Notes on Florideæ. By Geo. W. Martin.

Of the two orders comprising *Rhodophyceæ*, *Florideæ* is the most noteworthy. The number of species composing it is large, all of which have the predominating red shade in their normal condition, though other colors are sometimes very conspicuous. Like other noted cases, the order seems to be a very natural one; in fact, the genera and species graduate into one another so finely that sharp distinctions can not be obtained. However, it must not be inferred that exceptions do not occur here as is common to the other natural divisions of the plant kingdom. With the exception of a few genera, such as *Batrachospermum*, *Lemanea*, *Bangia*, *Chantransia* and *Hildenbrandtia*, all are marine; their favorite place of growth is below low-water mark and in deeper water, but some forms are found in tide pools.

Both morphologically and physiologically, by many it is claimed that this *order* exhibits the highest characters known to algæ. The structure of the frond varies with the genera; in some the tissues are very simple; in others very delicate and complex. All plant bodies are multicellular, and present a variety of forms; some are *filamentous*, either monosiphonous, as in *Ceramium*, or polysiphonous, as in *Polysiphonia;* growth is by means of an apical cell; others are *membranaceous*, formed by branching filaments cohering and the filling up of mucilaginous substance between; in the latter, growth results from a division of marginal series of cells.

While considerable variety of forms and complicated structures obtain in the *Floridea*, *the most noteworthy characters* to be brought out are the methods of reproduction; namely, *vegetative multiplication* and *spore reproduction.* Of the former, many methods are purely vegetative, among which, reproduction by multicellular gemmæ being the most rare, such as found in *Melobesia*. Non-motile cells from terminal cells of branches are thrown off, and to all appearances represent a kind of transition stage between the purely vegetative and the spore-reproductive. Of the latter, two divisions occur; namely, the *non-sexual* and the *sexual-spore* reproduction. The non-sexual spores are formed either *sexually* or *asexually;* the former are always reproduced by the *sporophyte*, and known as carpospores, while the latter are formed by the *gametophyte*, and known as gonidia, or ordinary spores. These are produced in unilocular sporangia, as in *Ceramium*, or in multilocular sporangia, as in *Dasya*.

These bright red, motionless spores are divided into three classes, viz., *tetraspores*, which may be cruciate, zonate or tripartite, *polyspores* and *sierospores*. The latter are common to species of *Ceramium* and *Callithamnion*, and consist of chains of oblong cells formed directly from the branches at their extremities. The

arrangement of the sporangia on the fronds is various. In some cases, as in *Dasya elegans*, they are limited to particular portions of the frond, borne on modified, lateral pod-like branches, so-called stichidia, the terminal cells of which give rise to sporangia. In others, as in *Polysiphonia*, they are developed internally, within the superficial cells, and are either isolated or collected in wart-like masses, *nemathecia*. The latter method seems to prevail among the genera. The fronds bearing the tetraspores are, with few exceptions, distinct from those bearing sexual fruit or cystocarps. Occasionally both tetraspores and cystocarps are found on the same specimen, as in certain species of *Callithamnion* and *Spyridia*. The tetrasporic plants are decidedly more abundant than the cystocarpic. In certain genera, among which *Callithamnion*, it is not uncommon to find *antheridia*, *cystocarps* and *tetraspores* on the same individual, a thing rarely to be seen in the *Florideæ*. But the most puzzling part of the whole life history of the order is the complicated process of sexual reproduction. In many cases the full development of the cystocarp is unknown. Many details connected with the act of fertilization are as yet very obscure. To account for all stages from procarp to cystocarp is at present a problem of extreme interest among algologists.

The organs of sexual reproduction include the antheridium and the procarp, the latter comprising the *trichophore* and the *trichogyne*. As a rule, the sexual cells are terminal in position and more or less fixed, usually placed on the youngest lateral branches of the frond, and are either unicellular or multicellular, thus forming clusters.

A brief description of the simplest arrangement to effect fertilization is the following:

The terminal cells of two lateral branches become changed in form and structure; the one, tuft-like, the antherid, contains a simple non-motile, non-ciliated antherozoid; the other, a terminal cell, with two below forming the procarp, enlarges and elongates above to form a long, slender, hyaline hair, the *trichogyne*, whose basal portion is the *trichophore*. In the simplest forms, as in the *Bangiaceæ*, the antherozoids come in contact with the extremity of the receptive trichogyne where they adhere for a time. After the walls of both points in contact are absorbed, the fertilizing influence is propagated through the trichogyne to the trichophore, which enlarges by cell division. In this case the trichophore becomes the carpogenic cell, which subsequently divides, each *division* yielding a carpospore. Such a product of fertilization is a *cystocarp*, whose formation is direct. Other cases of direct formation occur, as in *Nemalion* and *Chantransia*, where the carpogenic cell gives rise to an outgrowth of oöblastema filaments whose cystocarps consist of clusters of sporangia. In by far the greater number

of genera the cystocarps are not formed by direct, but by indirect, outgrowths from the trichophore. For example, in *Callithamnion*, the fertilizing substance passes from the trichogyne, if at all, through the *trichophore* and *sometimes several cells below*, before certain lateral cells are reached, which become spore bearing. In *Dudresnaya* the trichophore of one procarpic filament gives rise to several lateral tubes, itself becoming non-spore bearing, which convey the fertilizing impulse to certain cells of other procarpic filaments which have no trichogyne in other parts of the frond. Thus, cystocarps are formed at great distances from the trichogyne. In *Polyides* a similar arrangement obtains, but the cystocarps are not the auxiliary cells of the procarpic filaments; they are lateral expansions of the trichophoric tubes. In other genera, the evidences are ample to disprove the act of fertilization. In *Ptilota serrata*, as far as observations went, I found the antheridial plants very rare. Not a single antheridial plant or an antherozoid was found in contact with the trichogyne. A very peculiar phase in the development of the cystocarp was noted—a trichophore with five trichogyns; the antherozoids would have had to pass through two, in some cases three, cells to have fertilized the lateral carpogenic cells.

In *Batrachospermum*, the carpogonium develops cystocarps without any connection with the trichogyne—an entirely non-sexual process. A cellulose plug separates the trichogyne from the trichophore. In *three* species of this genus cellulose plugs were constant, and two nuclei in the trichogyne. Only about 10 per cent. of specimens examined showed evident fusion of antherzoids with the carpogonium. The oöblastema filaments are not outgrowths of the carpogonium, but from cells below, which is in opposition to Thuret and Bornet. Physiologically, then, two great types of reproduction seem to occur: one in which cystocarps develop from the carpogonium; the other in which cystocarps develop from the cell below.

To sum up the sex phase of Florideæ: Antherozoids very rare, non-motile and in some cases wanting. Only a very few cases of actual fertilization recorded by algologists. Not definitely known whether antherozoids fuse with carpogonia or whether apogamy is the rule. The commingling of the nucleus of the antherozoid with the nucleus of the trichogyne and the contents separated from the carpogonium by a cellulose plug—a hint, no doubt, toward an old hereditary act of ancestral forms.

Therefore, the strongest point in the investigation of the *Florideæ* is the separation of the trichogyne from the trichopore, and fertilization not accomplished.