MEMOIRES ON

CYNOMORIUM COCCINEUM

PARASITE OF THE ORDER BALANOPHORACEAE

BY

H. A. WEDDELL.

(Presented at the Academy of Science, January 9, 1860.)

I

The plant which is the subject of this memoire was probably known to ancients[1]. The localities where it occurs, its bizzare aspect, and its easy to note medical properties had to draw early attention to it. It is, however, only towards the end of the XVIIth century that we see it becoming the object of special mention[2], under the feather of Paolo Boccone, sicilian botanist, who defines it by this sentence: *Fungus typhoides coccineus melitensis*[3].

It is, as seen [in Boccone sentence], among the mushrooms that this singular vegetable was then classified.

Its fame, as a therapeutic agent, occurred among the knights of Malta, who made the greatest case of its haemostatic action, and this fame was so great at the time of Boccone, that he did not hesitate to declare the remedy *raritate and usu nullisecundus*. If, from our time, it has deposed of a deserved celebrity, it is that it could not compete successfully against its numerous and less rare substitutes.

After Boccone, in the first half and about the middle of the next century, several authors occupied themselves with claimed Maltese mushroom. Thus, it is initially Tilli [4], who did not know any more than Boccone of the parasitical nature, but who seeks to show that the woody fibres, considered by the preceding author dependences of its underground part, and whose itself had also noted the presence, were roots of foreign plants, with which his mushroom was accidentally of connection. He does not indicate, however, any new feature of its organization.

Micheli, friend of Tilli, and moreover experienced botanist, on the contrary, made an important step in the history of our plant: he noted, first of all, its place among the phanerogamic plants [5], he put out of doubt its parasitism, and finally published a figure [6] which leaves far behind those given before by Boccone[7], by Petiver [8] and Tilli [9]. The fungus of the older authors finally receives from Micheli the generic name of *Cynomorion* [10] (or *Cynomorium*) under which it was placed a little afterwards in *Genera plantarum* of Linné. Later, the famous Swedish botanist registered it in his *Species*, under the specific name of *C. coccineum*, and moreover made it the object of an essay to some extent, published in *Amœnitates academicæ*. Flowers of *Cynomorium*, it is hardly useful to say, are described with more exactitude than Micheli who had not been able to do it; but, under other reports, this study does not present anything which is not in the public works before, and it presents a faithful summary.

From the time of Linné, there was currently no other special note on *Cynomorium*, but its history continued to receive new ones and very important explanations in rather many works which had as their aims the general study of the natural family of Balanophoraceae, established to receive this plant and a certain number of similar plants. Among these works, I will be satisfied to quote, particularly the treatise of the plant which occupies us, those of L. Cl. Richard [11], who one not only owes the creation of the family Balanophoraceae, but also the discovery of the embryo of *Cynomorium*; a report of Unger [12], containing some anatomical research on the same plant; the beautiful monograph of Balanophoraceae of Doctor Joseph Hooker [13], and finally the remarkable work of M. Hofmeister [14] on the embryology of these plants.

My own studies on *Cynomorium* and Balanophoraceae in general, go up to the years 1850 and 1851, at which time I published on this subject a short memoire [15] inserted in *Annales des sciences naturalles*. This memoire did not have, it is true, to be born so early, because it was in principle intended to be used as an introduction to a monograph of the family; but obliged to suddenly suspend my research to undertake a new voyage to America, I decided to publish it separately, and before the ideas that I sought to make prevail there found controlled by a sufficient number of observations. An American botanist characterized these ideas by the words *more ingenious than sound*, rather exact expression of skepticism that I met, as of the access, at the majority of the masters of science, and whose persistence was not long in throwing in my own spirit of doubt about the exactitude of my conclusions. It is to clear them up that I was determined to undertake the new work which I offer today to the botanists. I must, however, recall that the principal results of this study were summarily exposed in front of the Société botanique de France, in its meetings of May 22 and July 24, 1857, where I also announced my intention to supplement my communication by making it follow *in extenso* a report on the same subject.

If it is allowed for me to add that I adopted so clearly the generally allowed opinions then on the analogy of composition between the ovary of *Cynomorium* and that of the phanerogamic plants in general, that I saw with regret, more than one year afterwards, M. Hofmeister to still lend to me, to refute it, an opinion that I had given up [16].

II

GEOGRAPHICAL DISTRIBUTION. - STATIONS.

A. - The family Balanophoraceae includes today about thirty species distributed between the New and the Old World. In the latter, in fact Asia counts the greatest number of them; then comes Africa, and finally Australia and Europe, which do not have any more than one. *Cynomorium*, which belongs to us, is thus the only representative in our district of the sphere, and is one of the most curious orders in the vegetable kingdom. Its distribution is, however, not limited to Europe, since, having its principal focus in the hottest parts of the Mediterranean basin, it exists for this reason on a considerable portion of the northern coast of Africa. The surface which it occupies extends, as recognized by Joseph Hooker, to 50 degrees longitude, between the island of Lanzarota (one of the Canaries[17]) and the Nile delta. North in the south this surface has a development much less considerable.

It is on the island of Malta that the plant initially drew the attention of the botanists; Boccolle, the first who identified it, also announces it in Sicily, as in the small islands of Lampedouse, of Favignana, of Ronciglio (or Ronzillo), and on the coast of Tunis. Later, he discovered it in Tuscany, in the vicinity of Livourne (its most northern locality), then in Canaries, and finally in the southernmost part of the Hispanic peninsula [18].

B. - A fact important to note, and which distinguishes *Cynomorium* from all the other plants of its family, is its constant station on the maritime littoral, or at least on saline, ground. A correspondent of Boccone even ensures that it would be subjected, in sites [19] where it grows, close to Malta, with a continual inundation by the floods of the sea. If it is thus, it is only one exceptional case, as I could easily convince myself by my own observation on several points along the coast of Algeria.

I studied the vegetation of *Cynomorium* during April and May 1857 in the province of Or'an, where I could observe it in two very distinct types of localities; i.e. on the low dunes, in the immediate neighborhood of the sea, and in the salted plains which are more or less distant to it. The ground of the first is made of an almost pure sand, while in the second the ground is usually of a clay nature, clay-limestone, and often a little marshy. The differences which the vegetation of these various localities present are not less striking; thus, in the salted plains, in that of Sénia, for example, where I especially botanize, not only is the flora much more varied than on the dunes, but the plants which make it up are closer together. Moreover, because the majority of them rise two to four decimetres, it follows that one can sometimes cross a considerable extent without seeing the parasites, which seldom reach such a great height. In other points on the plain, to the contrary, just as on the dunes, the plants are sparser and the brownish red clubs of of *Cynomorium* attract a glance at a distance [20].

III

HOST PLANTS. - MODE OF VEGETATION. - DURATION.

A. - Micheli, as I already said, was the first to recognized the parasitic nature of *Cynomorium*; he indicates it on the roots of the Mastic trees and of Myrtle [21] in Africa, on those of Obione (*Halimus portulacoides*) in Malta, and on *Salsola vermiculata* in Livourne. Delicata (*Cat. flor. melit.*) found it beside *Inula crithmoides*, and M. Bourgeau on *Tamarix gallica*. These examples are already enough to give an idea of the diversity of plants from whom the parasite is ready to adopt host juices. I could, for my account, note its organic connection with so great a number of plants which constitute the foundation of the vegetation in the places where I observed it, that I do not think that there is temerity to advance that with this need it almost indifferently draws with all the source juices necessary for its food.

B. - In this great number of different host plants, there is however a capital distinction to establish. Thus, ones, such as *Medicago maculata* (var. *arabica*), *Melilotus parviflora* or *Lepturus incurvatus*, for example, are annual, and cannot, consequently, offer to the parasite more than momentary food. Others, on the contrary, like *Salsola*, *Tamarix*, *Statice*, etc, being long-lived, can provide it a more permanent nutrition; from here it results that the duration of the parasite is regulated implicitly on that of the plants with which it could establish its connections; it is, according to the circumstances, annual or long-lived. If, in their underground walk, the ramifications of the rhizome find themselves in communication only with annual plants, they still die at the end of the season with the annual floriferous stem which finishes them. If, on the contrary, they could draw up relationship with the more robust roots of a long-lived host plant, then their existence is prolonged, and the points thus supported become new centers of vegetation. One will be able to have an idea of that by carrying the eyes to plate XXIV, where I represented a regenerated seedling of *Cynomorium*. The group of floral axes which constitute it, as you can see, are erected [developed] from a central node (C) developed around a large root of

Salsola (S); this node is none other than an adventitious production of an rhizome A emanating from a center of vegetation more or less distant from that to which it itself has just given birth, and which, in its turn, will produce others, owing to the horizontally projected new branches. The essential condition of their formation will be the meeting of a sufficiently vigorous host plant to provide for it; this is what distinguishes this mode from propagation of that of ordinary prostrate plants, in which evolution of the buds of the rhizome, being subjected to any similar condition, is almost necessarily done. It is not besides to my knowledge which one still noted in similar fact for other parasitic plants on roots, though it is presumable that there are some.

IV

ORGANOGRAPHIC AND ANATOMICAL EXAMINATION OF THE RHIZOME AND ITS APPENDICES. ORGANS OF PARASITISM.

§1. - Rhizome.

A. - Although I spoke about the rhizome in the preceding chapter, I did not define it. Under this name I include all the portion of the plant located below these bulbiform bulges which can look like the origin of the floral stems or poles. Considering this sort, and by taking for type the example which I showed, the rhizome is made up of a fleshy central body (pl. XXIV, C), relatively little developed, and of a variable number [22] of fleshy branches also, some of which are detached; usually simple branches, sometimes however forked or differently ramified. By its small volume, this central part differs much from that of some other Balanophoraceae, at which its place is made up by a fleshy mass sometimes considerable and suited, so that it appears, to emit floral stems during several consecutive years.In *Cynomorium*, it does not appear to me, on the contrary, peculiar to provide buds during only one season.

So now, for this central body, one makes vertical sections which intersect at the same time some of the branches, one will be able to be convinced that those are only one extension of that one, the nature of tissues being identical in both. In the same underground branch, one finds, however, some differences to announce according to whether it is more or less old, or according to whether one more or less studies it far from its base or closer to the time of its first development. At that time, whether it does or does not develop later into a floral stem, it presents (pl. XXIV, bbb) in the shape of a cylindroid body, approximately the thickness of the small finger, of a whitish or a little pink color, apex of the cone rather acute and resemble on all parts of the fleshy rootlets, simple, straight or a little flexuous, the length is not as large as when one examines them more closely at the end of the branch or its point, that a longitudinal section shows us (pl. XXVII, fig. 1) formed by a certain number of small narrowly overlapping linear scales. These scales, of very cellulous texture, do not take any development, as long as the branch, continuing its horizontal walk, does not finish as a scape, and they end up disappearing. On the contrary, when this one has suddenly been provided an inflorescence, these scales become the organs of real importance, that I will describe further.

Rootlets, although they are more persistent than the transitory scales of the young branch, however, also end up fading, and show themselves more on the adult rhizome only in the shape of desiccated brownish fibrillae, which one would then suffer to guess as to their true nature.

Arriving at the limits of its growth, the underground branch has a brownish or blackish color sometimes resembling corroded wine dregs; it is cylindrical or compressed a little, more or less flexuous, and has a thickness from two to four centimeters. As for its length, it is even more variable, sometimes of a few centimetres, as one sees in the examples on plate XXIV, sometimes reaching several decimetres. Its surface is usually unequal and is often longitudinally wrinkled.

B. - To study the interior structure of the rhizome, it is enough to make of them some longitudinal and transverse sections. When the plant is fresh, the surface of these sections offers a whitish color comparable to that of a turnip, but at the end of a few minutes, the tissue takes a pink or reddish colour [23] and the fibro-vascular bundles which arose up to that point of the sections, in the form of lines or barely yellowish points, become more obvious. The provision of these bundles, announced by Unger and Joseph Hooker, is remarkable. They are numerous, thread-like, straight or slightly flexuous and irregularly disseminated within cellular tissue, so as to simulate (pl. XXVI, fig. 27) bundles of a comparable nature of a monocotyledonous stem, from which they are distinguished, however, by their parallelism; one can rather easily ensure oneself of this disposition by means of repeated longitudinal sections that allow at the same time to note that these bundles continue in the body of the rhizome and in its ramifications, and of those in the peduncles and inflorescences [24].

Examined under the microscope, the section of the fibro-vascular bundles of the adult rhizome [25] generally presents a little wedge-shaped figure, the acute part of which is sometimes directed towards the axis of the rhizome and sometimes to the other side. One discovers there, at first sight (pl. XXVI, fig. 30), two elements; the broadest half of the bundle being made up of smaller cells and with walls thinner than those which make the other half of it, i.e. the half which forms the narrowed part of the corner, and which is characterized by its darker colour.

If one studies these bundles in longitudinal section (pl. XXVI, fig. 31), it is seen that the layer which corresponds to the head of the corner is made of cells lengthened and transparent cut in bevel or cut straightforwardly at their end, with thin walls, recalling finally, by their form, young woody fibres, from which they would differ however in that they almost constantly contain a certain quantity of starch [26]; while the more opaque layer which is juxtaposed to it consists of striped or scalariform vessels with more or less broad or opened lines, ringed [looped] by (fig. 32) all the intermediaries with the reticulate vessels [27].

The cellular tissue of the rhizome is largely made of utricules, polygons, round or ellipsoidal, remarkable by the quantity of starch that they contain, especially in youth. In the immediate vicinity of the bundles these cells are smaller, but it is especially within the periphery of the branch that the reduction in volume of the utricules becomes remarkable (pl. XXVI, fig. 28), so much so that the aspect of the tissue is notably modified by it. This peripheral layer, very variable as to its thickness in the various parts of the plant, very variable also in the various individuals, represent in *Cynomorium* the cortical layer and also replaces the true epidermis which is not shown there so to speak.

There is, it is seen, in the organization of the underground stem of *Cynomorium*, several characters which in general distinguish it from that of the exogenic stems. Most important of these characters consists, without any doubt, of the dispersion of the fibro-vascular bundles within an almost homogeneous cellular framework, in which one does not observe, consequently, either pith nor circumscribed cortical layers, nor medullary rays. It is to be noticed, however, that by traversing the series of the species of the family, one finds passages between this provision and a more regular structure [28]. Who knows, on the other hand, how many of the absence medullary rays are frequent in the parasitic plants? One can say as much of the lack of tracheary development of that of the epidermis, stomata, etc.; and one thus concludes that, among the rather many anomalies that *Cynomorium* offers to us, in the organization of its stem, none can make one exclude it from the group of the dicotyledons, in which one rather generally agrees to classify it today.

§ 2. - Haustorial rootlets

A. - The tissue of the young underground branch, or what amounts to the same, that at the end of the rhizomes which have already acquired a certain length, is characterized more by the great deal of starch [29] that it contains rather than by the nature of its fibro-vascular bundles which are yet only made up of one element, i.e. of the lengthened and transparent cells which can look to one like woody fibre rudiments [30]. Consequently one should not expect to find another thing in the rootlets that emanates from this young branch. They are, indeed, never made up of that but by a single and central bundle, continuous with one of the bundles of the rhizome, and formed, like them, of narrow cells, with blunt or acute ends. This bundle is surrounded of a cellular tissue sheath also with lengthened meshes, and filled with grains of starch; grains of the same matter, but even smaller, occupy also the cavity of the cells which form the central bundle. The line of cells most external to the sheath is similar to those which are subjacent to it; it presents, however, a characteristic such that towards the extremity of the rootlet, some of the utricules which make it up are covered so as to make its surface more or less papillose.

B. - What are the functions of the organs that I have just described? They are undoubtedly intended, like the rootlets of plants in general, to pump from the ground juices which can be there; but there their role does not stop: they contribute moreover, like essential organs of parasitism, to put *Cynomorium* in communication with the roots of the host plants that it depends upon. If indeed one of these rootlets comes to meet a rootlet of a foreign plant, at once its end, by which the contact usually takes place, more or less bulges (pl. XXVII, fig. 2 and 8), and in the cortical tissue of this root a small cellular cone projects which penetrates to the central fibro-vascular bundle (fig. 9). This cone, as one can ensure oneself by inspection of the quoted figure, is often only one simple contraction of the bulging part of the rootlet of the parasite; but at other times, this end is flattened more or less, at the point of contact, the perforating cone (as M. Chatin calls it) is born more abruptly, and offers more clearly the aspect of a special organ. When the point of contact of the rootlets of the parasite with that of the host plant takes place laterally, compared to the first, the bulge of this one is less sensitive; I noticed, on the other hand, that in these cases, the host rootlet was sometimes taken in a notch or a cove [indentation] of the parasitic rootlet.

§ 3. - Tuber-haustoria.

A. – The mode of connection by means of the rootlets, such as I have just announced, is obviously that which puts, first of all, *Cynomorium* in connection with the plants from which it appropriates the sap: for the parasite, the purpose of this is especially to facilitate the means of benefitting from the most delicate roots of its nurses; but the grafts occurring on the larger roots consist of bulkier haustoria, located, like their precedents, on side parts of the rhizome, but being distinguished some in that they only take birth where their presence becomes necessary, in consequence of the excitation that they produced in the vicinity of the foreign root, and of the new vitality which results soon from the first absorption of juices. They are tubers of a very variable form, resulting perhaps sometimes from the increase in rootlets themselves, and whose volume varies as much as the figure; one and the other depend on the position and the size of the root on which they insert. Their importance, finally, can be such, that acting like ramifications of the rhizome, they become, as I showed above, new centers of vegetation. The tubers in question have, however, generally the form and the volume that I indicated in figures 10, 12 and 13 in plate XXVII, and as in plate XXIV (eee). These ones even insert on the end of the host root, that more or less spreads out to offer a broader surface for their insertion; the others draw up their relationship with the root on its side parts; the root, in this case does not itself undergo quite as significant a deformation outside, while only the haustorium itself was moulded on its surface, and even sometimes embraces it in an almost complete ring. It is understood, then that the connection of parasitic and host tissues takes place not by only one point but by a very extensive surface, where a rather complete fusion is established so that it is difficult to distinguish everywhere what belongs to the one and what belongs to the other. Only here and there does one see points where the direction of the cells still make it possible to note that it is by a series of simultaneous perforations that this connection took place.

B. - Nothing is more variable, moreover, than the disposition of tissues in these grafts, and the proportion of the cellular and vascular elements which contribute to form them. Among the many cases which can arise, I was satisfied to represent (pl. XXVII) two of those which appeared to me to offer the most interest. One of these figures (fig. 11) represents the longitudinal section of a very small portion of tissue taken at the insertion point of a tuber haustorium on the end of a root of *Salsola* (fig. 10). This graft is pointed out by the complete absence of vessels in the part of the haustorium subjected to examination and by the clear way in which the vessels of the host root stop at the point of contact with parasite tissue [31], at the same time as they underwent an obvious multiplication there. It would be difficult, I think, to find a better example of the opposite opinion of Unger, who believed to be able to establish that, in certain Balanophoracea (with which he includes *Cynomorium*), the vessels of the host plant penetrate to the centre of the rhizome, that thus becomes an intermediate body by its nature between the parasite and the host plant [32]. In the case that I present there is, in truth, a species with an entaglement of tissues similar to that which takes place in the grafts of certain *Loranthus* on the branches which support them, but nothing that resembles vascular bundles which would pass from the one into the other.

The second example that I represented (fig. 14) is that of the insertion of a tuber-haustorium on the side parts of a large root of *Salsola*. Surfaces of contact being rather considerable, the insertion of the parasite was done there by means of several cones or spindles [sucker with conical or fusiform shape] which penetrate through the bark of the root, perpendicular to its axis, to the centre of the woody tissue. One of these spindles is formed mainly by vessels which penetrate between woody fibres and the vessels of *Salsola*, so as to contact them directly; while the other, which is provided with vessels only in its center, is in immediate connection with the same parts only by means of its cellular tissue.

FLORAL STEM. - SCALES. - INFLORESCENCE.

§ 1. – Scape.

The floral stem, or scape, is the aerial prolongation of the rhizome with which it presents, in particular, the greatest analogy from the anatomical point of view. The underground branch which must give it birth is bent on top and becomes ascending from horizontal, and sheathed with solid and persistent scales which replace, at its end, the delicate and transitory squamules which were in question previously. These new scales are distributed in spiral, like the leaves of other plants, and are intended to represent these last organs which one does not find in a perfect state in any the plants of this family; the others protect the inflorescence during its early age. In the adult state, this one occupies usually almost all the higher half, sometimes only one third or a quarter of the floriferous stem of which the total height is then 15 to 30, or more rarely 40 centimetres.

The lower part of the scape differs externally from the contiguous part of the rhizome by its bulbiforme thickening (which is however not constant), by the number and the development of its scales [33], and finally by the frequent absence of rootlets. In the less thick part of the stem, that which is usually immediately below the flowers, and it is generally also the only one which rises above ground-level; it is characterized, up to a certain point, by the presence of a multitude of fleshy squamules, or of large papillae, roughcasting the space located between the triangular and strongly acuminate scales which furnish it a long way. These papillae, of unspecified form (pl. XXVI, fig. 29), replace the pilous organs of the plants provided with epidermis, and continue themselves, by their base, with surface cellular tissue of the scape, composed of cells at the same time smaller than those which are shown more deeply, and less richly starchy, at the same time as they contain a stronger proportion of colored material.

The floral summit, in the shape of club in *Cynomorium*, varies little in its proportions [34]: it is cylindroid and more or less lengthened, of which the diameter, in it most bulging part, is two to four, or even five centimetres, and of which the surface, equal, though rough, is formed by the free extremities of the innumerable elements of the inflorescence. As for its color, one could believe, according to the Linnaean epithet, that it is usually very brilliant; it is, however, not, and I do not exaggerate while affirming, in the few hundreds of samples that I had under the eyes, I did not see any whose nuance approached that which Linné allots to the plant. This sample (pl. XXIV, B) was of a beautiful carmine, but not scarlet, and this is undoubtedly the natural color of the plant; but its usual color, that which results obviously from the thirst producing action of the air and some other causes, is a brownish or purplish red, or a wine red colour. Micheli had applied to *Cynomorium* the epithet of *purpureum* that Linné could, without disadvantage, have conserved.

The primitive colour of the scape is also dyed with carmine, at least in the part close to the inflorescence, and though less intense than that of the inflorescence, it is also fugacious, and passes very quickly to a nuance of purple or brick.

The odor which *Cynomorium* arrived at in the adult state was compared by some to that of spoiled meat; I found it, for my account, more analogous to that of desiccated meat. Its savour, very styptic, as I said, is nothing less than pleasant; I must point out, however, that it is more marked in the aerial part of the plant than in the rhizome.

§ 2. - Scales.

The general disposition of the scales, about which I have spoken only incidentally, was noted carefully by Joseph Hooker. Their form is that of an oval or a more or less acuminate triangle. The quoted author shows them to us, in the very young age of the plant, numerous and overlapping at the base of the bulged and often spindle-shaped scape, widened and disseminated above this part, and again overlapping in the young inflorescence that they cover in entirety. I add that those which are even born on the various parts of the scape are adnate by their base; while those that develop in the inflorescence are peltate (pl. XXV, fig. 3), the higher and acuminate part of the blade of these last being constantly much larger than the lower part which is at the same time blunt. As the inflorescence develops, these scales, originally brought closer, deviate from the others, and are finally so separate that at the time when the floral mass rises above ground-level, they are hardly realized, the majority being broken or more or less deformed and partially withdrawn into the milieu of flowers, as a consequence of the lack of lengthening of their pedicel. This one is usually flattened from top to bottom, and its thickness is larger on the side of the blade, which gives it, when the latter has suddenly been missed, the figure of a corner. The fabric of the one and other consists of a resistant cellular tissue (pl. XXV, fig. 4), traversed by one or more vascular strands, that J. Hooker saw being detached from the bundle which provides to the floralmass located immediately above and probably originating in its axil.

The epidermis of the foliar organs of *Cynomorium* are little characterized, and never present stomata.

§ 3. - Inflorescence.

A. - What is now the nature of the inflorescence of *Cynomorium*? To which type is it connected? - It is a question which first of all does not appear very easy to solve; the innumerable elements which make it up seem, indeed, like the flowers of *Typha*, to so uniformly cover all the surface of the spadiciform part of the scape that one believes to have under the eyes a simple capitulum; it was as such that it generally appeared to be consider, before the communication that I made on this subject at the Société botanique de France, in July 1857 [35], and in which I showed that this inflorescence resulted from an aggregation of an extraordinary number of small simple cymes [dichasia], often of perfect regularity (pl. XXV, fig. 8). But to completely inform oneself on the complex nature of the false capitulae of *Cynomorium*, it is essential to study it in its youth, i.e. when the floriferous end of the scape, hidden in the ground, is still covered with its armour of scales or bracts. One sees the flowers then being borne in distinct groups, with the axil of bracts laid out in spiral, like those of a cone of a cycad. Considered thus, as a whole, the inflorescence is obviously indefinite; but one then has suddenly examined attentively these partial inflorescences which, initially isolated, become finally confluent, one is not long in being convinced that each one of them has as a type the summit most definitely characterized. It follows from there that the inflorescence of *Cynomorium* is that which one calls mixed: it is indefinite as a whole, and defined in each one of its parts, like that of the Rose Trémière (*Althea rosea*), for example. If the interesting characteristic that I earlier had announce were not recognized, one should not, I believe, catch this with the state of the samples which the botanists had at their disposal; on the fresh plant nothing is more easy to note [36].

B. - To supplement the description of the inflorescence, it remains for me to say that the peltate scales which I described as being used for protection in youth, and which are only the principal bracts, are not, by far, the sole organs of this nature which meet there. It is indeed easy to be ensured, by an attentive examination, that the innumerable linear bracteoles, or wedge-shaped spathes (pl. XXV, fig. 5), intermingled with the flowers, also play, for the majority, the same role as those analogous inflorescences of other plants. It is important, however, to note that the position of much of these lower-order bracts are strictly not always that which they should be, because of the adherence which they contract with the branches of the summit of which they depend, to the displacement owing to their association. It arrives finally, very frequently, that many of the bracts fall off, the dichotomous branches showing some, then all or the majority (fig. 8) being entirely deprived [37]. The shape of these small organs is as variable as their size; one and the other undoubtedly depending, up to a certain point, more or less on compression to which they are subjected by the close organs, but especially from the importance of the ramifications of the summit to which they are attached. In truth, one observes all the intermediate forms between the peltate scales (which were in question earlier) and the linear bracteoles which are borne from the last ramifications of the inflorescence.

As one could expect, the tissue of these bracteoles is much more delicate than that of the peltate bracts. The majority are made of two or three rows of transparent cells, those of the part higher or widened bracteole usually round and being inflated by coloured juices (pl. XXV, fig. 6), those which constitute the narrowed lower part of the organ being, on the contrary, smaller, lengthened and generally colourless. The majority of these organs present, moreover, in their axis, a bundle of striped vessels (fig. 7) well developed, analogous with those which one meets in other parts of the plant.

VI

REPRODUCTIVE ORGANS

§ 1.

One of the general characteristics of the order Balanophoraceae is to have unisexual flowers, monoecious or dioecious. The only exception to that rule is offered to us by *Cynomorium* whose flowers are polygamous. I will point out, however, that the hermaphroditic flowers are in small numbers relative to the male flowers, and especially with the female flowers, which explains why several of the authors who occupied themselves of this plant did not see them. Male flowers, more than the hermaphrodites, are incomparably less than the females, without it being possible to fix in this respect a rule of proportion. It is difficult, by the same reason, to determine their relative position in the inflorescence; the only thing that it appeared possible for me to infer from an examination of this question, is that the male flowers never meet, so to speak, on the final ramifications of the summits, occupied, almost exclusively, by the female flowers.

One understands, by what I said of the nature of the inflorescence, that flowering must have one rather long duration [38]. On another hand, flowers of the one and other sex developing with one another simultaneously, the plant is under the conditions most favorable to its fertilization; also the number of the fertilized ovaries is constantly very-considerable, while in much of other species of the family, less supported by nature under this ratio, in which, for example, the evolution of the sexes takes place at different times, fecundation takes place, in general, on a very-small scale, or is even completely lacking.

§ 2. - Male Flowers.

Male flowers (pl. XXV, fig. 9, 10, 11) consist of a well developed perianth surrounding a single stamen and a deformed style.

A. - The floral envelope is formed by a variable number (usually 4 to 6, less often 7 to 8 or 1 to 3) of spatulate parts, analogous in their aspect and structure with the bracteoles of average size; they form sometimes a regular verticil surrounding the base of the filament, and sometimes an irregular spiral on the more or less lengthened pedicel of the flower.

B. – The stamen does not offer anything in its form nor in its structure which differentiates it from those of the majority of the phanerogamous plants. The anther, of pink or purple color, is bilobate and introrse; its oblong thecae open by a longitudinal slits, and become confluent with their higher part, at the moment of dehiscence (fig. 14). A little-developed connective joins together the lobes and fastens by its dorsal part at the higher end the filament whose length generally exceeds a third or half that of the perianth divisions (fig. 11) and is enough, moreover, such that at the moment of its dehiscence, the anther is carried apart from the compact mass of the flowers and of bracts that surround it.

Pollen is pale yellow; the grains which constitute it are globulous and smooth when they are dry (fig. 13, c); but, placed in water, they take the various aspects which I represented in figure 15, and soon emit, by side openings, one or more tubes.

The walls of the anther are formed (fig. 12 and 13) of a simple layer of large fibrous cells (fig. 1.3, a), covered, outwardly by a layer of epidermal cells (b).

C. – The base of the filament is with a sheath consisting of a remarkable organ (fig. 9, 10, 11) that L. Cl. Richard described under the name palea, and which it obviously is not, but was extremely well recognized by J Hooker as a modified style. It is a fleshy body, of a very-sharp dyed with carmine colour, semi-cylindrical or wedge-shaped, truncated or notched at its upper part, and provided, on one of its faces, with a more or less deep longitudinal groove which receives the filament. It is shown in the center of the young flower, immediately after divisions of the perianth, and had already considerably increased when the stamen is still little developed (fig. 9). As for its position, it always appeared me to be external compared to the axis of the partial inflorescence on which it depends, which still supports the assumption establishing that it is only a modified style. Its structure is entirely cellulous.

§ 3. - Female Flowers.

A. – At the beginning of this chapter, I announced, in the presence of hermaphroditic flowers, a character by which *Cynomorium* differed from all the other species of the family; I then add here that it is still distinguished from the majority of them by a much greater perfection of its female flowers which are rather often equipped with a floral envelope [39], consisting of a very variable number (1 to 8) of free and epigynous perianth parts [folioles]. This perianth is also entirely lacking sometimes, and when it exists, it is never as developed as in the male flowers, the parts which make it up being constantly much narrower; they are besides also in these flowers much more prone to dissociate than in those from the opposite sex, then being borne at various heights on the wall of the ovary, just like saw we them being borne from the pedicel of the male flowers, a pedicel that J. Hooker considers (1. C, p. 35), and with much reason it seems to me, as representative of an undeveloped ovary [40]. The study of the first age of the female flower will emphasize the exactitude of this association, at the same time as it will initiate us with the history of one of the most interesting parts of the plant which is the subject of this study.

B. - *Development of the perianth, style, ovary and ovule*. - When one examines a very young female flower, such as one sees at the end of one of the last ramifications of a young apex (pl. XXV, fig. 8), one finds it represented by a small cylindrical body, rounded at its free end, and often accompanied, at its base, by one linear bract (pl. XXVI, fig. 1). This small papilliform body has a perfectly homogeneous cellular texture, and can be looked at only as one ramification of the axis of the summit, borne in the axil of the bract which is joined to it, and still deprived of any appendicular organ.

The first clue to the appearance of the floral organs is seen at the top of the papilla which seems to be depressed slightly, while letting one see at its circumference some vague crenellations (fig. 2). As those are more pronounced, one distinguishes there, if there is under the eyes a flower whose perianth must have three leaflets (fig. 4), four small mamelons, three outside are incipient perigonial divisions, and the fourth, central, the rudiment of a style [41].

From this moment, four mamelons, almost equal and similar between them up to that point, cease being it: the central mamelon taking the initiative and offering at the same time, on one of its faces, a groove which seems to penetrate in a lower position between the perigonial mamelons.

Another very-important change coincides with those which I have just announced: the pedicelliform part of the flower, which had preserved its homogeneity up to now, presents towards its higher part (fig. 5), and immediately below the base the style, a small opaque spot which indicates that some modification took place in its centre. This comes, indeed, maybe by a tear, maybe by any other means, to check the condition of the things, one realizes (fig. 6) that, in the place that I indicated, it hollowed out a small cavity, and that, in this cavity, it developed a new body which fills it rather exactly, and which is only one pendant ovule, whose funiculus attaches at a point on the wall which corresponds to the anterior part of the groove of the style. This cavity, as it appeared to me at that time, was always closed or did it communicate before with the outside by a hiatus open at the base of the carpel which constitutes the style? - Such was the doubt that I expressed in front of the Société botanique de France, when I subjected to them these facts, in July 1857; and I acknowledge with regret that today, in spite of the new searchings to which I delivered myself, I do not dare be any more affirmative. I will thus limit myself to saying, that while being based on analogy, one is allowed to believe that the ovarian cavity communicates at a certain time, and during a very short time, with the outside, and that it grows hollow, to some extent in the manner of a well, at the bottom of the depression that forms, around the stylar mamelon, young perigonial laciniations. - One will understand the difficulties one meets in the appreciation of the fact, if there is regard for the volume and the nature of the object to which this research relates; its diameter is indeed only a fraction of a millimetre, and its texture is so delicate, that the least contact is enough to deform it.

The subsequent development of the ovary and the ovule is a relatively easy observation, for little which one has at his disposal of good materials, and the results which this study provided me are soon found complete enough to convince me that the ideas that I have formed, in my first research on the nature of the pistil of Balanophoraceae, were completely erroneous. In a word (as I said in the *Bulletin* de la Société botanique), the ovary and the ovule of *Cynomorium* do not present anything which primarily differentiates them from those of the majority of the other phanerogamic plants. My observations on this subject exactly agree with those points of M. Hofmeister, whose first work on this matter had not yet arrived in Paris at the time when I made the communication about which I spoke earlier; but in addition they differ much from those of Doctor J. Hooker, in that he (1. C, p. 18) never managed to discover in the ovule the traces of integuments at the time he examined them; while these results are invariably provided, on the contrary, by the observations of M. Hofmeister and those of mine [42]. That one examines, for example, this body at an age more advanced than that where we left it earlier, then one will see (fig. 7) that, not far from its free end, it presents a rather thin annular pad which surrounds a still rather considerable projecting portion of the nucellus. This pad, I hardly need to say, is the integument of the ovule, an integument which remains single. Continuing to increase, this envelope soon does not let one see the nucellus but by a small circular opening (fig. 8) which is decreasing moreover, not to appear, on the young seed, that in the shape of a small spot, still very visible however on the testa of the ripe seed (fig. 9). It is the case to point out that the micropylar opening of the ovule is not placed completely at the opposite end of the point of the funiculus; it constantly appears at the lower part of the wall which corresponds to the groove of the style, which indicates that there is the beginning of the anatropous (condition); a fact confirmed by the existence of a short raphe. Notwithstanding this characteristic, the ovule of *Cynomorium* should not however be classified among the hanging orthotropic ovules; there exist, as one knows, a rather small number of examples of this.

Before passing on to the examination of the seed, it remains for me to follow the development of the other parts of the flower, as from the moment when we suspended study of it until their adulthood.

When we lost sight of the young perigonial divisions, these appendices [appendages?] rose yet only very little above the top of the ovary. The style which already exceeded the perigonial mamelons by almost half its height, continues to take the initiative, affecting a regularly linear form, and finally reaching one and half the overall length of the adult ovary. The leaflets of the perigone continue, on their side, to increase until they acquire approximately two thirds the total height of the style. The end of this one (pl. XXV, fig. 16 and 17.) is round, but without quite a significant bulge, and a stigmatic surface regularly embossed by the projection of the ovoid and uniserial cells which make it up and which distends an intense juice of a carmine color. The groove or furrow in which we noted the presence on the style, as if to mark its appearance, so to speak, is attached to its axis, and is prolonged at the adult state [43].

The distribution of the vessels in the female flower was clearly shown by the last authors who wrote on *Cynomorium*. The bundle which must provide these striped vessels (fig. 20) usually forks at the top of the pedicel; the two secondary bundles resulting from this division go up each side of the ovary, provide, making way, traces to the perigonial leaflets, and form, under the base of the style, a very visible anastomosis, from where are detached a short branch for the ovule, and two other longer branches and perfectly parallels which place one and on the other side of the groove of the style (fig. 19) to finish, without meeting, very close to its top. I sought, by means of a theoretical figure (fig. 25), to give an idea even more complete on this distribution; I will point out, however, that the branches which go to the floral envelope do not always have the importance that I granted to them, since it rather often arises that some less developed leaflets do not receive any at all.[44]

The ovarian cellular tissue, within which meet the vascular bundles, does not present anything to be noted, if it is only below the style, it is less tight than elsewhere; in a lower position it is continued without line of demarcation with tissue of the pedicel which is usually very short, and, by its intermediary, with that of the axis on which it was borne.

C. *Symmetry of the flower*. - the true nature of the inflorescence being known me, it was not difficult for to me to note the relative position of the flower. It is such as the groove of the style is rather constantly directed [45] towards the axis of the cyme on which the flower depends.

As for the relative position of the style and divisions of the perigone, it does not present anything well-determined, at least seemingly, which is rather easy to understand if one keeps in mind the variations which so frequently take place in the number of the parts which make the floral envelope. While supposing, for example, with J. Hooker, that the number of the leaflets of the envelope is normally six, it is not obvious that, when it is less (and I will dare state that this is the rule), it is at least extremely probable that it is in consequence of the abortion of some or one of several of these parts. Thus there will be then a different diagram, according to whether this abortion relates to such or such leaflet. This is indeed the relationship. One can establish, however, that, when perigonial divisions are three (pl. XXV, fig. 16), a rather frequent case, one finds some, most usually one on each side of the style, and the third, ahead or behind of this organ [46]. With these data one will have no difficulty in supposing what will have to be the position of the other three.

D. *Fruit, seed.* - When the fruit of *Cynomorium* becomes ripe, the style and the perigonial leaflets fade but the ovarian tissue is distended and thinned and its succulent appearance and white or pink color is preserved. Under the influence of moisture, this pericarp is not long however in being destroyed.

The single *seed* (pl. XXVI, fig. 9) is globulous, except a light projection towards its funiculus point, and its surface examined with the magnifying glass is finely reticulate. Its total diameter is a millimetre and a third to a millimetre and half. The micropyle, placed almost opposite the hilum, is revealed by a dark purpurin spot which is based, by its edges, on a clearer general color.

The sections which I made represent (pl. XXV, fig. 22, and pl. XXVI, fig. 10) will allow the reader to have a rather exact idea of the internal structure of this great part of the plant; a part already very often studied, I agree, but on which there remains, however, still something to say, since J. Hooker, the last who was occupied by some of this, refused to admit the presence of a testa, and, consequently, of a micropyle, already shown for us by the examination of the development of the ovule. [47] By compensation, he described, much more exactly than all his precursors, the form, dimensions and the position of the embryo; also I will have, under this report, very little to add to the excellent observations that his report contains.

Such as I saw it, the seed of *Cynomorium* appeared me to include (pl. XXVI, fig. 10) three essential parts that I will examine successively:

1˚ The *testa*, of which the thickness, on the side at the point of the funiculus (h) of the seed, is approximately double what it is towards its micropylar opening (micr). It consists of five to ten rows of cells containing a rather great quantity of resinous matter. The cells of the external rows are a little larger than the following ones; those of the internal line form almost a distinct layer; they are smaller, with thicker walls, and of a beautiful red color which slices in an extremely elegant way on those of close tissues, and forms a line of very clear demarcation between the integument of the seed and endosperm, to which it is closely adherent besides; at the point which corresponds to the chalaza (ch), one sees this internal testa layer to thicken a little and form, on the surface of the endosperm, a well-manefested depression. In the ovule, one rather distinctly sees a vascular strand which crosses the integumentary layer, to lead to the base of the nucellus; but I could not show the existence of it in any of the many sections that I made from ripe seed; this is why I did not indicate it in my figures.

2° *Endosperm* (1. c., *alb*) is, of all the elements of seed, that tissue which is most resistant; it is also the part best known. Its section [48], exactly circular, except the chalazal depression indicated earler, which shows it is to be composed of translucent and colourless cells, with thick walls and the consistency of a little cornea, ones of rather regular form, oblong or cubic, occupying the periphery; others more central, with sinuous walls, communicating together by pores (pl. XXVI, fig. 11). Doctor Lindley reported in these cells the presence of starch that J. Hooker did not find there. As for me, I always found it like a fleshy endosperm [49].

3° *The embryo* (1. c., *embr*) described so well by J. Hooker, fills a cavity close to the base of the endosperm. It is a small body in the shape of a spinning top (pl. XXVI, fig. 12), a little broader than long, whose point is rounded, which reaches the periphery of the endosperm, is turned directly towards the micropyle, and whose body does not present, in any point, continuity nor traces of lobation; it is an acotyledonous embryo in all the meaning of the word, and that one can suppose formed primarily by a stem [axis, strictly an epicotyl] whose radicular end is naturally indicated by its direction towards the opening of the integument of the seed, as well as by the study of the germination of the plant, in question further.

§ 4. - Hermaphroditic Flowers.

When one withdraws from a male flower its stamen, places it at the top of the ovary of a female flower, immediately opposite the groove of the style, then that will be one of the hermaphrodite flowers of *Cynomorium* (pl. XXV, fig. 23). The description that I previously gave of the organs of the one and the other sex exempt me from going into other details on their composition. I will thus restrict myself to draw attention to a curious fact about dichogamy which they present, and which all the more deserves to be mentioned that it is not without analogy with that which was noted formerly by L. Cl. Richard, in *Helosis guianensis*, and, more recently, by Doctor Hooker, in *Balanophora* of India. In the plants of these genera, where the flowers are monoecious and are joined together on the same axis, the female flowers arrive nevertheless at perfection long enough before the males, so that they are already faded, when stamens are ready to function. If thus the female flowers were fertilized, they could be so only by the pollen of a close inflorescence. Eh well! what occurs there, between the male flowers and the female flowers of the same inflorescence, has, in *Cynomorium*, between the organs male and female of the same flower; the pistil of the hermaphrodite flowers of this plant being already faded for a long time (pl. XXV, fig. 24), and the embryo in full process of development, before the anther was not able at the point to be able to emit its pollen.

The existence of the hermaphroditic flowers of *Cynomorium* was initially stated by Linné, and they were described carefully, more lately, by J. Hooker, who drew, in his analogy with the flowers of *Hippuris*, one of the reasons he proposed bringing together the order of Balanophorales and that of Haloraginales.

VII

GERMINATION.

§ 1.

If, as it was supposed, yet well not a long time ago, the embryo of *Cynomorium* consisted only of one small globulous cellular mass, without distinctive parts; if, even, as some also believed it, the ovule lacked integuments, the study of germination had been almost indispensible with the complete knowledge of the seed. But, in the current state of science in this respect, one could only confirm the exactitude of already acquired facts. By undertaking it, my goal thus was especially to attend to the development of the first organs of the parasite and to recognize the mechanism by which it is put in communication with the plants which must contribute to its food. It will be seen that if the results at which I arrived are not absolutely complete, they are nevertheless of rather great interest, and that finally one can, without too much improbability, fill in the gaps in thought which they still offer.

§ 2.

Knowing that one had already made several useless attempts to obtain the germination of seeds of Balanophoraceae, I sought to place myself, as of the principle, under the most favorable conditions to achieve this goal. Useful to me for this purpose was a small greenhouse with cuttings, where heat could be regulated at will, and I chose, to make my sowings in soil [derived from the place] where the plant vegetates in its native land; this did not prevent me, however, to make other sowings under different conditions so that the experiments were comparable.

All of the seeds I used were extracted from the same inflorescence and put into the soil the first days of June, to a depth of only two or three millimetres; the soil being maintained, consequently, in a constant state of moisture. The temperature of the apparatus was taken to 20 degrees Centigrade, and maintained at this point without interruption for one whole month: but there did not appear any interior change in the seeds that announced that germination had ensued. Thinking whereas that the temperature of 20 degrees was too low, I changed it to 30 [50], and I gained satisfaction 18 days afterwards to note that germination had started.

One of the seeds sown in the salty ground of Oran [51] had indeed emitted a whitish and semi-translucent radicle, of a very-delicate texture, already four millimetres long, and which, singular thing, instead of plunging downwards towards the bottom of the vase which contained it, on the contrary, it went up vertically to the surface of the ground and rose above it to a height of two millimetres.

Naturally very-surprised by this phenomenon, but not knowing, however, up to which point it could be constant, I first of all did not dare to allot to it a great importance; I occupied myself only with the germination itself; I realized easily by means of sections passing through the axis of the radicle, reproduced most perfectly in figure 14 of plate XXVI. By comparing it to figure 10 on the same plate, one will seize, at first glance, the changes that took place there, and confirm point in point the exactitude of the deductions made *a priori* on the nature of the various parts of the seed.

It is only the radicular end of the embryo which gained considerable development (fig. 14, R), while being prolonged on the outside by the very slack micropylar opening of the testa. The opposite (cotyledonary) end remained in place simply having somewhat lost its primitive form; and the body of the embryo, whose volume increased by a third or double, encroached as much on the place occupied by the softened endosperm or partially reabsorbed it.

Internally, the tissue of the embryo, whose cells lengthened in the direction of the micropyle, continued, without a line of demarcation with the tissue of the radicle, and one and the other is pointed out by the presence of in all their central cells a notable quantity of starch, that under the microscope gives them an opaque colour which one does not find in two or three lines of external cells. It is noticed, however, that the quantity of this matter contained in the part of the embryo comprising endosperm is less than in its external prolongation. Oil appears to have completely disappeared from it.

The free end of the radicle is pointed out by the projection of its cellular surface, that manefests there as a papillose surface and moreover give it an external resemblance to the haustorial rootlets which resemble the young rhizomes of the adult plant; they also approach those by their internal structure.

§ 3.

The appearance of the plantlet that I have just described was promptly followed by that of several others, represented, like the first, by the radicular prolongation of the embryo, and, like it, drawing itself up vertically towards the sky. From this moment, a day hardly occurred until the end of the month where I did not have the occasion to note the exit of some new radicle, and all, without exception, instead of moving in bottom, like the radicles of the ordinary plants, rose in the air in the manner of the stems.

While thinking of this singular phenomenon, the question which naturally came to my mind was to know if the direction taken by the radicle of my plant did not depend on the conditions under which I had made my sowings, rather different conditions indeed from the point of view of the distribution of heat and those which are presented in nature [52]. Would seeds of other plants, for example, placed under the same conditions, behave in an analogous manner? - I soon found the solution to this last problem, by germinating two host plants of *Cynomorium* of which I had hastened to entrust the seeds in the same soil as soon as I saw appearing the first radicles of the parasite. They were a leguminous plant (*Melilotus parriflora*) and a graminaceous one (*Rottbœllia incurvata*). They did not delay in their development, but their radicles behaved exactly as if germination had been done under the ordinary conditions [53]. It remained to determined what was the intensity of the force that carried the radicle towards the sky, and up to which point it was persistent.

To this end, a seed that presented, at the moment of its germination on the surface of the ground, the radicle in the position represented by figure 13 (pl. XXVI), was turned over so that the radicle pointed towards the ground; however, two days afterwards this radicle had been rectified again, and the position indicated by figure 17 was occupied. Figure 18 represents a radicle whose development was opposed twice of the kind, and which offers two successive curves resulting one and the other of the tendency to take again the position of which I had disturbed it. Lastly, a third experiment provides me a result even more decisive. A germinated seed, whose radicle rose to approximately 3 millimetres above ground level and was turned over so that this radicle was directed directly downward (fig. 19). Fifteen days afterwards, having unearthed it, I found that it had doubled in length, while bending abruptly to regain the light (fig. 20).

The facts that I have just announced prove, if I am not mistaken, that there is in the radicle of *Cynomorium* a remarkable tendency to move towards the sky, and that this tendency appears under circumstances where the radicle of other plants move naturally towards the center of the ground; this is all the more interesting a phenomenon in that it was still observed to be similar to any other representative of the vegetable kingdom [54], but which is perhaps explained, up to a certain point, by the particular constitution of the seed which we examine [55]. The embryo being indeed to some extent reduced to the axis [epicotyl + hypocotyl], one can suppose that the organ which looks like a radicle (and one could not apply another name to it), takes part rather primarily of the nature of the stems so one is not to be astonished too much that it behaves like such [56]. - It is rather probable, on another side, that the plant derives some material advantage from this anomalous direction of its first emanation;could this not be, for example, that by going [this way] it meets rootlets of the plant which must be used by it as host [nurse].

§ 4.

I must return to my account maintaining the result of the various attempts that I made to bring forth the later development of *Cynomorium*, with this I could obviously only hope to arrive at the favour of a graft of the radicle onto a foreign plant. It was indeed obvious, according to the way in which the plantlets until this moment [57] had behaved, that if they drew some nutrition from their envelopes, this nutrition could not be quite substantial. In order to test this assumption, I had sown a certain number of seeds of two of the plants on which the parasite sometimes fixes its haustoria in the plains of the surroundings of Oran; it was, as I mentioned above, *Rottbœllia incurvata* and *Melilotus parviflora*, that were not longer than a day in putting out their radicle and their axis, and I at once brought closer the radicles *Cynomorium*, seeking, as much as possible, to vary the situations and the points of contact. But maybe the conditions under which the bringing together took place were not those where it is made naturally, maybe by very other causes, I in general obtained only the result indicated by figures 21 and 22; i.e. the radicle of the parasite being put in rapport, by its end, with that of the host plant (fig. 21), instead of joining itself there, soon rectified itself, to take again its primitive direction (fig. 22). It was the same when, instead of putting the radicle of *Cynomorium* in connection with the downward axis of the host, I brought it closer to the stem.

I did not obtain, ultimately, a beginning of success except in only one case: it was with a young *Melilotus*, close to the radicle of which I had horizontally laid down a germinated seed of *Cynomorium*, so that the end of its radicular prolongation was plunged in the milieu of hairs which covered the young root of the plant that I intended for its host. Six days afterwards, I noted that the radicle of the parasite had lengthened approximately a millimetre, while spreading out slightly, on that of the *Melilotus* (fig. 23). A little later I observed than the part close to the point of contact had tested a spindle-shaped thickening, and soon I saw the higher face of this one split to deliver passage initially (fig. 24) to a first, then to a second rootlet (fig. 25), analogous with the radicle itself, and which, like it, moved vertically to the top.

It is when things had arrived at this point that I regretted to see the development of the young plant stop. However, one is allowed to suppose that if, instead of being made on the surface of the ground, the experiment had taken place in its centre, and in a milieu of hairy rootlets of an already vigorous host plant, I would have announced the appearance that they would not have faded but would have been grafted in their turn; new rootlets would have occurred following these, and in the most active center of this vegetation, where would have flowed in greater abundance nutritive juices and this would have finally become a true rhizome.

I recommend thus to those who want to resume the study of the early age of this plant to bury germinated seeds below the sowing of the host plants, so that the rootlets of those can go to their meeting. One will not be able, it is true, to also conveniently follow in this way the progress of the vegetation, but a more complete result will probably be obtained.

EXPLANATION OF THE PLATES

N. B. - In plates XXV, XXVI and XXVII, the objects are represented more or less expanded, except in figures 1 to 3 of the pl. XXV, 26 and 27 of the pl. XXVI, and 4, 8, 10, 12 and 13 of the pl. XXVII, where they are seen of natural size.

PLATE XXIV

CYNOMORIUM COCCINEUM L. - floriferous and fruit-bearing individual smaller than in nature; have to bring closer figures 1 and 2 the following plate, which represents portions of the plant of natural size. - a: rhizome of which an end, grafted on the medium of a root of *Salsola vermiculata* (S), developed in a central body or node (C), which gave birth, in its turn, to a considerable number of simple branches, the majority ascending and finished by floral poles. One of these last (B) did not undergo the action of the air long enough yet so that the inflorescence lost the sharp but transitory color which characterizes the floral organs in a state of freshness; - *bbb*: young roughcast rhizomes of rootlet-haustoria; similar rootlets also roughcast the other rhizomes, on which one still sees there that of it and faded stubs: *eeee*: tuber-haustoria inserted on the impressed extremities of a root of *Salsola*.

PLATE XXV

Fig. 1: longitudinal section of the higher part of a fruit-bearing stem of *Cynomorium*, of natural size;
Fig. 2: transverse section of a part of the same stem;
Fig. 3: two of the principal bracts of the inflorescence, of natural size;
Fig. 4: transverse section of the blade of one of the preceding bracts;
Fig. 5: very-small portion of a inflorescence, including a male flower and several female flowers; one also sees several orders of bracteoles there;
Fig. 6: floral bract insulated on which one sees the provision of the surface cells, and by transparency, the vascular bundle which occupies its axis;
Fig. 7: part of a bundle of striped vessels withdrawn from one floral bract;
Fig. 8: very-small portion of the inflorescence only made up of female flowers of very different ages, laid out on a regularly dichotomous axis;
Fig. 9: young male flower;
Fig. 10: another male flower, older;
Fig. 11: adult male flower;
Fig. 12: transverse section of an anther before its dehiscence;
Fig 13: very-small portion of tissue of the wall of the anther; *a*: fibrous cells; *b*: epidermal cells; *c*: pollen grains;
Fig. 14: dehiscent anther;
Fig. 15: pollen grains which remained a little in water and one emits a pollen tube;
Fig. 16: adult female flower, with three perigonial leaflets;
Fig. 17: stigma and higher part of the style on one of the faces of which a portion of the furrow is noticed which traverses it;
Fig. 18: stigma and higher part of the style split longitudinally in the direction of the groove of this last;

Fig. 19: transverse section of the style, showing the position of the two bundles of striped vessels which traverse this organ in all its length;
Fig. 20: small portion of one of the vascular bundles of the style much enlarged;
Fig. 21: female flower, a little before the time of fruit maturity;
Fig. 22: longitudinal section of the fruit; *p*: pericarp; *t*: testa; *ch*: chalaza; *micr*: micropyle, *alb*: endosperm; *embr*: embryo; *v*: point where the vascular bundles of the ovary meet at their top, by giving birth on the one hand to the twin bundles of the style, and in addition the bundle which goes to the chalaza;
Fig. 23: adult hermaphroditic flower;
Fig. 24: hermaphroditic flower whose ovary already contains an almost ripe seed, although the anther is not yet open;
Fig. 25: theoretical figure intended to show the distribution of the vessels in the various organs of the female flower.

PLATE XXVI

Fig. 1: very-young female flower accompanied by the bract of the axil in which it was borne;
Fig. 2: female flower a little older, the cylindrical papilla of its round end which represents only the flower, in the preceding figure, present at its top several hardly projecting crenellations or mamelons;
Fig. 3: flower a little older; its papilliform part is crowned by three mamelons which represent the three perigonial leaflets incipient from a flower whose style was not yet shown, that is to say, rudiments of the style and the two perigonial leaflets of a bifoliolate flower with perigone;
Fig. 4: the same flower age as the preceding one; in the milieu of the three peripheral mamelons which represent a fourth perigonial division, a little broader but equal height which is the rudiment of the style
Fig. 5: the stylar mamelon exceeded the perigonial mamelons and already shows on one of its faces the groove which, at the adulthood, furrows from one end to the other; below the central mamelon, in the body of the flower, one sees by transparency the indications of the ovarian cavity which grew hollow there;
Fig. 6: vertical section of the preceding flower; in the open ovarian cavity is seen an ovule suspended ahead of the point which corresponds to the base of the style;
Fig. 7: vertical section of an older ovary; the ovule was covered with one envelope through the opening of which the nucellus is covered;
Fig. 8: ovule even older; the micropyle is still largely open, but the nucellus does not cover it any more;
Fig. 9: mature seed; a small spot announces only the presence of the micropyle;
Fig. 10: cross section of a seed passing through the chalaza *ch* and the micropyle *micr*; *t*: testa; *h*: hilum; *alb*: endosperm; *embr*: embryo;
Fig. 11: cross section of some of the cells of the external layers of endosperm, much more greatly enlarged than that in the preceding figure;
Fig. 12: embryo;
Fig. 13: germinating seed; the radicle, *r*, exit horizontally by the micropylar opening of the testa, bent itself to move vertically to the top;
Fig. 14: cross section of a germinating seed, passing through the chalaza *ch*, and radicular axis *r*;

Fig. 16: some central cells of the radicle filled with starch grains, accompanied by other more external cells which do not contain any trace of this matter;
Fig. 17: germinating seed, of which the radicle, placed initially so that its end was turned downward, bent itself abruptly upward;
Fig. 18: the same seed of which the radicle, directed again downward, still bent itself to take again its primitive direction;
Fig. 19 and 20: germinating seed of which the radicle, directed initially naturally upward, was turned over so as to occupy an opposite position and which was bent as in the preceding examples:
Fig. 21: germinating seed whose radicle was lying horizontally so that its end plunged in the milieu of hairs of a radicle of *Rottbœllia incurvata*;
Fig. 22: the same seed whose radicle was bent at top;
Fig. 23: germinating seed whose radicle was put in connection with the radicle of *Melilotus parviflora* with which its end contracted adherence;
Fig. 24: the same separate seed of the host plant; the radicle was split along its higher face to deliver passage to acellulous mamelon developed in its interior;
Fig. 25: the mamelon developed in a rootlet behind which soon occurred another, both moving moving upward to the top;
Fig. 26: transverse section of an adult rhizome of natural size; one sees there the section of fibro-vascular bundles distributed irregularly in the milieu of the cellular framework;
Fig. 27: transverse section of an axis below the inflorescence, of natural size, the fibro-vascular bundles arise under the same aspect as in the rhizome;
Fig. 28: cross section of peripheral cellular tissue of the rhizome; it is made of cells all the smaller and tighter as the more external ones;
Fig. 29: papillae of irregular forms, furnishing the axis in the vicinity of the inflorescence;
Figs. 30 and 31: cross and longitudinal sections of a fibro-vascular bundle of the floral axis; it is composed of lengthened cells (*f*), with very-thin walls and striped vessels (*vr*) surrounded by cells loosely plain (*c*) and filled with starch which constitute the framework of it;
Fig. 32: longitudinal section of a portion of a vascular bundle composed of striped vessels and of reticulate vessels.

PLATE XXVII

Fig. 1: longitudinal section of the end of a young rhizome; *a*: squamules overlapping; *bb*: rootlets-haustoria;
Fig. 2: cross section of a young rhizome; one of the rootlets which while being borne is thickened at the end, to fix itself on a rootlet of a host plant;
Fig. 3: longitudinal section of a fibro-vascular bundle and tissue close to a young rhizome; the cells are filled with starch grains of various forms and sizes; the striped vessels are few in number;
Fig. 4: cross section of a fibro-vascular bundle;
Fig. 5: withdrawn starch grains of tissue of a young rhizome;
Fig. 6: transverse section of haustorial rootlet;
Fig. 7: longitudinal section of the same organ;
Fig. 8: rootlet-haustoria of natural size, on a root of host plant;

Fig. 9: cross section of the reinflated end of a parasitized rootlet (s) and of a root of *Rottbœllia* (*rn*), at the point where the insertion of the one takes place on the other;
Fig. 10: longitudinal section of the end of a root of *Salsola fruticosa* (*rn*) on which is established a tuber- haustorium of the parasite (*s*);
Fig. 11: very-small tissue portion taken on the subject of the preceding figure, in one of the insertion points of the haustorium (*s*) on the host root (*rn*);
Figs. 12 and 13; tubers haustoria inserted laterally on the roots of *Salsola* which they more or less embrace;
Fig. 14: transverse section of tissue of one of the grafts represented in the preceding figure; *s*: tissue of the haustorium; *rn*: tissue of the host root.

Footnotes

---

[1] It is, I think, that one owes inference from a passage of Pline (Edit. de Littré [1851], t. II, p. 101), announced by Dodoens (*Stirp. Hist.*, edit. ann. 1583, pempt. 4, lib. 3, capit. XXIII), in which the word χυνομσριον (*a similitudine canini genitalis*) [with similarity to dog genitals] he writes in all his letters, and could not, this seems to me, be applied to another plant other than that which is in question here. The Arabs gave it the name *Zeb*, of *Zeb Arbi* and *Zeb el Turco*, who express about the same idea as the Greek word.
[2] *Icones et descriptiones rariorum plantarum Sicilae, Melitae, Galliae and Italiae*, ann. 1694.
[3] From where the name *Fungus melitensis* under which one finds it registered in the pharmacopeias.
[4] *Catalogus plantarum Horti Pisani* (ann. 1723).
[5] It is Lippi however who deserves the merit of having first affirmed that *Fungus melitensis* was not a mushroom (*Hist. Acad. sc.*, ann. 1705, p. 68).
[6] *Nova plantarum genera*, tab. 12 (ann. 1729).
[7] l.c. tab. 43, and *Museo di piante rare della Sicilia*, tab. 81 (ann. 1697).
[8] *Gazophylacium*, tab. 39 (ann. 1784).
[9] l.c., tab. 25.
[10] This name, like one seen it in a preceding note, according to any probability, has belonged with the parasite as one moves sufficiently back in antiquity.
[11] Mémoires du Muséum, VIII (ann. 1822).
[12] *Ann. Wien. Mus.,* II (ann. 1840).
[13] On the structure and affinities of Balanophoraceae, in Trans. Linn. Soc., XXII (ann. 1856). - There is only one chapter of this work where the author occupies himself especially with *Cynomorium*, but one also finds, in the general information on the family, many passages which apply to it more or less directly. The value of the generally recognized opinions of my friendly scientist will be useful to me, I think, of sufficient excuse for the many quotations which I made of his work; I must add that if I more than once allowed myself to emit an opinion different from his, it was only after mature reflection and especially by pressing me on parts which he did not have at his disposal.
[14] *Embryobildung des Phanerogamen,* in *Pringsheim Jahrb. für Wissenschaftl. Bot.,* I, 109 (ann. 1857) et *Neue beitr. zur kentniss der Embryobildung des Phanerogamen,* in *Abhandl. der math.-phys. Cl. der Kön. Sächs. Gesellsch. der Wissensch.* (ann. 1859).
[15] *Considérations sur l'organe femelle des Balanophorées et des Rafflésiacées,* in *Ann. sc. nat.*, 3e série. XIV (ann. 1856).
[16] This negligence was even more sensitive to me for another reason: M. Pringsheim, who visited Paris towards that time, and who, while passing, wanted to thoroughly examine microscopic preparations (relating to the structure of seed of *Cynomorium*, with its germination, with the nature of its inflorescence, etc.) that I had subjected to the Société botanique de France, had expressly asked for the authorization from me to give an account of it to M. Hofmeister, authorization that I had hastened to give him.
[17] Where it is probably not frequent, because M. Kralik, who explored carefully a part, did not find it there. [not clear this is where the footnote goes. Original text lacks a reference in the text to number 2 on p. 272]

[18] Linné also indicates, among the localities of *Cynomorium*, Jamaica, but by error: he confused it with a species of *Helosis* mentioned by Patr. Browne.
[19] It is a small uninhabited island bearing the name of *Scoglio del Generale* (Shelf of the General); the name derives from *Heritz tal General* and was applied to the plant by the Malteses at the time of Boccone.
[20] M. M. Cosson and Kralik communicated an interesting note to me, relative to the other Algerian dwellings of our plant. "It grows, they say, enough abundantly in the Saharan area of all Algeria; we saw it in the three provinces. It develops preferably in a muddy, deep alluvial, slightly salted or even very salted terrain; one encounters it until nearly 800 kilometers of the sea. Sometimes, but seldom, we saw it until on small very-arid mounds; generally: *in depressis hieme inundatis*, but very-desiccated already at the time of the development of the plant. More rarely still we gathered it in pure sand or in gravelly places."
[21] I do not know if they were re-examined on these plants.
[22] It is seldom as considerable as in the example that I represented.
[23] Fragments of the fresh plant soaked in water do not impart [transmit] it such that after several hours there is a little marked reddish colour; immersed in alcohol they give, at the end of a certain time, a very marked color, comparable to water reddened by the addition of a certain quantity of wine. Desiccated quickly in air, the tissue preserves a pink or burgundy wine colour.
[24] M. Gœppert, I know, voiced an opinion that there was in Balanophoraceae, two distinct vascular systems, one in the rhizome that has its origin in the host root (root assuring nutrition); another, going down from the floral stalks towards the rhizome where it would constantly remain independent of the preceding system; but I found absolutely nothing, in my dissections, which militated in favour of this manner of seeing already victoriously fought by Joseph Hooker. I must point out besides that *Cynomorium* lends itself much better to the observation in that it contains only very little of this viscous matter, indicated per M. Gœppert under the name of balanophorine, which appears to make so difficult the study in living plants of this family. Here, on the contrary, changes in color, that take place in living tissue following its cutting, notably facilitate its study. It is understood that it is not indifferent, for the examination of a question of this kind of having only a limited number of samples, that one hesitates to sacrifice [them] or to use them with discretion.
[25] It is here especially a question of the bundles taken at a certain distance from the periphery of the rhizome: those that are brought too close to it are often not presented with less thickness than part of the elements that one will meet there later.
[26] Cells completely similar to those that were announced by M. Chatin in several water plants and received from him the name *fibre-cells*.
[27] Two kinds of elements which I describe here, as constituting the vascular bundles of the rhizome of *Cynomorium* are those illustrated well by Unger, but the description that he and Joseph Hooker gave to these bundles differ, in some connections, from mine.
[28] Joseph Hooker made the remark that the stem of *Helosis mexicana* offers many features much resembling that of Menispermaceae.
[29] It is undoubtedly because of this quantity of starch contained in its tissue that *Cynomorium* was employed in some countries as food (Webb, *Fl. Canar.*), in spite of its bitter and even styptic savour.
[30] It is nevertheless very clear that these little characterized organs play, in my plant, the role of vessels; and it is hardly doubtful but, even after the appearance at their sides of the striped

vessels, they do not continue to act in par with them, since they do not appear to undergo, at any time, the thickening which usually appears, early or late, in woody fibres themselves. There is obviously, in the nature of these organs, a permanent modification, operated for their adaptation to a function which is not, in general, especially reserved [to these organs].

[31] It could, *a priori*, appear difficult to distinguish the tissues which belong to each of the plants which contribute to the formation of the graft; however, except in some exceptional cases, it is nothing, in consequence of the colouring which appears in the cells of *Cynomorium*, as soon as its tissue is exposed to a few moments of light.

[32] Gœppert, as with Unger, while refusing to view the rhizome of the parasite as a body of special nature, does not believe about it less, as I said in a preceding note (p. 277), about the penetration of the nurse vessels in parasitic tissue; and I must point out that this opinion is allowed up to a certain point by Joseph Hooker, since, in one of the three groups where one could, he says, to classify Balanophoraceae, from the point of view of their various modes of insertion, he places those "where the vascular bundles of the host root finish in a way defined in parasitic tissue, at some distance from the insertion point, vascular systems of the two plants not being anyhere in immediate rapport."- the two other groups would include: 1° Balanophoraceae in which connection only takes place by the intermediary of the cellular tissue; 2° those in which the vascular tissue of the rhizome is continuous with that of the host root. - But, it is easy to see that one and the other of these last two modes of insertion meet in the plant of which I make this history.

[33] I never saw on the adult plant as many as those in the example illustrated by Micheli.

[34] As one can see it in the group of which I gave the figure (pl. XXIV); the plant is represented there smaller than in nature.

[35] Voyez le *Bulletin* de la Société, ann. 1857, p. 796

[36] Joseph Hooker (1.c., p. 13) summarizes thus what we knew of the inflorescence of Balanophoraceae, before the time when I made known the true nature of that of *Cynomorium*, which one will undoubtedly find that the others are only particular states. He says "The flowers are arranged in uni- or bi-sexual spherical, oblong, cylindrical, or ovoid capitulum, in all the genera except in those of *Lophophyteae* and in *Sarcophyte*, in which they occur in compound spikes or panicles. However simple these capitula appear, they are invariably found to be compound if examined at an early period of growth, when the bracts or scales imbricate completely over them, and cover definite masses of flowers, representing branches of the inflorescence. *Sarcophyte* presents the most perfect inflorescence, and he only one with a fully branched panicle; it has general bracts on the main axis below each ramification, but no partial ones. *Lophophytum* represents the next degree of perfection in inflorescence: each bract is a very highly developed peltate organ, subtending a cylindrical branch of themain axis, which is covered with flowers: -- a modification of this arrangement is found in all the *Helosideae*, and in *Cynomorium*, where the bracts are peltate and imbricate in a young state, and either pelate and attached by their margins, or scattered, in the older state."

I did not have the occasion to observe the interesting characteristic announced by the quoted author relative to the protective role of the scales in a very young inflorescence of *Cynomorium*. "at that time, he says (1.c., 34), the scales of the inflorescence are very oblique, peltate, so that, in a vertical section, one sees each one of them being curved at the top, to cover the lower part of the peltate scale which is placed immediately above; while at the bottom it is prolonged into a long lobe with semilunar concave curve, round on the side of the axis of the inflorescence, covering a mamelon roughcast with incipient flowers." - The young inflorescences were in very small number which I could examine and did not offer anymore the projecting mamelons represented by J. Hooker (l.c., pl. I, f. 1), and scales, already connected, seemed to be used rather as protective organs with the flowers born above, that with cells born below them.

[37] The monograph of which I obviously so often quoted the name in this memoire, on the nature of these organs, an opinion different from that that I express here, when he says (1.c., p. 34): "the paleae which occur abundantly amongst the flowers, and vary extremely in form, consist of rudimentary flowers, both males and females, and of perigonial leaves, removed from their flowers by unequal growth;"but he adds: "There is a disposition in some of the floral scales of larger size than the rest, to assume the position of a bractlet under each flower, or group of flowers."

[38] In Algeria it takes place as of the first days of March, and is prolonged until May.

[39] The only the other species of Balanophoraceae which offer this developed organ as well are *Mystropetalon*, as J. Hooker views as the most perfect type of the order, and *Dactylanthus*, a new genus recently described by the same scientist.

[40] This comparison appears to imply that the quoted author views, as do I, the ovary of *Cynomorium* as being axile in nature; I do not dare however to affirm that it is his opinion on this as well.

[41] I represented in figure 3 a flower of the same age as that of figure 4, but which shows at its top only three mamelons. I do not know if these mamelons represent three perigonial divisions of a flower whose style was not yet developed, or if one of them is the incipient style from a flower whose perigone was intended to have only two leaflets.

[42] J. Hooker goes still further; he does not admit either, in the ovule, of the existence of a nucellus, being by there resulted in emitting, on connections of the embryo sac (to which is reduced, according to him, the ovule of Balanophoraceae), an opinion as paradoxical as that which I myself had put on the day in my first work on this delicate matter. - See what I say on this subject in the *Bulletin de la Soc. Bot. de France*, III, p. 663 and 691.

[43] Doctor J. Hooker gives a description of the style and stigma which differs in some connections from the mine; he says (1.c., p. 36) that "the stigmatic tissue runs down the mesial line of the style, occupying the canal, and is covered by a very delicate epidermis." - I did not find anything, I must acknowledge, in my dissections, which corresponds to this description; and I will say of it as much the "narrow channel but very manifest which, according to M. Hofmeister (*Neue Beitr*., p, 573) traverses the axis of the style and emerges in the ovarian cavity."- I could not, indeed, discover that the groove which I described, groove always largely open (when the plant is alive), and which clearly stops well above the top of the ovary, in the adult flower; the tissue of this organ being made up (pl. XXV, f. 18) of cells lengthened and similar between them, wrapping the double vascular strand in question a little further, and continuing with cellular tissue slightly rarefied to the higher part of the ovary. I must add however that an appearance favorable to the opinion expressed per M. Hofmeister, relative to the existence of a channel making connection between the cavity of the ovary and the style, it is several times offered to me on the microscope slide; but I allotted it to the presence of vessels at the top of the ovary, moved on the one hand towards the style, and the other towards the ovule (fig. 22).

I many times noted the adherence of grains of pollen to the stigma and the penetration of pollen tubes between the cells of this organ; but I never succeeded in following them to the ovary. Happier, and especially more skillful than me, M. Hofmeister could note their presence in

the micropylar canal and in contact with the embryo sac, in which he saw appearing endosperm and embryo successively.
[44] M. Hofmeister, who described carefully the distribution of the vascular bundles of the female flower of our plant, known to be everywhere made up of spiral vessels, if it is not at the end of the perigonial perianth parts where the strands would end in a group of spiral and reticulate vessels. However, I must say that nowhere did I see in *Cynomorium* tissues vessels which deserved the name of spiral vessels. In fact the striped (or scalariform) vessels are presented to it everywhere, associated sometimes with reticulate vessels which are only one form of the precedents, as I said before.
[45] This position can vary a little in consequence of the compression operated by the close parts; but it is only one very accidental case there.
[46] In the description which he gives of one of these flowers, Joseph Hooker indicates (1.c., p. 35) that the third leaflet is always posterior, which does not agree with my observations. He adds that there exists at the base of the ovary two other perigonial leaflets placed on the same plan as the two higher side leaflets; however, if it were allowed to me to judge this provision by the figure that the author gave (1.c., pl. 1, fig. 2), I would say that the organs which he took for the two hypogenous leaflets are another thing, only two very young flowers forming, with the central flower, a portion of a cyme. The comparison of the figure of J. Hooker with that which I gave (pl. XXV, fig. 8) from a portion of the female inflorescence will come, I think, in support of this explanation.
[47] The error into which the quoted author fell comes, without any doubt, from where he took the testa as an internal layer of the pericarp; one will judge this by the following passage from a letter by M. Bentham, to which I had communicated my observations on this subject: "I spoke, he says me, with J. Hooker of your *Cynomorium* and about the testa that you find with the seed. It seems to him that which you have taken for this part of the seed would be rather the internal wall of the ovary which is detached easily and even remained adherent to the seed. Hofmeister who followed the development of the seed of *Cynomorium*, starting from the young ovule, confirmed the observation of Hooker - the absence of the testa." - This last sentence is referred, I suppose, with the first observations, probably new, of the German scientist; because, in those which came to my knowledge, and whose report is in the works that I quoted, M. Hofmeister insists very particularly on the existence of the ovular integument.
[48] I suppose it was made in the same direction as that of the testa, i.e. passing by the chalaza and the point which corresponds to the micropyle.
[49] In the report that I published in 1851, I said to have always seen in Balanophoraceae a fleshy or oily endosperm, from where J. Hooker believed to be able to conclude (1.c., p. 86) that I claimed to have found oil in *Cynomorium*, which by no means my words implied.
[50] This figure is only approximate, because although the apparatus was in the interior of my apartment, its temperature varied necessarily a little with that of the ambient air.
[51] In order not to have to reconsider this subject, I will say here that the seeds which I had sown in other soils only germinated much later.
[52] My apparatus was heated by means of a small hot watertank, placed under a container filled with wet sand in which the pots were inserted which contained seeds. By this provision, the ground of the greenhouse was hotter than the atmosphere of the bell jar which covered it, and the subbases of this ground were much higher than that.

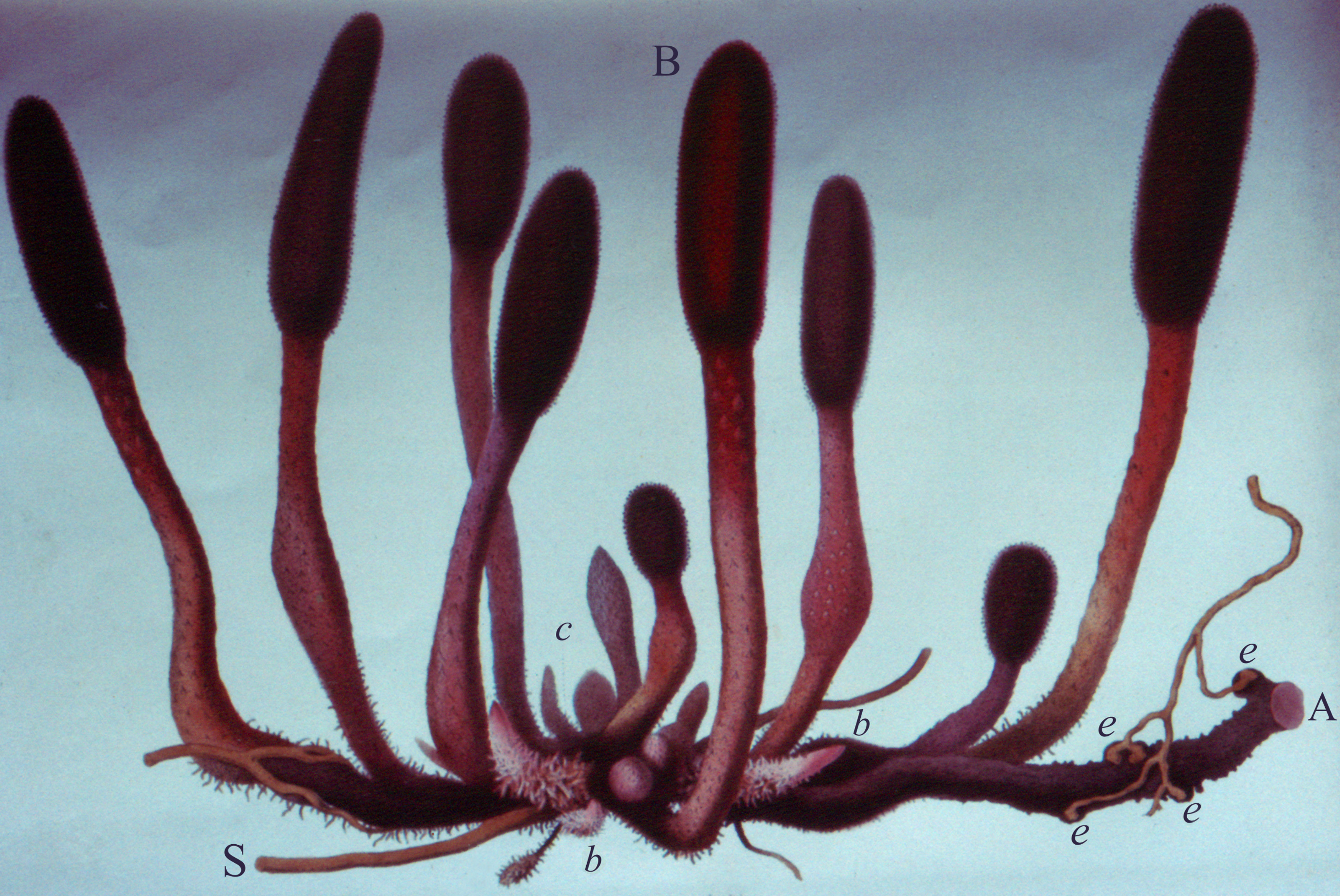
[53] Although this result was rather conclusive, nevertheless an experiment of another kind still made me hesitate to entirely admit the opinion that the conditions of temperature did not have anything to do with the direction taken by the *Cynomorium* radicle. Having indeed ceased one day heating the apparatus, and atmosphere of the greenhouse being cooled almost suddenly, I noted that the majority of the tested radicles had a very-pronounced incurvation. By examining the fact, I was not, however, long in finding a more probable explanation for it than that which I had offered at first with all my spirit. It does not appear doubtful now only the incurvation of the radicles to to me, which had occurred following the fall in the temperature, was not due primarily to the changes in the hygrometrical state of the air which coincided with the fall in the temperature changes which had perhaps brought in these organs of so delicate texture a beginning of desiccation. Other germinated seeds, withdrawn from the greenhouse at a less advanced age, and placed under a bell jar at the temperature of the surrounding air and in wet ground, preserved their drawn up position, very continuously to lengthen. With this it is wise to add that those radicles which had undergone the strongest incurvation at the time of the change mentioned, being lengthened thereafter again, without the temperature of the medium being increased, were not long in curving again at the top.

[54] One should not lose sight of the fact that it acts here especially like the radicle, or first root of the plant, and not of the rootlets, whose direction is less constant.

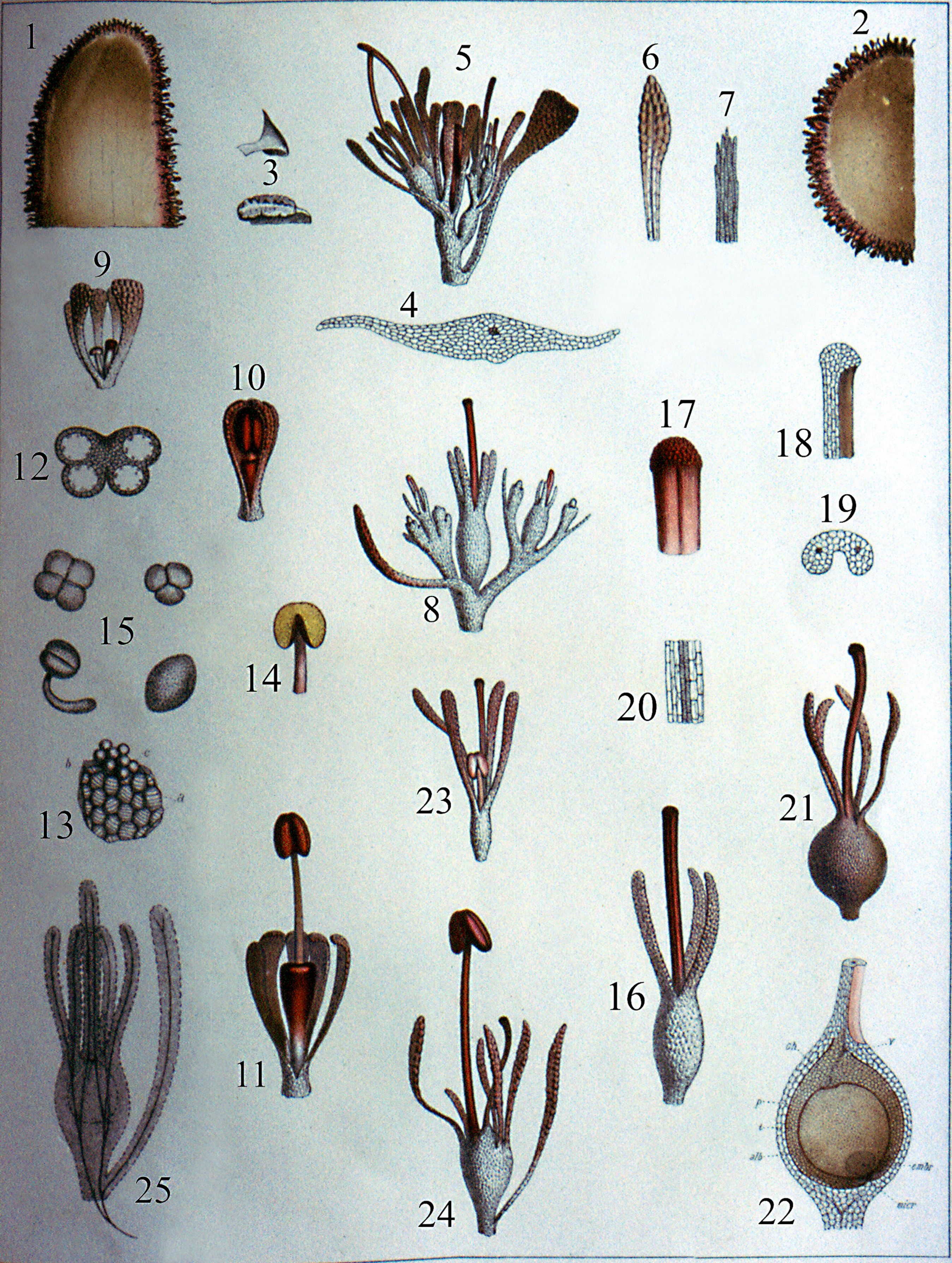
[55] The constitution is the same, moreover, as that of many of other acotyledonous embryos and in particular of the embryos of the other plants of the same family, like of Rafflesiaceae, etc. on which it would be interesting to repeat the observations that I made on *Cynomorium*.

[56] Should one solve the question and say that, in the embryo of *Cynomorium*, there is not only a complete absence of the radicle itself, but also the absence of the poles; does one admit their existence in the embryos of all the phanerogamic plants with known germination? - In my opinion, it would be to go too far, because, as a consequence, it would then be necessary to also suppose that this embryo has the faculty to germinate at an unspecified point of its surface, that which does not obviously take place. M. Miers thinks that the embryo of Triuridaceae is like this case, and he indicates it, for this reason, under the name of protoblastus. See, on this question, an extremely lucid note by Joseph Hooker, consigned in its Monograph of Balanophoraceae (p. 49), where the opinion of M. Miers seems me to be fought with much success. It is, I think, useless to insist on the interest which would present, from this point of view, the study of the germination of plants such as *Hydnora* and *Sarcophyte*, whose acotyledonous embryo is at the same time central and completely globulous.

[57] After having risen a few millimeters (one centimeter at most), the radicles browned little by little and ended up being desiccated.

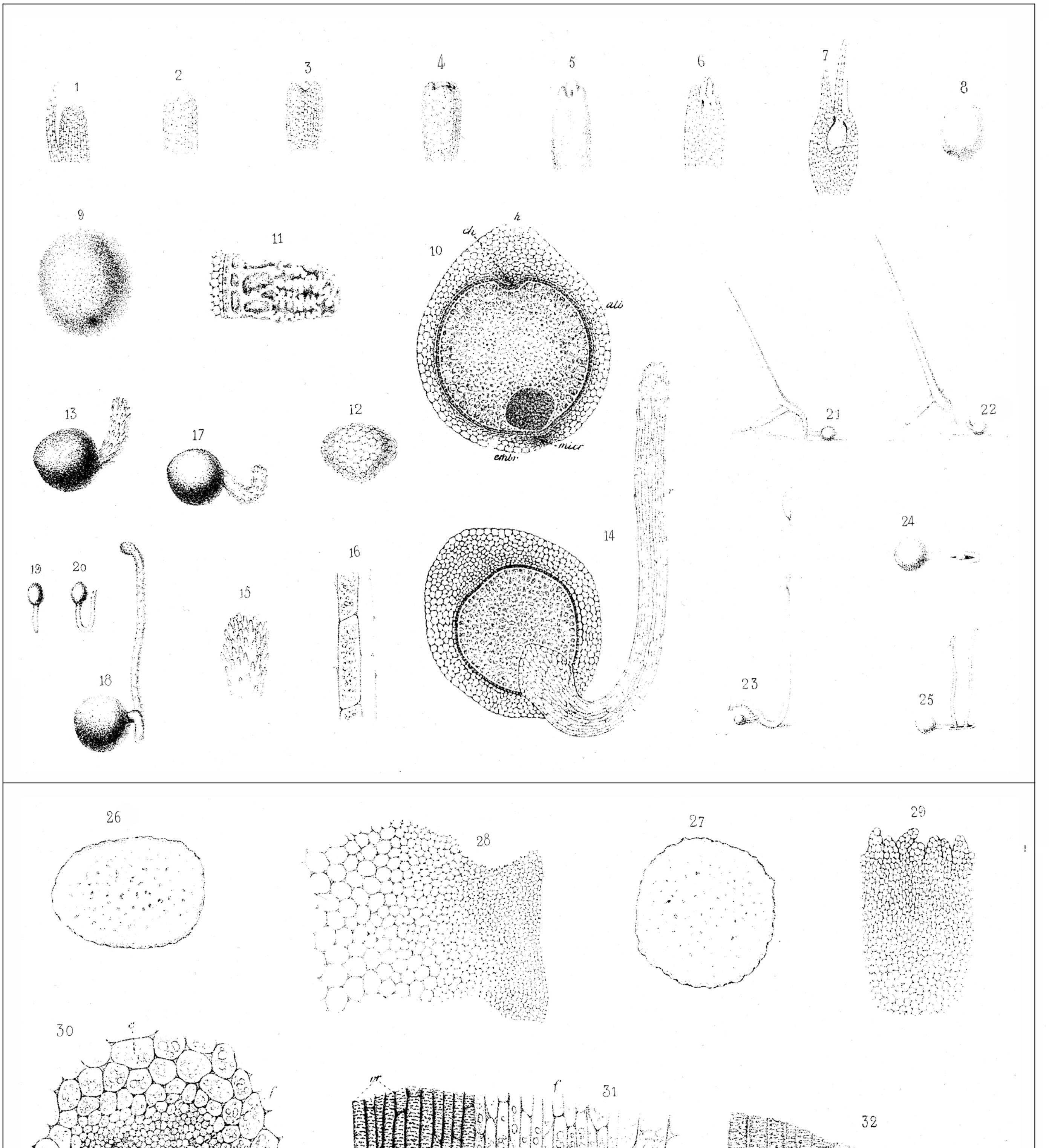


A. Riocreux pinx^t et lith.



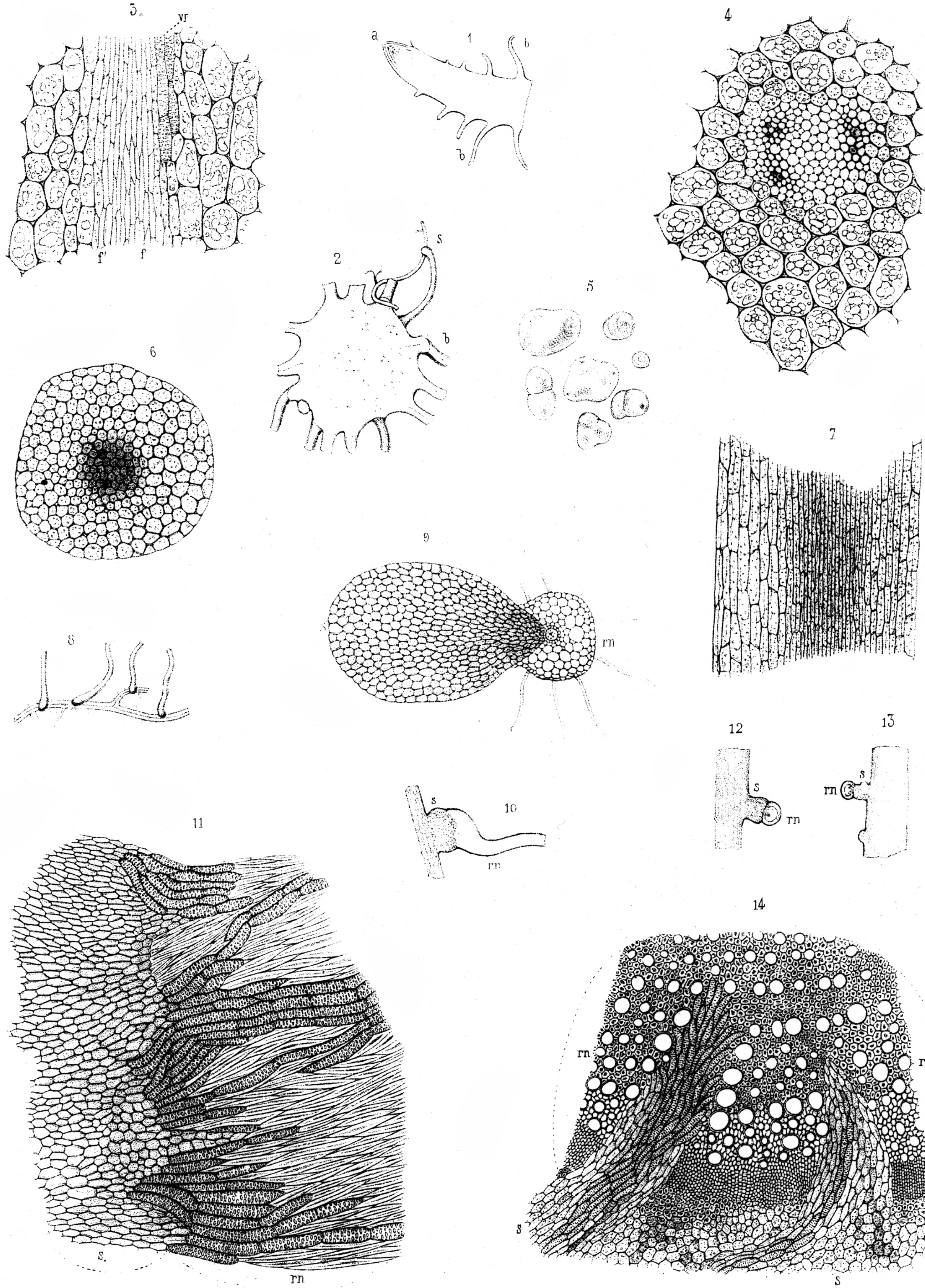
H.A Wedd. et A.Riocreux del

A. Riocreux lith



H.A.Wedd. del

A. Riocreux lith



H. A. Wedd del.

A. Riocreux lith.