

occipital and upper opercular regions. The distance between the eye and the dorsal equals the distance between the end of the snout and the preopercle. Dorsal VI, 15, the two portions very narrowly separated; the longest soft rays $\frac{1}{2}$ length of head, a little longer than the rays of the first fin, the base of which measures $\frac{1}{2}$ its distance from end of snout. Anal with 12 rays. Pectoral $\frac{3}{4}$ length of head, with silk-like upper rays. Ventral not reaching vent, with well-developed anterior flap forming an obtusely pointed process on each side. Caudal rounded. Caudal peduncle as long as deep. 61 scales in a longitudinal series, 22 between dorsal and anal. Greenish to blackish olive, more or less spotted and marbled with black; dorsal and caudal fins spotted with black; ventral whitish; yellowish white beneath.

Total length 19 centimetres.

Of the two British species with which this *Gobius* may have been confounded, *G. paganellus* and *G. niger* differ in the larger scales, there not being more than 17 between the dorsal and the anterior rays of the anal and 55 in a lateral series, and in the absence of the antero-lateral lobe of the ventral disk. Günther's statement (Cat. Fish. iii. p. 55) that the interorbital space is scaly in *G. capito* is erroneous; a specimen with 17 longitudinal series of scales between the dorsal and anal fins, put down by the same author as *G. capito* (spec. b), has only 55 scales in the lateral line, and is, in fact, a *G. paganellus*. Fine large specimens from the Bosphorus, received from Dr. Dickson since the publication of the British Museum Catalogue, have been carefully compared with the specimen described above, which affords the first evidence of the presence of *G. capito* in the English Channel.

XXIII.—On the Classification of Ciliate Infusoria.

By Dr. V. STERKI*.

AFTER so eminent a naturalist as Bütschli has modified Stein's system of Ciliata, it may appear rather assuming if I venture to propose some changes. It is done because my views have long been held, and have been confirmed as the years passed.

In the first place, it seems that the Peritricha are of an organization quite different from that of all other ciliates. The formation of the anterior part, peristome, mouth, &c., is

* From 'The American Naturalist,' vol. xxxii. no. 378, pp. 425-428.

unique, although having some resemblance to that of the *Stentorina*. There is no adoral zone with transverse rows of cilia like that in *Heterotricha* and *Hypotricha*, as has recently again been asserted by Delage et Herouard *. The arrangement of the muscular elements in the ectoplasm, or myonems, is quite different. The formation of a temporary posterior girdle of cilia for locomotion in the most typical *Peritricha*, and even the permanent one in some others, is a very distinguishing feature; and a distinction of highest order is their mode of fission in the longitudinal axis † or by gemmation. This character has been explained in various ways, and some have tried to bring it in conformity with the transverse fission in the other groups. Nevertheless it remains different, and shows, combined with the other features noted above, that this group is of quite another type or phylum, the more so if we add the peculiar phenomena of conjugation. The remaining Ciliata differ from the *Peritricha* in regard to these characters, and they resemble one another in respect to the most significant of them.

In opposition to the *Peritricha* we may give to this second group the name *Pantotricha*. Among the latter those forms having a true adoral zone with a distinct beginning and end at the mouth-entrance, and bearing transverse rows of single cilia—that is, the *Hypotricha* and most of the *Heterotricha*—evidently are of a common type, and range in one group, which I propose to name *Zonotricha*. True, the extreme forms are very different, *e. g.* a *Stentor* on the one hand and a *Stylonychia* or *Euplotes* on the other; but it is well known that both series, by gradual changes, in fact, run together, and that there are forms which may be ranged with one or the other. Many *Peritricha* are quite depressed, while there are *Oxytrichidæ* nearly terete, showing little differentiation of the dorsal and ventral faces, with fine and densely set cilia over most of the body (*Strongylidium*). And such forms as *Stichospira* ‡ make the distinction still more illusory. Tactile hairs (or “dorsal cilia”) are wanting in some of the *Oxytrichidæ*, as well as in *Euplotidæ* and *Aspidiscidæ*. Longitudinal differentiation in the ectoplasm of *Urostyla* &c. comes very near the myonems in *Peritricha*. With the *Zonotricha* range *Halteria*, probably also *Strombidium* and *Gyrocoris*.

* ‘Traité de Zoologie Concrète: I. La Cellule et les Protozoaires.’ Paris, 1896, p. 452.

† It must be noted, however, that in all groups the direction of the division is across that of the myonems.

‡ See the writer’s article, ‘The American Naturalist,’ vol. xxxi. no. 366, June 1897, pp. 535–541.

A rather aberrant group falling under the same head are the Ophryoscolecidae, with their retractile peristome.

After removing these forms the Oligotricha, *i. e.* mainly the Tintinnidina, make a more uniform small group, characterized by the circular uninterrupted zone bearing cilia of a different form and type, inside of which the mouth is situated.

The Gymnostomata have been made by Bütschli a group of highest order, equal in value with all the other groups combined. It has been shown above that in a number of essential features they differ from the Peritricha and are in harmony with the other Planotricha, and they are especially so with the Aspirotricha. Yet the formation of the mouth, together with some other characters, is so significant that it does not seem natural to reunite these two groups into the old order Holotrichida, as the French authors have done (*loc. cit.* pp. 430, 452). In the great diversity of the formation of the body among the Gymnostomata we have an interesting analogue with an equally wide range among the Zonotricha.

The highest position must be assigned the Oxytrichidae and Euplotidae. Here the differentiation of the main feature of the ciliates, the cilia, reaches its maximum, not only morphologically, but also physiologically, combined with the highest development of intellectual faculties, as far as we dare speak of such. In all these points the Peritricha, which have often been placed at the head of the class, are inferior; and their inferiority is demonstrated also by the fact that at least half of them are epizoa, or commensals; a large number of animals of both categories live in colonies, either actually coherent or close together, modes of life which are not so much different as is commonly supposed.

The groups Peritricha*, Gymnostomata, Aspirotricha, Oligotricha, and Zonotricha seem to have the significance of orders of about equal standing with "orders" throughout the animal kingdom. Thus we would have the following table:—

Subclasses.	Superorders.	Orders.
{ Peritricha.		Peritricha.
{ Pantotricha.	{ Gymnostomata.	Gymnostomata.
	{ Trichostomata (em.).	{ Aspirotricha.
		{ Oligotricha (em.).
		{ Zonotricha.

The Ciliata are here regarded as a class. To this point a

* The Peritricha might probably be divided into two orders; but, since I have not seen *Licnophora* and *Kentrochona*, the question is left open here.

little digression may be excused. Why should not both Ciliata and Suctoria be treated as classes? Conceded that Bütschli is right in regarding the tentacles as mouths, and I believe so, that would not necessitate ranging them together. The possession of cilia by the Acinetina, in the early stages of development, has possibly been overestimated. How many features are shown in the earlier or larval stages of other and higher animals to disappear at a later period, *e. g.* cilia in Mollusca (velum) and Echinodermata? If an amœboid stage, or the development and disappearance of flagella, were accorded so much significance, how should we then, with good reasons, regard the Rhizopoda, Sporozoa, and Flagellata as so many classes? The close resemblance of the phenomena of conjugation in the Ciliata and Suctoria is certainly significant; but we have essentially identical ways of fecundation &c. of the ova in different main groups of Metazoa. In their definite formations the Ciliata and Suctoria are as much different from each other, or much more so, than, for example, the classes of vertebrates and arthropods. The question seems to be rather one of logic: if the Suctoria in their definite stage are to be considered a degenerated type of Ciliata, they must be ranged under the same head as a subgroup; if not so, they may well rank as a class at the side of the Ciliata.

New Philadelphia, Ohio,
April 1898.

BIBLIOGRAPHICAL NOTICES.

A Natural History of the British Lepidoptera. A Textbook for Students and Collectors. By J. W. TUTT, F.E.S. Vol. I. Sonnenschein, January 1899. 8vo. Pp. vi, 560.

To the superficial mind it might appear that there was already a sufficiency of works on British Butterflies and Moths; and yet many of those which have recently appeared treat of the subject from an enlarged standpoint, and cannot be denounced as superfluous. Among these we have met with none, not even Mr. Barrett's, which approaches the work which Mr. Tutt has undertaken, for comprehensiveness and richness of detail. The amount of matter, too, which it contains is enormous, for it is so closely printed, and small type is so freely used, that every page probably contains on an average from two to four times the amount of matter which might reasonably be expected to occupy a page of similar dimensions.

The first part of the book may be regarded as introductory, and contains chapters on the origin of the Lepidoptera; the ovum, embryology, and parthenogenesis; external and internal structure



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