The Attaching Discs of the Ulvaceae.

BY

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With Plate XLV and three Figures in the Text.

THE thallus in the Ulvaceae consists of a somewhat delicate green frond, terminating below in a narrow and very often short stalk or stipe, which is attached to stones, wood, or, less often, to other Algae by means of a tough disc-like expansion.

This attaching organ was described by Thuret¹ in 1878 as a small disc formed by the interwoven tubular prolongations of the cells of the thallus. Any cell of the thallus was said to have the power of forming the tubes, with the possible exception of those cells which become zoosporangia. Just above the disc the thallus is distinctly thicker than higher up, and Thuret noticed that in some cases the tubes were woven together in dense strands or bundles, several such strands occurring side by side in one disc.

Some material of *Ulva latissima* (Harvey), preserved in formalin, was accidentally obtained growing upon a fragment of the frond of some other seaweed of the *Furcellaria* type. Hand sections showed that the tubular prolongations of the cells (or disc filaments, as I shall call them) had in some places displaced the small peripheral cells of the supporting thallus, in a way which suggested either a parasitic or a saprophytic habit. Later on, in fresh material from Rottingdean, a frond of *Ulva* was found attached to part of a thallus of the *Polysiphonia* type of structure, and here the disc filaments had actually penetrated into the cells of the host, just as is done by the intracellular hyphae of some parasitic Fungi. Other *Ulva* plants were collected which were attached to small chalky stones, and the discs of these were detached, carefully scraped, and washed free from grit as far as possible; they were then fixed in weak Flemming solution and embedded in the usual way. The microtome sections obtained from this and also from the parasitic material were stained with Kleinenberg's haematoxylin and eosine. Hand sections and preparations of teased-out hyphae were also examined.

A vertical section through the disc of a thallus of *Ulva* at its point of attachment to the supporting seaweed showed the tubular prolongations of

¹ Thuret: Études algologiques, 1878.

the superficial cells passing obliquely down to the disc, where they spread out and appear to become closely interwoven with one another. When they reach the host, the tips of the filaments swell up and become closely appressed to the surface, often appearing to form a kind of pseudo-parenchymatous investment; this is shown diagrammatically in Text-fig. 1.

TEXT-FIG. 1. Longitudinal section through attaching disc of *Ulva*: outline, and cells of host, drawn with camera lucida; filaments of the disc shown much simplified, and somewhat diagrammatically. $\times 100$.

Microtome sections through the discs of fronds which had been attached to stones showed that wherever the filaments had reached the exterior their tips had become swollen and multinucleate; often definite cell-divisions appeared to have taken place, two or three successive segments having been cut off from the swollen part of the filaments (Pl. XLV, Figs. 5, 6). These larger segments were often surrounded, especially on the outside, by the cut ends of many minute filaments. Some of these had their origin in peripheral cells of the thallus, as seen in Pl. XLV, Fig. 8, at *a*; others appeared to have reached the periphery from within, and to have found no room for expansion at the end of their course; it is possible that some may also have formed by the branching of larger filaments, such as that shown in Pl. XLV, Fig. 1. The longitudinal section of such a disc is seen in Text-fig. 2, and a small part taken from the region A is shown in detail in Pl. XLV, Fig. 7.

The region marked B is part of the disc of another frond, formed, as it appears, from an outgrowth of the disc filaments, but this capacity for forming new fronds from the tissue of the disc was seen better in a hand section, which is represented diagrammatically in Text-fig. 3.

On teasing out the filaments from thick sections, it was found that they pursue a somewhat sinuous course through the lower part of the thallus, often bending on themselves, and the pointed awl-shaped tip suggests an active boring movement, as though the penetration of the tangled filaments were against distinct resistance (Pl. XLV, Figs. 2, 3). In some cases the filaments appeared to have branched, as in Pl. XLV, Figs. 1, 4, but these were very difficult to isolate, owing to the delicate nature of the tubes. In one case, however, no fewer than ten branches had been given off (Pl. XLV,

Fig. 1). Thuret states that the tubular filaments may reach a length of 6-10 mm., but those measured by me were never more than 3 mm. in length.

The superficial cells of the thallus giving rise to the filaments seem to be always multinucleate. In their upper region from three to five nuclei have usually been observed (Pl. XLV, Fig. 8). The tubes are exceedingly narrow, and are smaller when running on the outside than when running in

TEXT-FIG. 2. Diagram of longitudinal section through disc of *Ulva latissima*. The oblique lines show the general direction in which the filaments run. The dotted regions show the false tissue formed by the large and small filaments at the periphery of the disc: the region around A is that from which Pl. XLV, Fig. 7 is drawn in detail. At B is the lower part of a frond formed from an outgrowth of the disc.

the interior of the thallus (Pl. XLV, Fig. 8, at *a*); in either case minute nuclei occur at intervals down these tubes, and from two to five nuclei are commonly found crowded together in the tips of the tubes. These apices vary very much in size; they are usually narrow and pointed, with small nuclei, until the periphery of some part of the disc is approached, when they increase greatly in size, the nuclei become larger and more numerous,

and two or three successive segments with usually more than one nucleus are cut off (Pl. XLV, Figs. 5, 6). It is probable that the small filaments bore their way into crevices and become firmly attached there, whilst the larger multinucleate segments give rise to the new thalli. All the filaments appeared to have been full of living contents at the time of fixing (early

TEXT-FIG. 3. Diagram of longitudinal section through disc of *Ulva latissima*, which has given rise to four fronds. The lines show the general direction of the filaments; the cross-hatched region is part of the periphery of the disc which has not been cut in the median plane.

spring), so that it is probable that, whilst the thallus of this species is annual, the discs are perennial.

The nuclei vary somewhat in size, but always appear as small refractive bodies, with a single nucleolus. Two nuclei may often be seen closely associated, but no case of an actually dividing nucleus has been observed.

Stained microtome sections through discs of *Ulva*, which were attached to a thallus of the *Polysiphonia* type, leave no doubt as to the parasitic or

saprophytic nature of the fronds. The host plant had been completely encircled by the developing disc, and the thick walls of the pericentral cells were pierced and riddled with the small pointed ends of the filaments, which usually contained more than one nucleus. In many of the cells the tips of the filaments had evidently expanded, forming a delicately vacuolated lining of cytoplasm almost filling the cell, and containing numerous and characteristic embedded nuclei (Pl. XLV, Figs. 9, 10). At the periphery of the host may be seen the appressed tips of large and small filaments, just as in the disc already described; both these kinds of filaments were found in the process of boring their way through the solid wall, and this is probably achieved, as in the Fungi, by the secretion of some cytohydrolithic ferment.

It is impossible for me to say whether the host plant was living at the time of fixing, but I have myself often observed both *Ulva latissima* and *Ulva lactuca* growing attached to the frond of some other living seaweed, and it seems probable, therefore, that this plant is at least a facultative parasite. Since, however, it is known that both species of *Ulva* grow luxuriantly in the presence of the nitrogenous products of decay, it is probable that the saprophytic habit could also be readily adopted.

THEORETICAL CONSIDERATIONS.

It is well known that the different species of *Ulva* which commonly occur on our coasts are especially abundant in the brackish water of estuarine localities, and also on the open shore in the neighbourhood of towns. In some cases the fronds grow so luxuriantly as to be cast up in masses by the tide, and the offensive smell of the sulphuretted hydrogen which is formed as these plants decay is sometimes a serious nuisance to the inhabitants. Before, however, this can be effectively remedied, much more must be known of the life-history and habits of the plant, as has already been shown in detail by Mr. A. D. Cotton in his suggestive paper on the subject.¹

From the above account it appears that there is probably a very effective means of reproduction in the formation of these adhesive discs, which are undoubtedly very tenacious of life, can probably live through the winter independently of the thallus (which is described by Harvey and others as annual), and can bear new fronds by the upgrowth of the filamentous tubes of the disc. It would therefore be necessary to adopt some measure to destroy the vitality of these in order to check their spread effectively.

From the point of view of affinity, the multinucleate character of the filaments of the disc in *Ulva* serves to emphasize the isolation of the whole group of Ulvales, and to remove it from any near relationship with the Ulothricales. On the other hand, the simple segmentation of the tips of the filaments has no resemblance to the method of wall formation in

¹ Cotton, A. D.: On the Growth of *Ulva latissima* in Water polluted by Sewage. Kew Bulletin, 1910.

a typically coenocytic group such as the Siphonales. The method of formation of the disc, indeed, resembles far more closely that found in the simplest red seaweeds, such as *Bangia* and *Porphyra*, but whether this is a case of true affinity, or of parallel development in widely different groups, must be decided only on the result of further research.

The apparently parasitic penetration of the disc filaments into the tissue of some other Algae, and the way in which they appear to entirely take possession of the cells of the host, are, as far as I know, unparalleled at present amongst the Chlorophyceae.

PLATE XLV.

Illustrating Miss Delf's paper on the attaching discs of *Ulva*.

All the figures were drawn with a No. 3 eyepiece (Swift) and D. D. objective (Zeiss), excepting Figs. 7 and 8, which were drawn with a No. 4 compensating ocular (Zeiss) and $\frac{1}{12}$ apochromatic objective (Swift).

Fig. 1. Part of a single filament teased from just above the disc. $\times 510$.

Fig. 2. The tip of a disc filament with two nuclei. $\times 510$.

Figs. 3 and 4. Disc filaments from a teased preparation, showing irregular branching. $\times 510$.

Figs. 5 and 6. Cell-divisions in filaments which had reached the periphery of a disc. $\times 510$.

Fig. 7. Part of the periphery of a disc, showing large and small filaments. $\times 510$.

Fig. 8. Part of the stipe in longitudinal section, showing filaments extending within the surface of the thallus and (a) forming a small-celled tissue externally. $\times 510$.

Figs. 9 and 10. Small part of the periphery of the cross section of a seaweed resembling *Polysiphonia*, infested with filaments from an attached disc of *Ulva*. ($\frac{1}{12}$ apochromatic.)

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DELPH — ULVA

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Delf, Ellen Marion. 1912. "The attaching discs of the Ulvaceae." *Annals of botany* 26, 403–408. <https://doi.org/10.1093/oxfordjournals.aob.a089397>.

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