

ON THE EPITOCOÛS PHASE OF THE NEREID, PERINEREIS  
NUNTIA VAR. BREVICIRRIS GRUBE

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ONE PLATE

(Received Aug. 27, 1933)

It is known that there is an epitocous phase (sexual phase) in the life of nereids. In this phase the general form of the body as well as the habits changes to such an extent that earlier workers on nereids considered the worms of epitocous phase as of a different genus and named it *Heteronereis*. Until now, the epitocous phase of many species is not well known, for usually the morphological description of nereids has been based on the normal phase (atocous phase) only. The study of the form and the habits of nereids in the epitocous phase is very important in systematics as well as in ecology and embryology, because the same distinct characteristics of each species appear in the epitocous phase as in the atocous one. In the atocous phase no sexual dimorphism is apparent, but we can easily distinguish the difference of sexes in the epitocous phase. In this paper I will describe the epitocous stage of a nereid *Perinereis nuntia* var. *brevicirris* Grube which is found abundantly in the northern coast of Formosa.

*Season of Maturation.* In our island the maturation of this nereid usually takes place in May and June, but occasionally in April and July. The average temperature of water in which this epitocous nereid occurs is 28°-29°C.

*Morphological Changes.* Morphological changes in the nereid begin about a month before maturation. The blood vessels swell, the black spots which appear on the dorsal surface of the anterior parapodium enlarge, all parapodia somewhat expand, the eyes colored with greenish purple become very large, and a greenish-black pigment can be discerned around the eyes. Ten days after (3 weeks before maturation) we can distinguish the male from the female with the naked eye, for

the male becomes light red in color, while the female becomes light green and is larger than the male. In both sexes the eyes continue to expand, the pigment near the eyes becomes more dense, and the blood vessels more and more thickly distributed in the parapodia, so that the tips of parapodia become red in color. About 2 weeks before maturation of the worms the transformation of parapodia commences, but this phase may not be truly epitocous, so it is named subepitocous (Pl. 9, fig. 1, *c*). At this stage the parapodia and swimming bristles are not completely transformed. The completely transformed worms are smaller in size (fig. 1, *a, b*), the body-wall has become thin and the gonads expanded in all parts of the body. We should notice that in the beginning a partial transformation of the parapodia commences in both sexes at about 40th segment, and progresses gradually from them to both ends. There appear appendages of dorsal and ventral cirri, and normal bristles begin to fall off. But within the last week parapodia change to epitocous type rapidly: in the female 6-7 days and in the male 5-6 days after the change of coloration. The matured male is red in color, but its anterior parts are milky white. The light green color of the female is due to the green eggs filling the body. In these matured worms the extreme anterior and posterior parapodia are not transformed.

The transformation of the parapodia is the most important characteristic of the epitocous phase. In this nereid the final change of the parapodia commences in the male at the 17th parapodium (Pl. 9, fig. 5), in the female at the 21st (fig. 3). Thus in the male 16 pairs and in the female 20 pairs of the foremost parapodia are unchangeable, though all (except perhaps the extreme six) are enlarged in their basal part. The transformation commences in this nereid regularly at the definite parapodia, as described above, but in exceptional cases, the 16th and 15th or perhaps the 14th pair of parapodia in the male (20th, 19th and 18th in female) also change completely or merely develop appendages on dorsal and ventral cirri (figs. 2, 4).

There is considerable discussion as to the segment from which the parapodia begin to change. In 1897 E. Ehlers noticed the fact and described it as follows:— ".....; von Interesse ist, zu sehen, wie diese Arten in der epitoken Form von einander abweichen: bei *N. dumerili* sind im Männchen die Ruder vom 16., beim Weibchen vom 21. Ruder ab voll entwickelt, bei *Nereis agassizi* beim Männchen vom 22. Ruder ab; bei *N. magalhaensis* in beiden Geschlechtern voll vom 26. Ruder ab."

The number of the segment at which the epitocous transformation of parapodia begins is recorded in the case of many nereids, but the records are very incomplete, so that the data regarding many species of epitocous worms cannot be obtained. Of course the typical transformation of parapodia is different in each species, so that if we have no details for each type we cannot compare them. Nevertheless I give for reference a rather incomplete table, which shows the comparison of some epitocous characteristics of a few species of *Perinereis*. Unfortunately many of the descriptions are incomplete, neither coloration nor the seasons of maturation being recorded. From the table we see firstly that the point of the beginning of transformation of the parapodia is distinct in almost every species, and secondly that in female it begins further back than in the male. In other genera of Nereidæ these two characteristics are also

TABLE SHOWING SOME EPITOCOUS CHARACTERISTICS OF PERINEREIS COMPARED

	Commencement of epitocous transformation of parapodia	Coloration	Swimming bristles	Season of maturation	Observer
<i>Perinereis aibuhitensis</i> Grube	♂ 21, ♀ 23	no record	+	no record	Horst
* <i>P. binongkæ</i> Horst	16 (no details)	no record	+	no record	Horst
* <i>P. camiguina</i> Grube	gradually	no record	-	no record	Horst
<i>P. cultrifera</i> Ehlers	♂ 14-20, ♀ 18-23	♂ whitish, ♀ greenish yellow	+	no record	Izuka
<i>P. cul.</i> var. <i>perspicillata</i> Grube	♂ 15, ♀ 18	no record	-	no record	Monro
* <i>P. nancaurica</i> (Ehlers)	no record	no record	-	no record	Monro
* <i>P. nuntia</i> var. <i>brevicirris</i> Grube ( <i>Nereis mictodonta</i> Marenzeller)	21 (no details)	no record	+	no record	Izuka
<i>P. nun.</i> var. <i>brevicirris</i> Grube	♂ 17, ♀ 21	♂ red, ♀ green	+	May to June	Takahasi
* <i>P. nun.</i> var. <i>heterodonta</i> Gravier	21 (no details)	no record	+	no record	Fauvel
<i>P. rumphii</i> Horst	♂ 24, ♀ 29	no record	+	no record	Horst
* <i>P. singaporiensis</i> Grube	20 (no details)	no record	+	no record	Monro

noticeable. In the table, species with asterisks seem incomplete, and the specimens which are recorded as having no swimming bristles may be subepitocous worms. In my specimens subepitocous parapodia contain some of the normal bristles until the final transformation is completed. In some cases these subepitocous parapodia have no swimming bristles at all.

Typical transformed parapodia of this nereid are similar in both sexes (Pl. 9, fig. 6), but in the male the parapodia are smaller in size than in the female and each dorsal cirrus has 4-9 papillæ along the lower side (fig. 7). Only occasionally we can find the papillæ in the female. Swimming bristles (fig. 8) appear on the parapodia of the middle region of the body early in the epitocous phase. Anterior unchangeable parapodia usually have no swimming bristles, moreover even the normal bristles on these parapodia often drop off in the matured worms. These normal bristles fall away at the same time with those of transformed parapodia, but instead of developing new swimming bristles there appears a new set of short bristles of normal type.

Anal segment is decorated with many colored papillæ, and that of the female is more complicated than that of the male (Pl. 9, fig. 9). As I described above, the eyes of the epitocous nereid is enlarged (fig. 10, *e*), so that it might be mistaken for a nereid different from the normal one. Paragnathi and other parts of the head are not changed. Alimentary canal is pressed and narrowed by the expanded gonads, so that 90 per cent. of the epitocous nereids have nothing in the canal.

*Habits.* As the gonads expand the alimentary canal is flattened, and consequently the epitocous worms are prevented from feeding for a long time. But their carnivorous habit remains, so they bite one another, and only occasionally largest female can even swallow a small injured worm. If there are mingled many atocous and epitocous worms in one place, many wounded epitocous worms are eaten by atocous. This fact suggests that the matured worms are no longer alive after this phase. Other epitocous changes of habits appear very late. Before the last rapid transformation of parapodia the worm burrows in the sand and makes a thin mucous tube inside the sand burrow. This phase lasts about a week, and the worm does not like to go out from the burrow even in the night, and all the while its body performs a continuous undulatory movement. Transformed parapodia are intensely red in color when the worm is moving, for in that case the blood passes through the blood vessels more swiftly. The beats of blood

current in the normal worm are 10-12 per minute, but in complete epitocous worm 15-18.

Individuals of atocous phase measuring 100 mm or more are almost mature. All of them do not change at the same time, for I have not seen the swarming of this epitocous nereid. The worms live for 4-5 days after full maturing, for after the gonads are discharged into the water through the parapodia, the worms lose their lives in a few minutes and disappear. When the worms discharge gonads they move irregularly on the sand, and often make shallow depressions in the sand about 40 mm in diameter.

There are many worms which have no epitocous phase in spite of their very large size, but we do not know the reason for this. The maturing of the worms cultured in the laboratory is usually delayed by 7-10 days as compared with those in the sea. As a whole, in our island, both sexes mature almost at the same time, and the males are found more numerous than the females; ♂:♀ = 5:4.

(Taihoku, August 8, 1933.)

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## PLATE 9

- Fig. 1. Epitocous worms of *Perinereis nuntia* var. *brevicirris* Grube, dorsal view.  
A, female; B, male; C, subepitocous male. Natural size.
- Fig. 2. 20th right parapodium of female, posterior view.  $\times 35$ .
- Fig. 3. 21st right parapodium of the same specimen. Swimming bristles not seen.  
 $\times 35$ .
- Fig. 4. 16th left parapodium of male, anterior view.  $\times 35$ .
- Fig. 5. 17th left parapodium of the same specimen.  $\times 35$ .
- Fig. 6. 30th right parapodium of female, anterior view.  $\times 35$ .
- Fig. 7. Showing the dorsal part of 30th parapodium of male.  $\times 35$ .
- Fig. 8. A swimming bristle.  $\times 240$ .
- Fig. 9. Anal segment of male with the last parapodiated segment, dorsal view.  
 $\times 10$ .
- Fig. 10. Lenses of eyes. e, lens of epitocous worm; g, lens of atocous worm.  $\times 17$ .

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PLATE 9

