

VIII.—*On the Fecundation of the Florideæ*.

By E. BORNET and G. THURET*.

THE fecundation of the spores of the Algæ by the antherozoids is a well-known fact, upon which we have now very precise observations. But there still remained a gap to be filled up in the history of the Florideæ—one of the highest groups of Algæ, and the most remarkable of all, on account of the number and variety of genera composing it and the peculiarities of their organization.

Most of the Florideæ, as is well known, present two sorts of fructification, upon distinct individuals,—one consisting of spores which divide into fours, *tetrasporic fructification*; the other, formed by agglomerations of undivided spores, has received the name of *capsular* or *cystocarpous fructification*. We also find, and generally upon different individuals, cellular productions of various forms, composed of small colourless cells, each enclosing a hyaline corpuscle. These organs are designated the antheridia of the Florideæ. The corpuscles which they contain are regarded as analogous to the antherozoids of the other Cryptogamia; but from these they differ considerably, inasmuch as they consist only of a simple globular or oblong vesicle, which is always immobile and destitute of cilia. Their relation to the fructification of the Florideæ has hitherto remained entirely unknown.

They are, nevertheless, certainly fecundating corpuscles; their action is manifested from the first development of the cystocarp when the latter is still composed only of a small number of cells surmounted by a caducous unicellular hair. Nägeli was the first to indicate this transitory structure of the cystocarp in the Cermiæ, Spyridiæ, and Wrangelieæ; but, being preoccupied by other views, he never suspected its physiological importance. According to him the capsular fructification is asexual, the tetraspores alone representing the female organ. We hope to show that this is by no means the case, and that the peculiar structure presented by the cystocarp at its origin is destined to facilitate contact with the corpuscles issuing from the antheridia, from which result fecundation and the ulterior formation of the spores.

Let us take, for example, one of the inferior tribes of the Florideæ—that of the Nemalieæ, in which the development of the cystocarp is most easily observed on account of its simplicity. If we study the origin of this organ in *Helminthora divaricata*, J. Ag., we shall find that it commences by a small cell springing from the side and at the base of one of the dichotomous filaments of which the frond consists; this cell elongates,

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is divided successively by transverse septa, and becomes a very short branchlet composed of four superposed cells. Subsequently the superior cell alone continues its development, and becomes filled with a refringent protoplasm; soon a small protuberance makes its appearance at the apex, and gradually elongates into a long hyaline hair, which is often slightly dilated at its extremity. At last this hair exceeds the filaments of the frond. It is the essential organ of impregnation; hence, on account of its importance, we give it the name of *trichogyne*. When the corpuscles issuing from the antheridia come into contact with the upper part of this hair, they adhere to it, and several of them are often found fixed at its apex. Then the cell which forms the base of the trichogyne begins to swell and to become divided by septa, and is soon transformed into a small cellular mass which will constitute the young cystocarp. During this time the trichogyne seems to wither; its membrane becomes destroyed, and disappears by degrees, until no traces of it are to be found, even before the cystocarp has arrived at its complete development.

In the higher tribes of the Florideæ the organization of the cystocarp is more complicated, and the fecundation is not so direct as that just described. Thus in the Callithamniæ it is not in the basal cells of the trichogyne, but in two lateral cells that those glomerules of spores known as *favellæ* are formed after fecundation. In the Rhodomeleæ, Chondrieæ, and Dasyeæ the structure of the little cellular urn, or *ceramide*, which will afterwards enclose the spores, is already well advanced, and its form perfectly recognizable, when one of the superior cells begins to be elongated into a trichogyne. When the cellular tissue is closer, as in *Ceramium*, *Plocamium coccineum*, Lyngb., &c., the connexion of the trichogyne with the development of the cystocarp becomes difficult to follow, on account of the opacity of the frond. Lastly, the very existence of this delicate hair has appeared to us impossible to verify in the plants with thick fronds, such as the Gigartineæ, Gracilarieæ, &c. It is, however, to be presumed that its presence is a general fact among the Florideæ, since we find it in all those the structure of which adapts them to researches of this kind. And whenever we meet with this organ the essential point is ascertained, that its appearance always precedes that of the spores.

The moment when the corpuscles of the antheridia adhere to the apex of the trichogyne deserves particular attention; for a phenomenon then occurs which leaves no doubt as to the importance of this contact and the reality of the fecundation. We have, in fact, in a great many cases been able to see with perfect certainty that at this period a true copulation takes place, and that a direct communication is established between the two

organs. Thus, in *Ceramium decurrens*, Harv., we have most distinctly seen the corpuscles soldered to the tube of the trichogyne. Various species of *Polysiphonia* have likewise presented us with frequent and perfectly decisive examples of this. In these plants the corpuscles are often seen implanted upon the trichogyne by a small process, which is very short, but perfectly visible; and when the functions of the trichogyne are accomplished, we still, for some time, find it bearing the empty corpuscles suspended from its apex. We may instance especially *Chondria tenuissima*, Ag., as one of the Algæ in which the copulation of the two organs may be ascertained the more distinctly because both of them are of a size which is not usual in the Florideæ. The antheridial corpuscles are, moreover, remarkable for their elongate form. The trichogyne is inflated into a club at its apex; and as it is twice as large as that of the *Polysiphoniæ*, it is easy to study its structure. The membrane of which the walls are formed, which is very visible on the sides of the tube, is so attenuated at the apex that it eludes the eye, and the refringent protoplasm with which the trichogyne is filled appears to be destitute of an envelope at this point. When one of the corpuscles comes into contact with this part, it unites therewith by a portion of its surface, and very soon no line of demarcation between the two organs can be distinguished; the finely granular matter which they contain mingles; frequently the apex of the trichogyne swells and becomes deformed, in consequence of the partial fusion which takes place between them; its contents become detached from the walls of the tube, and contract, and then we no longer see anything in the trichogyne but a row of a few irregular granules to the apex of which the remains of one or several corpuscles are still attached.

The number of corpuscles emitted by the antheridia is very considerable, and they are often found scattered among the hairs with which nearly all the Florideæ are provided. This abundance explains how fecundation may be accomplished in these plants, notwithstanding the obstacles which seem to be opposed to it by the diœciousness of most of them, the immobility of the fecundating corpuscles, and the fugacity of the trichogyne. We may add, moreover, that on examining the cystocarps borne by a specimen in a good state of fructification, we may observe a certain number of them the development of which has not passed the period at which they were furnished with a trichogyne: these have become simple organs of vegetation; but their origin is recognized from their form and the position which they occupy on the frond. It seems natural to attribute the frequency of these abortions to the circumstance that the contact of the corpuscles with the trichogyne has not been effected at the proper time.

From the preceding observations it follows that the phenomena

of fecundation in the Florideæ differ widely from those hitherto known to occur in the Algæ. The structure of the organs, their mode of action, the period at which their functions are performed, and the effects which they produce present important differences related to those which distinguish the Florideæ from the other Hydrophytes. We no longer find in this case a direct action of the antherozoids upon the reproductive bodies: the operation is less simple, and in some respects presents some resemblance to that occurring in the higher plants; for we see in the same way a fecundation produced by immobile corpuscles upon an external organ, and having as its result the determination of a complete development of the apparatus of fructification.

IX.—*On the Ballast-Flora of the Coasts of Durham and Northumberland.* By JOHN HOGG, M.A., F.R.S., F.L.S. &c.*

IN this short paper I beg to offer to botanists a few remarks on the plants which have been introduced with ballast by ships on the coasts of Durham and Northumberland.

This interesting subject has already received some attention from our practical and field-working botanists, namely the late Mr. Winch, the late Mr. Storey, the Rev. A. M. Norman, and Mr. M. A. Lawson, who have all published, in the 'Transactions of the Natural-History Society of Newcastle-on-Tyne,' and in those of the Naturalists' Field-Club, some lists of the *rare plants* which they found growing on the ballast-hills in their own vicinity. I have been able, from an acquaintance of some years with the ballast-districts of the county of Durham, to add several *rarer* species to those lists which were formed by the botanists whom I have already mentioned.

The extent of the two counties to which I have now limited myself comprises the sea-coasts and chiefly the banks of the rivers Tees, Wear, and Tyne: of the latter are the great ballast-deposits at Port Clarence and those at West Hartlepool, at East Hartlepool, and the embankment of the railway to the north of the latter town, the mounds of ballast at Seaham, at Sunderland, and near Wearmouth, as well as those at South and North Shields, and others along the Tyne nearer to Newcastle.

In the following lists of species I shall only divide them into *two* heads or divisions, viz., the first, those plants which are *exotics* or foreign to our island, and, the second, those more scarce indigenous and naturalized plants of Great Britain which were rarely seen, if not entirely unknown, in the before-named portions of England.

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