

striking instance of *Thalassicolla sanguinolenta*, which becomes so deformed by the inception of numerous coccospheres and coccoliths, that I described it as a special genus under the name *Myxobrachia* (compare pp. 23, 30 ; also L. N. 21, p. 519, Taf. xviii., and L. N. 33, p. 37).

205. *Symbiosis*.—Very many Radiolaria, but by no means all members of this class, live in a definite commensal relation with yellow unicellular Algæ of the group Xanthellæ. In the ACANTHARIA they live within the central capsule (*Zooxanthella intracapsularis*, § 76), in the SPUMELLARIA and NASSELLARIA, on the other hand, within the calymma but outside the central capsule (*Zooxanthella extracapsularis*, § 90); in the PHÆODARIA a special form of these symbiotic unicellular Algæ appears to inhabit the phæodium in the extracapsulum, and to compose a considerable portion of the phæodellæ (*Zooxanthella phæodaris*, § 90, or better perhaps *Zoochlorella phæodaris*, § 89). Undoubtedly this commensal life is in very many cases of the greatest physiological significance for both the symbiontes, for the animal Radiolarian cells furnish the inquiline Xanthellæ not only with shelter and protection, but also with carbon dioxide and other products of decomposition for their nutriment; whilst on the other hand the vegetable cells of the Xanthellæ yield the Radiolarian host its most important supply of nutriment, protoplasm and starch, as well as oxygen for respiration. Hence it is not only theoretically possible, but has been experimentally proved, that Radiolaria which contain numerous Xanthellæ can exist without extraneous nutriment for a long period in closed vessels of filtered sea-water, kept exposed to the sunlight; the two symbiontes furnish each other mutually with nourishment, and are physiologically supplementary to each other by reason of the opposite nature of their metastasis. This symbiosis is not necessary, however, for the existence of the Radiolaria; for in many species the number of Xanthellæ is very variable and in many others they are entirely wanting.

The symbiosis of the Radiolaria and Xanthellæ, or "yellow cells" (§§ 76, 90) was first discovered by Cienkowski in 1871 (L. N. 22). Ten years later this important and often doubted fact was established by extended observations and experiments almost simultaneously by Karl Brandt (L. N. 38, 39) and Patrick Geddes (L. N. 42, 43). This commensal life may be compared with that of the lichens, in which an organism with vegetable metastasis (the Algid gonidia) and an organism with animal metastasis (the Fungoid hyphæ) are intimately united for mutual benefit. But the symbiosis of the Xanthellæ and Radiolaria is not as in the lichens a phenomenon essential for their development, but has more or less the character of an accidental association. The number of the inquiline Xanthellæ is so variable even in one and the same species of Radiolaria, that they do not appear to be exactly essential to its welfare; and in many species they are entirely wanting. Their significance is questionable in the case of those numerous deep-sea Radiolaria which live in complete darkness, and in which, therefore, the Xanthellæ, even if present, could excrete no oxygen on account of the want of light. Nevertheless it is possible that the phæodellæ of the PHÆODARIA (usually green, olive, or brown in colour), which are true cells, represent vegetable symbiontes,