

Pyrocystis noctiluca.—Mr. Murray says:—"This organism is always present, and often in enormous abundance, at the surface of the open ocean in tropical and subtropical

that forms phylogenetically closely allied may live some as plants others as animals. He proposes the theory that the Flagellata are a primitive group from which the Noctilucidae, Rhizopoda, and Cilio-flagellata are derived, and that from the last come the Peritricha, and from these the other Ciliata.

"Since the appearance of this paper, George Klebs* in 1883 published some observations on the freshwater forms, and more recently has given an account of the marine Peridiniidae.†

"Claparède and Lachmann considered Cilio-flagellata as unicellular animals, intermediate between Ciliata and Flagellata. Warming,‡ however, in 1875, expressed the opinion that the Peridiniidae were plants and ought to be classified as intermediate between the Diatoms and Desmids. Nearly all observers, including Prof. Allman, agree in ascribing to them a long flagellum and a row or two rows of cilia in the equatorial groove. There seems to be some reason to doubt the existence of the equatorial cilia, at least in some species. *Polykrikos auricularia*, Bütschli, certainly possesses eight rows of cilia, but according to Klebs it is a true ciliate Infusorian and not a Peridinean at all. As to the existence of the posterior flagellum in *Ceratium* there is no doubt, though often it cannot be observed; it arises from the protoplasm of the body within the aperture of the case, and I have myself seen it in active motion. I have not been able to detect any cilia, and Klebs up till a short time ago had been unable to discover any locomotive organ except a single flagellum. In the account of his recent studies of the marine Peridiniidae, Klebs makes the following statements concerning the locomotive organs. Upon the long flagellum which projects backwards in *Ceratium* he has nothing new to communicate; it is as described by earlier writers. But several times he observed in *Ceratium tripos* a second flagellum, arising like the first from the ventral longitudinal cleft, and he believes that in the normal condition this second flagellum vibrates in the equatorial furrow, like the furrow-flagellum which he observed in freshwater forms. He has not been able to find the opening by means of which the flagella and internal protoplasm are continuous. With regard to this point I see no difficulty; in my own observation referred to above, although I could not make out the actual junction of the flagellum with the protoplasm, it was perfectly obvious that the flagellum arose within the area on the ventral surface of the body where the protoplasm was nude. As described and figured by Bergh, the case is wanting over this area and the protoplasm is uncovered. Klebs also says that he has never seen a specimen of *Ceratium tripos* in locomotion. The specimen which I was able to observe at my leisure for some time moved across the field of the microscope with considerable rapidity, so that I had some difficulty in keeping it in view until I fixed it by means of a cover-glass.

"Concerning the internal organisation, Klebs extends what he said of freshwater forms to those of the sea. Usually the protoplasm is coloured yellow by diatomine, which is not diffused but confined to definite bodies like chlorophyll corpuscles. He also found starch and colourless oil in the cytoplasm. He observed a process in *Ceratium fusus* which seemed like spore formation. Copulation he had never seen. The chain forms, observed first by Mr. Murray and afterwards by Pouchet, he regards as connected with a pelagic mode of life; this I do not understand; chains of pelagic organisms such as Diatoms, *Salpa*, &c., are produced by budding or division, and therefore the same is probably the case in *Ceratium tripos*.

"Physiologically the species of *Ceratium* are certainly plants. The substance of which the case consists is closely allied to cellulose, and contains no inorganic matter; unlike cellulose, it is not dissolved by ammoniacal oxide of copper. The body contains a single oval nucleus, deeply stained by the action of carmine.

"Although some Flagellata undoubtedly live as animals, it has not yet been absolutely proved that any of the Peridiniidae digest. Stein and Bergh affirm the fact in *Gymnodinium*, but Klebs does not accept their conclusion.

"Unless the occurrence of *Ceratium tripos* in chains be due to a process of division, nothing is known of the multiplication or reproduction of *Ceratium*. In allied freshwater forms division has been known to occur for some time. In *Peridinium tabulatum* and *Glenodinium cinctum*, according to Klebs, the old case is burst during division into two halves at the transverse furrow and thrown off, each of the new cells forming a new case for itself.

"Klebs decided from his studies of freshwater forms, that the Peridiniidae were a group of unicellular plants to be classed with the Thallophytes, their immediate affinities being uncertain. From his study of the marine forms he comes to the conclusion that *Ecuvivella marina*, Cienkowski, is a true Peridinean, and that this organism shows affinities on the one hand with the yellow cells of Radiolarians, on the other with the Cryptomonads, the central group of the Flagellata.

"*Ceratium* may be therefore considered as a genus of unicellular Algae. Three species of *Ceratium* (*Ceratium tripos*, *Ceratium furca*, and *Ceratium fusus*) are extremely abundant in the waters of the Firth of Forth and neighbouring seas at all seasons."

* *Untersuchungen aus dem botanischen Institut zu Tübingen*, Bd. i. p. 346, 1883.

† *Botanische Zeitung*, Nos. 46 and 47, 1884.

‡ *Vidensk. Meddel. f. d. nat. Foren. i Kjøbenhavn*, Aaret 1875.