscuta*, *Orobanche*, *Arum*, &c., where the cotyledons, plumule, and radicle are fused into a fleshy mass, there is always some pullulating point on its surface out of which the young stem and its root are expanded. But no development of such a nature has been found in any of the Rhizogens: indeed all our knowledge on the subject of their reproduction is purely negative; that is to say, although nothing absolutely certain is yet ascertained on this point, we assuredly know that the mode of the germination of its seeds is different from that of all other classes, and that in this particular alone the Rhizogens stand quite isolated. On this topic many hypotheses have been suggested, none more probable than that of Mr. Brown, who suggested (Linn. Trans. xix. 232) the possibility that, in all these plants, their propagation is effected by the generation of cellular tissue proceeding from the sporuliferous contents which compose their peculiar kind of "homogeneous embryo," the growing molecules of which penetrating and extending under the bark of the parent stock, by their progressive development, produce new and fully matured parasites, a development in its ultimate results as effective as the growth resulting from the cotyledonous embryo, which in Exogenous and Endogenous plants is considered essential to their reproduction. We have, however, as already stated, no positive evidence by which this ingenious hypothesis can be supported.

In regard to the fertilization of the ovule, although we are not aware of the manner in which this takes place, we are quite certain that an impregnation of some kind must be effected in Rhizogens. In the *Burmanniaceæ* we find all the usual sexual parts as perfectly developed as in the higher orders of Endogens and Exogens—that is to say, a perfect perianth, stamens completely formed, anthers charged with grains of pollen possessed of the same mode of expansion and apparent function; for, in some cases, we see the pollen-tubes issuing from each anther-cell and brought into contact with a 3-lobed stigma provided with papillose surfaces; from this point we trace the usual stigmatic channels through the style, and sometimes (but not always) thence through other passages, which convey the fecundating influence to three parietal placentæ in the ovary,

all charged with numerous ovules; these are suspended by their funicles, and grow into seeds, each provided with the ordinary number of integuments. It therefore seems extraordinary that, with all these appliances just as we see them in the most perfect Phanerogamia, after the fertilization of the ovules and the growth of the seeds, no indication can be detected of the presence of a cotyledonous embryo, which invariably is generated by the same sexual apparatus in all Exogens and Endogens.

Many of the most celebrated physiological botanists have maintained (and their views have obtained general assent) that in fecundation it is a necessary part of the function that the pollen-grains, on touching the stigma, should emit those capillary prolongations known by the name of boyaux, or pollen-tubes, which then descend along the style by forcing their way through its external channels, which in ordinary cases are connected through other similar passages within the ovary, communicating with the placenta; it is further maintained that, in order to fertilize an ovule, it is essential that one or more of these pollen-tubes should travel thus far, so as to enable it to reach the foramen of the ovule which it enters, thus coming into contact with the embryo-sac, when, by the stimulus exerted by this mere juxtaposition, it gives rise to the formation of a germinal vesicle within the sac, which grows into an embryo, the sac affording nutritive power to the embryo by its connexion with the chalaza.

This ingenious theory of the agency of the pollen-tube, so willingly and so generally accepted, is, however, doubted by some botanists, who have brought many strong arguments to prove its fallacy. Among these, one of the most disconcerting is the improbability that a pollen-grain should possess the potency of suddenly emitting a tube the length of 20,000 times its own diameter (for it would sometimes require to be 6 inches long), and drive forward this delicate thread against the powerful resistance which mere friction would impede to its progress through a channel of such length and equally extreme tenuity; it becomes, indeed, an argument of great weight that the power necessary to effect this would be too enormous to be supported in a fabric of such delicate texture—a power which no one has seen, and which no reflecting mind can believe to exist. It is, moreover, argued that where such pollen-tubes have been seen, or rather are supposed to have been seen, at the termination of the stigmatic channels, the eye has been deceived by appearances arising from another well-ascertained structural development of a very different nature, which may easily be mistaken for pollen-tubes.

There appears much reason in these arguments, and not less so in others that have been advanced; and if they hold their ground, we must fall back again upon the now antiquated but by no means irrational view, that it is not the pollen-tube, but simply the fluid material contained in the pollen-grain, and emitted from its tubes, which is the direct agent in the process of fertilization. No one can doubt that such a fluid could readily be conveyed through the extremely narrow channels of the style by the well-known law of capillary attraction; by such means, directly or indirectly, the fluid would quickly reach the micropylar extremity of the ovule, when, entering the foramen, the fertilization would be effected by its impact upon the embryo-sac—a mode of stimulation similar to, and as feasible as, that of the impregnation of the ovum, known to be universal throughout the animal kingdom. It is only a revival of a doctrine long entertained,

to compare the active fovillæ of the pollen-grain with the spermatozoa of animals, and to indicate the correspondence of their main function*.

I will not attempt to deny categorically the truth of the doctrine now universally entertained, that it is the pollen-tube alone, simply by its impact on the embryo-sac, which effects the fertilization of the ovule; for it must be confessed that this theory, if founded upon fact, is one which seems to fulfil all the conditions necessary to account for the phenomena of impregnation. The fact itself, if universal in its operation, is one that ought to be patent to every observer; but I can safely affirm that in the numberless instances in which I have searched for the presence of a pollen-tube in the foramen of the ovule, I have never yet been able to discover one. This is an objection of no weight whatever, as it might well arise from my obtuseness of vision, or a want of sufficient dexterity. As, however, I shall be able to show that such a mode of impregnation does not occur in *Myostoma*, and as the belief in the doctrine referred to as applicable to all phanerogamous plants is now so universal, I thought it desirable to sift the evidence we have on record, and which I now adduce, upon which this general belief is founded. It appears to me that this review will induce most persons, who have not prejudged the question, to come to the conclusion that the very important fact alluded to has not yet been satisfactorily proved.

The proofs of the facts under consideration are generally supposed to be furnished by Mr. Brown's celebrated memoir "On the Organs and Mode of Fecundation in *Orchideæ* and *Asclepiadeæ*," published in the 16th volume of the Linnean Society's Transactions. I have examined that memoir with great care, but can nowhere perceive any fact advanced to support the belief above mentioned as regards the agency of the pollen-tube; on the contrary, I will show, by quoting Mr. Brown's own words, that his important evidence does not point to that conclusion.

Mr. Brown, with his usual caution and profound sagacity, remarks that Amici first announced the discovery of the penetration of the pollen-tubes into the cavity of the ovarium in several plants, and believed (though he never saw it) that in every case of fertilization a pollen-tube comes into contact with the ovule; and Dupetit Thouars fancied he saw in *Orchideæ* ramifications from pollen-cords mixing with the ovules; but Mr. Brown states positively that his own observations had not advanced so far on that important point, and "that what he had to adduce concerning *Asclepiadeæ* made him hesitate still more from adopting these statements" (*l. c.* p. 707). It will be seen that his own details support this disbelief. He observed in *Bonatea*, and in general among the *Orchideæ* (p. 727), prior to the evolution of the pollen-tubes, a series of

* The surprising vital energy of the fovillæ, and the rapidity of the motion of these particles, which vary considerably in size (from $\frac{1}{4000}$ to $\frac{1}{3000}$ of an inch), though first seen by Gleichen a century ago, was scarcely noticed until Brown called attention to the fact, which he fully described (*R. Brown, Misc. Bot. Works, i. 466*). The circumstance again fell into oblivion after the general belief in the theory of the agency of the pollen-tube in impregnation; but lately M. Faivre has once more called attention to the subject (*Bull. Soc. Bot. France, vii. 772*), and has described the "mouvement Brownien" in the pollen of *Gloxinia*, which, he says, is of long duration, the fovillæ having not only a rotary motion round their axis, but a lateral sliding, and an advance of one particle beyond another; and he also observed that a conjunction of these granules sometimes takes place: this last circumstance was also noticed by Brown in the pollen of *Lolium perenne* (*l. c.* p. 463).

“mucous-tubes,” first apparent on the stigma, which gradually extended themselves through the style in a bundle like a cord, which, on reaching the summit of the ovary, there became divided into three lines running parietally along the sides of the cell; and on reaching the beginning of the three placentæ, each line again divides into two branches, which run along the sides of the placenta (p. 706); and he noticed the extremities of many of these “mucous-tubes” scattered over the surface of the placenta (p. 742). At first he took these “mucous-tubes” to be pollen-tubes, (p. 739), but he afterwards retracted that opinion. He states that, in size, in number, and in appearance, they so greatly resemble them, “that they are with difficulty distinguishable” from them (p. 741). Having traced these “mucous-tubes” to the sides of the placentæ, he remarked that those which were scattered over their surface became remarkably and irregularly flexuose (p. 743); and in not a few cases he traced them into the mouths of the ovules, to which they adhered with considerable firmness [p. 742]. The fact “that the tubes thus traced to the foramen of the ovules are of the same nature as the mucous-tubes, and not those produced directly by the pollen, was proved [to him] by their exact agreement with the former in every respect” (p. 743), except by not being granular on their surface and distinguished by having generally those interruptions in the cavity, formed of a substance which he termed “coagula,” and which he never met with in the tubes actually adhering to the grains of pollen (p. 741). In his concluding remarks, he states that the two most important facts, which he considered to be the résumé of his researches, are, 1, “the production of tubes not directly emitted from the grains of pollen, but apparently generated by them” (or, to have spoken more correctly, which become visible at the period of the emission of the pollen-tubes and their application to the stigma, as shown in p. 739), and, 2, “the introduction of one, or sometimes more than one of these [mucous] tubes into the foramen of the ovule” (p. 743).

We may deduce from these facts, that the “mucous-tubes,” here so minutely described, and to the agency of which so much importance is attached, are the stigmatic channels accurately described by Mirbel under the name of “vaisseaux conducteurs de l’aura seminalis”*, as contradistinguished by him from the “vaisseaux nourriciers” of the placenta (which extend to the funicle of the ovules), and that the extremities of the “mucous-tubes” which spread over the placenta, and where they become much curved, constitute that peculiar fringe-like tuft called “telæ conductrices,” some of which tubes were seen by Mr. Brown to enter the foramen of the ovules, and there become agglutinated to them (*l. c.* p. 742)—a circumstance that should be especially remembered. The function of this fringe of tissue is to conduct the fertilizing influence transmitted from the stigma through the “mucous-tubes” to the apex of the ovules,—this adaptation being clearly portrayed in the great number of cases figured by Prof. Agardh in his ‘*Theoria Systematis*,’ where the mouths of the ovules, in the course of their development, become nestled in this fringe-like tuft. In fine, there is not a single fact described by Mr. Brown in his celebrated memoir to prove, nor an opinion stated to show, that the pollen-tube ever reaches an ovule in the *Orchidaceæ*.

* Mém. de l’Acad. vol. ix. p. 633.

M. Brongniart states confidently * that he never was able to see the pollen-tubes descending the style as Amici had asserted; he searched for them with great care, but was unable to trace them beyond the tissues of the stigma, where they terminated.

Subsequently, in one of his latest communications to the Linnean Society, Mr. Brown further stated, in regard to the "supposed pollen-tubes," or what he termed "mucous-tubes" (equivalent to the stigmatic channels of Mirbel), which he observed in *Cytinus*, running along the style, and reaching the cavity of the ovary, their extremities there mingling with the ovules, that he never found any of them applied to the apices of the ovules, even after their enlargement †.

Mr. Brown's observations, as above quoted, are somewhat modified in the same memoir, in regard to the *Asclepiadææ*. His invaluable researches prove that the pollen-mass in that family consists of a congeries of pollen-grains agglutinated together as in the *Orchidææ*: he there observed the protrusion of a single tube from each pollen-grain; but this did not take place before the pollen-mass touched the stigma, when, by its stimulus, the tubes were evolved and combined together in a loose bundle, which now passed over the surface of the large stigma; and at the moment the latter breaks away from the two styles, this bundle is seen to enter their large apertures. Consequently, the styles and ovaries being usually very short, it is not surprising to find this bundle of tubes passing through the large opening of the styles into the cell of the ovary. But though Mr. Brown saw them in this position, as shown in plate 34. fig. 11, he states positively that he was never able to trace any one of the tubes further than the commencement of the placenta (p. 726); and so rarely does this happen, that it was only in a single species of the family that he was able to see consecutively "the rupture of the pollen-mass, the production and protrusion of the pollen-tubes, their union into a cord, with the course and entrance of this cord into the cavity of the style" (p. 729). He describes the pollen-tube as being very transparent, $\frac{1}{2000}$ inch in diameter, neither branched nor jointed, and with no apparent interruptions in its cavity; and, though sometimes of a comparatively considerable length, it cannot be said to be emitted from the pollen-grain, but is manifestly an elongation of its inner membrane (p. 725).

In regard to the fertilization of the ovule in *Orchidæææ*, Mr. Brown states (p. 709) that, "at the period when the nucleus has acquired more than half the size it attains in the ripe seed, a thread may be traced from its apex very nearly to the open end of the testa, or to the apex of the original nucleus, consisting of a simple series of short cells, in one of which he observed a circulation of very minute granular matter, the lowermost cell being the rudiment of the future embryo;" but there is no attempt here to show that there is any connexion between this thread and a pollen-tube.

Prof. Henfrey, in his memoir "On the Development of the Ovule in *Orchis*" (Linn. Trans. vol. xxi. plate 2. fig. 27), portrays the growth of the confervoid filament just mentioned, showing it in figs. 15 *et seq.*, together with the earliest contact with it of what he conceived to be a pollen-tube, but which is manifestly identical with the extremity of the "mucous-tube" so well described by Mr. Brown, agreeing with it in all essential re-

* Ann. Sc. Nat. xx. 332.

† Linn. Trans. xix. 227.

spects: it never enters the embryo-sac, but deviates a little on one side during the elongation of the confervoid thread. In the progress of this growth, he observed (p. 8) the pistillary cords extending nearly to the base of the ovary, lying alongside the placenta, presenting the appearance of pollen-tubes, and seemingly continuous with those seen on the stigma, derived from pollen-grains. This corresponds precisely with all that Mr. Brown minutely describes, who affirms positively that they are not pollen-tubes, though greatly resembling them. Prof. Henfrey's memoir, therefore, does no more than confirm the very accurate observations of Mr. Brown, and affords no better proof of the conveyance of the pollen-tubes from the stigma to the mouths of the ovules, or of their immediate agency in the act of fecundation.

Though the existence of pollen-tubes cannot be doubted, their utility and their true function may admit of another interpretation. It should be remembered that they are not formed of ordinary cell-structure—that is to say, of pointed consecutive cells capable of self-extension, which would admit the possibility of their progressive growth to any length desired; but, as Mr. Brown has described them, each pollen-tube is a single elongated cell produced by the mere expansion of the delicate pellicular inner tunic of the pollen-grain, and which, from the manner of its production, must be of very limited length; and though longer in some cases, in most instances they are rarely seen longer than the diameter of the pollen-grain. This extension is evidently a contrivance for some special purpose, the design being probably that it may be able to penetrate the mouths of the stigmatic channels, and serve as a funnel for pouring out and directing the course of the fluid contents of the pollen through these “mucous-tubes” to their ultimate destination.

The structure seen in the *Burmanniaceæ* seems to favour this view of the subject. I have shown, on a former occasion, that in all the genera of the tribes *Burmannieæ* and *Dictyostegieæ* the communication between the stigmata and placentæ is direct and perfect, and that the pollen-grains in *Dictyostega* emit copiously an entangled cottony mass of delicate threads, which strongly adhere to the stigma, and show the empty utricles of the pollen-grains suspended from their extremities; but there is no evidence to demonstrate that these threads, which enter the stigmatic channels, are continued beyond their orifices and carried to the placentæ. Analogy strongly points to the negative; for in *Myostoma* and *Ophiomeris* there is a want of all direct means of communication between the style and the placentæ, the stigmatic channels ceasing at the base of the style. Now, if it were essential for the fertilization of the ovules, as the prevailing doctrine insists, that the pollen-tubes should be prolonged so as to reach the ovules in the bottom of the cell of the ovary, then we ought to see them issuing from the base of the style into the cavity of the cell; and as the ovary contains upwards of a hundred ovules, the pollen-tubes in corresponding number would form a thick bundle which could not escape observation. It is therefore only necessary to say that, as no such fascicle of threads is to be seen in *Myostoma*, we have it demonstrated that, in this case, the theory of the application of pollen-tubes for the fertilization of its ovules is distinctly disproved. On the other hand, if we here adopt the view before explained, that the fluid contents of the pollen-grains alone pass through the stigmatic channels in

Myostoma, the mode of the fertilization of its ovules is more easily accounted for. This absence of stigmatic channels between the base of the style and the placentæ is far from a rare occurrence in phanerogamous plants; I pointed to it in the case of *Ephedra*, and quoted several authors who had observed the same circumstance in numerous other families*.

Among these it may be especially noticed that Dr. Weddell, in his admirable memoir on the *Urticeæ*†, shows that the ovary is unilocular, and the ovule is attached by its funicle to the base of the cell, and that its micropyle points upwards: here no channel of communication exists between the stigma and basal placenta, the stigmatic channels of the style terminating in the summit of the cell, where a tuft of tissue is seen similar to that described by Mr. Brown on the placentæ of *Orchideæ*, and to which the expanded mouth of the outer coating of the ovule adheres with considerable tenacity; and he adds, “il n’est même pas rare de voir le tissu conducteur pénétrer dans l’exostome [micropyle] et l’obturer complètement,” precisely in accordance with the observations of Mr. Brown. There is no mention anywhere of the descent of pollen-tubes to perform the act of fertilization.

In corroboration of this, it may be mentioned that Dr. Hooker and Mr. Griffiths saw pollen-grains upon the stigma of *Balanophora*, but failed in tracing any transmission of pollen-tubes‡; and I quote the words of the former (*l. c.* p. 17), showing that he could obtain no clue to the period when impregnation took place; nor could he trace any indication of a chalaza, raphe, or foramen, at which “impregnation is probably effected.”

The want of an embryo in the seed would lead us to infer that in the nucleus of the Rhizogens there is no embryo-sac, in the ordinary acceptation of the term, and that the development of the ovule is different in its nature from that of Exogens and Endogens. We have as yet little knowledge on this subject; but in future investigations it must be remembered that in *Myostoma* the mouth of the external tunic of the ovule is never closed, that its funicle is tubuliform, and that it terminates in the mouth of that tunic, that there is no raphe, no vestige of a micropyle in its summit, or of a chalaza in the base of the inner integument. These very exceptional points of structure, by their influence upon functional development, would alone almost lead us to expect a difference in the organization of the seed.

In this organization, as observed in *Myostoma*, and which seems to prevail generally in Rhizogens, are we to assume that an embryo is absolutely wanting, or can it be so very minute as to escape our means of observation? The latter view is not easily maintained, because in all cases where a very small embryo exists it is enveloped in a very homogeneous large mass of albumen, composed of cells of great cohesion; but here the

* Ann. Nat. Hist. 3 ser. ix. 429: Contributions to Botany, ii. 146.

† Archiv. Mus. ix. 31, pl. 5. B. 4.

‡ Dr. Hooker mentions, in a note (*l. c.* p. 17), that Hofmeister had observed a pollen-tube in the ovule of *Cynomorium*. Mr. Brown also saw a similar filament in the ovule of an Orchid, and showed that it was not a pollen-tube: his description of it quite coincides with that of the confervoid filament figured by Prof. Henfrey, which he traced and found to be a cellular elongation of the embryo-sac of the ovule in *Orchis* (Linn. Trans. vol. xxi. tab. 2. fig. 27), and which he states is the same “which Schleiden has certainly mistaken for a pollen-tube” (*loc. cit.* p. 9).

mass of the nucleus does not appear to approach in any way to the nature of albumen, it is divided by the slightest pressure into irregular nodules, some more coherent and darker than others, as they seem more matured, all composed of minute oil-cells, more or less disintegrated and reducible to simple cells intermixed with black atoms: it therefore becomes a question whether the reproductive power of these seeds resides in these cells or in these atoms. The latter view seems more probable, from their resemblance to the sporidia of *Acrogens*. But as the latter generate plants of a very low order of development, being deficient of flowers, wanting calyx, corolla, stamens, ovaries, and seeds, while the former produce plants endowed with perfect flowers, such atoms should bear the more appropriate name of blastidia, bearing the same relation to protoblasts that sporidia do to spores.

The evidence here adduced concerning *Myostoma*, as well as that advanced on previous occasions respecting other genera of the *Burmanniaceæ*, added to the valuable information which I have quoted regarding the *Balanophoreæ*, *Rafflesiaceæ*, &c., all combine to show that all these families, including the *Triuridaceæ*, constitute a special alliance, and that the Rhizogens, as a class, stand preeminently distinct from all others, on account of the peculiar organization of their seeds, the unusual mode of their germination, and perhaps not less abnormal manner of the fertilization of their ovules. Under this view the *Burmanniaceæ* would stand at the head of this class, because of their hermaphrodite and more perfect flowers, and the more complete development of all their parts; they would stand next to *Cytinaceæ* on the one hand, and touching *Orchidaceæ* on the other. But whether the latter family belongs to the same class has yet to be determined; in external appearance, their seeds offer much resemblance to those of the *Burmanniaceæ*, having a similar lax outer integument, enclosing a nucleus, the nature of which, as far as I can judge, seems yet involved in much obscurity*.

Griffiths concluded that *Thismia* should be placed in a position between *Burmanniaceæ* and *Taccaceæ*; but it appears to me to have little relationship with the latter family. Endlicher arranged the *Burmanniaceæ* after *Taccaceæ*, between *Hydrocharideæ* and *Iridaceæ*. In the systematic plan of Dr. Lindley, this family stands between *Marantaceæ* and *Orchidaceæ*. Formerly I pointed out the analogies existing on the one hand to *Triuridaceæ*, and on the other to *Orchidaceæ*. Prof. Agardh so far agrees in placing the *Thismieæ* next to *Orchidaceæ*; but he separates them from *Burmanniaceæ*, and disputes any analogy between them and *Taccaceæ*. The views of this author, however, set at defiance the opinions of all other botanists in regard to the general affinities of the *Burmanniaceæ*; for he places in one alliance *Saurureæ*, *Begoniaceæ*, *Melastomaceæ*, *Pentaphragmeæ*, *Gesneraceæ*, *Orobanchæ*, *Burmanniaceæ*, *Thismieæ*, *Orchidaceæ*, and *Cytinaceæ*, separating and associating in another, distant alliance *Balanophoreæ*, *Hydnoreæ*, and *Rafflesiaceæ*, which he couples with *Taccaceæ*, *Araceæ*, *Aristoteliæ*, *Lardizabaleæ*,

* The best accounts of the earliest development of the ovule in *Orchideæ*, the circumstances seen about the period of its impregnation, and of its progressive growth, are those of Mr. Brown and Professor Henfrey, to which I have already referred; but, notwithstanding the copiousness of their details, neither of them indicate the nature of the really acting force which gives vitality to the nascent embryo, and both fail in showing the internal structure of the seed. I am therefore justified in making the above remark, as we have yet much to learn concerning the subject.

and others. It needs no argument to prove the utter incompatibility of alliances of such loose and heterogeneous affinities.

MYOSTOMA, gen. nov.

Flores hermaphroditi. *Perianthium* gamophyllum, tubulosum, imo ovario adnatum, tubo regulari, subcylindraceo, sulcato, supra medium ampliore, ad faucem breviter constricto, limbo 6-partito, segmentis 3 angustissime linearibus, marginibus valde revolutis et hinc subulatis, carnosus, infra faucem enatis, omnino exterioribus, tubo paulo brevioribus, patentim radiatis et subreflexis, 3 alteris alternis, orbiculatis, convexis, imo auriculato-cordatis, et late breviter unguiculatis; marginibus valde imbricatis, apice fornicatis, et faucem semper claudentibus. *Stamina* 6, æqualia, remote discreta, segmentis opposita; *filamenta* brevia, subfiliformia, fauci affixa, pendentia vel axin versus conniventia; *connectivum* longiter triangulare, extremitate angustatum et obtusum, ex adverso truncatum, ad angulos in cornua 2 erecta expansum, et inter cornua ex apice filamenti suspensum; *anthera* biloba, lobis lineari-oblongis, discretis, parallelis vel paulo divergentibus, dorso omnino adnatis, extrorsum spectantibus, sulcatis, et medio septulo longitudinali bilocellatis, hinc bivalvatim dehiscentibus. *Pollen* simplex, globosum, pallide stramineum, membrana tenuissima minute reticulata pustulis 3 hyalinis pertusa. *Stylus* brevis, teres, e disco erectus. *Stigma* stylo æquilongum, subito incrassatum, profunde 3-fissum, lobis curvatim erectis, subacutis, subtriquetris, intus planis, extus angulosis, undique papillois. *Ovarium* inferum, turbinatum, 6-sulcatum, disco epigyno coronatum, 1-loculare, pluriovulatum; *ovula* numerosissima, ad placentas 3 parietales paulo supra basin breves crebre aggregata. *Capsula* turbinato-campanulata, hyalina, carnosula, post circumscissionem et lapsum perianthii ore omnino aperto. *Semina* numerosissima, minima, funiculis longiusculis e placentis suspensa, crebre intertexta, et fundum loculi implentia; *integumentum externum* oblongum, tenuissime membranaceum, laxum, longitudinaliter carinato-nervosum, nervis parallelis circa 12 e summo ad basin fissilibus, hinc valvatim solubile, interstitiis hyalinis, lineis obliquis crebre striatis, ad imum pulvino parvo reticulato notatum, ore late apertum; *integumentum internum* brevius, ovatum, integrum, membranaceum, reticulatum, nucleum arcte tegens; *blastidium* (nucleus) torulosum, in corpuscula plurima inæqualia solubile, *corpusculis* sine perithecio proprio e cellulis aggregatis oleaginis fusco-brunneis atomisque nigris sporuloideis compositis, *embryone* visibili nullo.—Plantula *Brasiliensis*, *humilis*, *hyalina*; *rhizoma* *tuberosum*, *fibrillosum*; *caulis* *simplex*, *sulcatus*, *erectus*; *foliola* *pauca*, *minima*, *bracteiformia*, *acuta*, *terminalia*, *sessilia*, *imbricatim decussata*; *pedunculus* *solitarius*, *terminalis*, *cauli similis*, *intra foliola enatus*, *primum brevis*, *demum elongatus*, *ebracteatus*, 1-florus; flos *hyalino-albidus*, *erectus*.

MYOSTOMA HYALINUM, nob.: tubere parvo, noduloso, fibrillifero; caule nudo, sulcato, hyalino; foliolis 4, bracteiformibus, albidis, sessilibus, acutis, erectis, per paria oppositis, imbricatim decussatis, imo fere vaginatim nexis, persistentibus; pedunculo intra foliola enato, brevi, caulis diametro et demum tertia parte ejus longitudinis; flore solitario, terminali, carnosulo, tubo hyalino, ore pallide aurantiaco; capsula hyalina, demum cupulari. In Brasiliæ montibus Organensibus, circa Petropolin.

This plant was found by my son, in March 1862, in the virgin forests near Petropolis, at an altitude of about 3000 feet above the level of the sea. He found only a single cluster of these plants, growing in a damp mass of dead leaves, which carpeted the middle of a small open space about 12 feet wide, overshadowed by lofty trees. The tubers, with their fibres, did not appear attached to the roots of the surrounding trees, but simply imbedded in the decaying leaves. It was under precisely similar circumstances that I found the plants of *Triuris* in the year 1837. The stem is from 2 to 3½ inches long, half

a line thick, surmounted by four bracteiform leaflets, 2 lines long, 1 line broad, in decussate opposite pairs. The pedicel, in flower, seldom exceeds half an inch, but ultimately grows to a length of an inch; the tube of the perianth is 4 lines long, 3 lines in diameter in the middle, and suddenly contracted for a short space to a breadth of 2 lines; the three inner segments are 3 lines in diameter, auricularly cordate at base, where they are furnished with a short claw 1 line broad, attached to the edge of the throat; the three outer alternate segments originate a little below the contraction of the throat, are 4 lines long, half a line thick, in their coiled state somewhat subulate, at first horizontal, but soon curving downward; the filaments, pendent from the throat of the perianth, are opposite the segments, half a line long, the connective being of the same length, and its two erect horns equally long; the style and stigma are each half a line long; the capsule 3 lines long, and 3 lines broad across its mouth.

DESCRIPTION OF PLATE LVII.

- Fig. 1. Entire plants of *Myostoma hyalinum* in flower and in seed, natural size.
 Fig. 2. A flower, with a portion of the stem, showing the leaves, magnified.
 Fig. 3. A longitudinal section of the same, showing the position of the stamens, style, stigma, and two of the parietal placentæ, with the seeds removed.
 Fig. 4. An inner segment of the border, outside and inside view.
 Fig. 5. Transverse section of one of the outer segments of the border.
 Fig. 6. A stamen seen from within, more magnified.
 Fig. 7. The same seen sideways.
 Fig. 8. The same on the side facing the perianth, showing the extrorse anthers.
 Fig. 9. A grain of pollen, very highly magnified.
 Fig. 10. The capsule seen from above, showing the position of the placentæ, natural size.
 Fig. 11. A capsule, with the contained seeds, magnified.
 Fig. 12. Seeds, a little magnified.
 Fig. 13. A seed suspended by its funicle, much magnified.
 Fig. 14. A portion of the funicle, very highly magnified.
 Fig. 15. The outer integument, showing the manner in which it splits by pressure, the included nucleus having been removed, much magnified.
 Fig. 16. The nucleus, after removal.
 Fig. 17. The integument of the nucleus after the contents are removed.
 Fig. 18. The contents of the same, consisting of several irregular spherules, all magnified on the same scale.
 Fig. 19. One of the spherules, more magnified.
 Fig. 20. The minute oily globules and sporule-like atoms, into which the spherule is resolved by pressure, highly magnified.