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On the Change caused by Rhizocephalan Parasites in the Hermit-Crab, *Eupagurus lanuginosus*¹⁾

By
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(With 11 Text-figures)

Recently it was demonstrated that one or more neurosecretory substances participate in the sexuality of a crab (Carlisle, 1953). Further, Matsumoto (1952) suggested that destruction of neurosecretory cells of the thoracic ganglion is parallel to the modifications of the external sexual characters and the possibility of production of sexual character-control substance by the thoracic ganglion, in a brachyura, *Charybdis japonica* parasitized by *Heterosaccus papillosus*. The present study is an attempt to ascertain whether these phenomena are widely found in the sacculinized decapods or not, using *Eupagurus lanuginosus* infected by either of two species of rhizocephalan parasites.

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Material and method

As the material, about 50 specimens of the hermit-crab, *Eupagurus lanuginosus* parasitized by the rhizocephalan, *Peltogaster paguri* or *Peltogasterella socialis* were secured at Atsuta near Ishikari on the western coast of Hokkaido during about two years from October of 1954 excepting the winter months of December to February. They were fixed with Bouin's solution or 10% formalin *in toto*. After measuring the external portions, internal organs were cut in 8 μ sections by the routine paraffin method. The sections were stained with Heidenhain's iron hematoxylin or Delafield's hematoxylin and eosin.

Modifications resulting from parasitism

1) *Pleopods*: In the male, the ratios of the length of the internal ramus to that of the external one indicate 0.3–0.5 in the first and second pleopods. In the female, the values range 0.9–1.2 in the first, second and third pleopods. In the parasitized male, however, the ratios were found to increase; they indicated

1) Contributions from the Akkeshi Marine Biological Station, No. 88.
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0.5-1.0. The values in the first and second pleopods of the parasitized female were unchanged, though the values in the third ones alone decreased, indicating 0.5-0.9. Some of the parasitized males became furnished with extra appendages showing the complete female type, in contrast with the case of *E. ochotensis* in which the extra appendages ranged from those of the perfect female type to a small process. Seven specimens of about 300 males, however, were provided with four pleopods, as already reported by Shiino (1931) in *E. samuelis*. The growth of extra appendages is, therefore, not always dependent on the parasitism in these species.

2) *Gonads*: The damage of the gonads by the parasites in the male was generally weaker than that in the female, though the degree was variable in each sex. In the males heavily affected testes were reduced to a fibrous tissue surround-

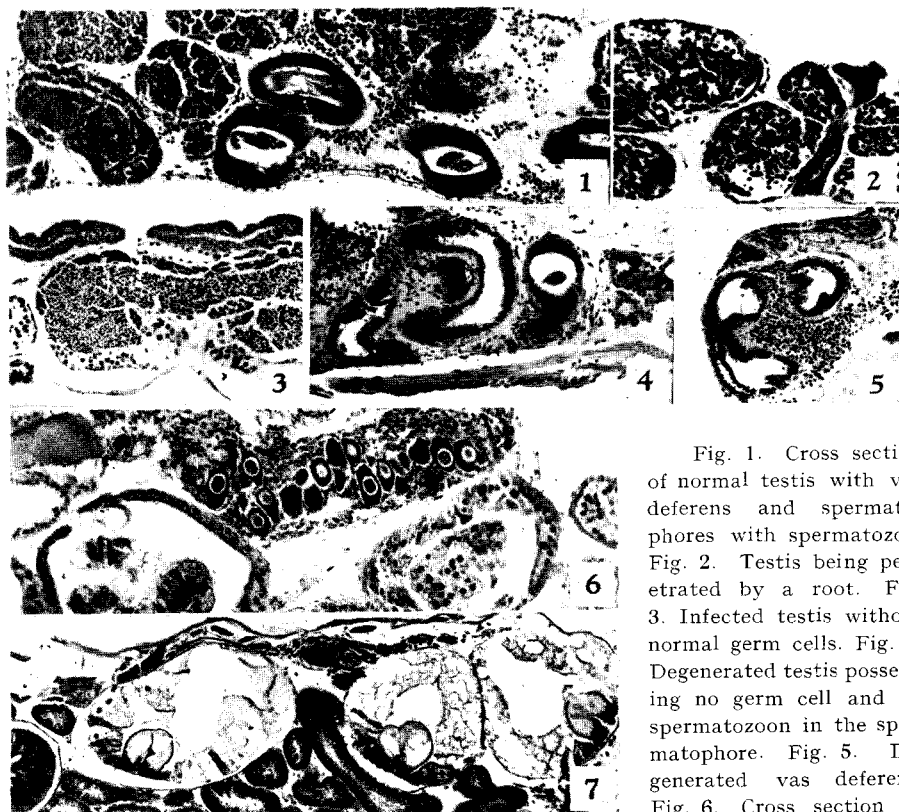
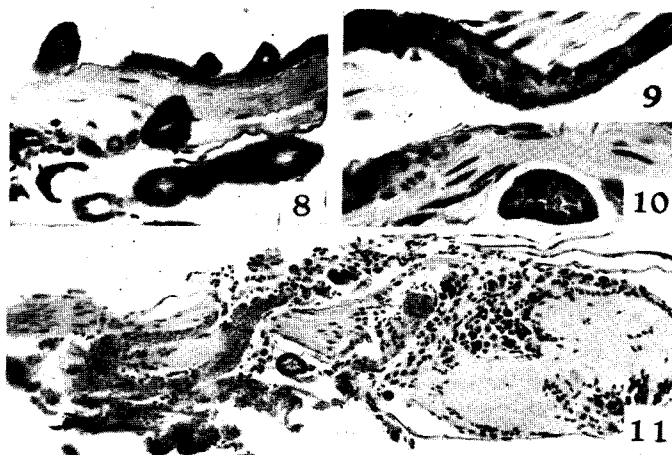


Fig. 1. Cross section of normal testis with vas deferens and spermatozoa. Fig. 2. Testis being penetrated by a root. Fig. 3. Infected testis without normal germ cells. Fig. 4. Degenerated testis possessing no germ cell and no spermatozoon in the spermatophore. Fig. 5. Degenerated vas deferens. Fig. 6. Cross section of normal female abdomen through an ovary. Fig. 7. Cross section of parasitized female, corresponding in portion as above. All figures, $\times 60$.

ded by a mass of blood corpuscles. On the other hand, the males slightly affected seemed to possess reproductive ability, in spite of harbouring a considerably large parasite. There were found intermediate forms between these two extremes (Figs. 1-5). In most of the infected females, the ovaries had disappeared but congestions were usually found at the corresponding portions (Figs. 6-7).

3) *Other portions*: Among the internal organs excepting genital ones, the nervous tissue and the liver (hepatopancreas) suffered marked effects by the parasitism. The livers of the parasitized individuals showed a considerable degeneration of the tissue as already reported by the present writer (1955). Inter-tubular portions of the livers were filled with developed roots of the parasite, though each liver tubule was free from the root-invasion.



Figs. 8, 9 and 10. Root-invasion in abdominal commissure. Fig. 11. Roots invading in posterior portions of thoracic ganglion. Fig. 8, $\times 150$, Figs. 9 and 10, $\times 270$, Fig. 11, $\times 70$.

On the other hand, direct penetration of the roots was observed in the central nervous tissue of the host. The abdominal commissure always revealed heavy invasion of the roots (Figs. 8-11). In the thoracic ganglion mass, however, the penetration of the roots was restricted in the posterior portion of the ganglion. There were only a few neurosecretory cells in the posterior portion of the ganglion, though there were found many neurosecretory cells in some limited parts of the thoracic ganglion. The middle and anterior portions of the ganglion and the brain (cephalic ganglion), in which many neurosecretory cells were found, were entirely free from the root-invasion so far observed. In some hosts, slight root-invasion was demonstrated also in the abdominal flexor muscle and abdominal nerve.

Discussion

Recently, Matsumoto (1952) reported that there occurred the decrease of number of the neurosecretory cells in the thoracic ganglion of a sacculinized crab. He noticed that the alteration of the external sexual characters was in accord not with the damage of the gonads but with the decrease of the number of neurosecretory cells in the thoracic ganglion of the host.

In the present study, the relation between the damage of some internal organs and the modifications of the external sexual characters was examined on the following assumption. If development of the external sexual characters depends on a hormonal substance produced by some organ and if modifications of the external sexual characters are brought about by the change of this hormonal substance which has resulted from the damage of that organ, it may be probable that a correlation exists between the degree of destruction of the organ and the external modifications. The results are summarized in Table 1. The data show obviously that the modifications of the pleopods were brought about independently of the destruction of the gonads. Moreover, no significant correlation is found between the destruction of the ganglion and the external modifications. Therefore, it can not be decided whether or not the hormonal substance, by which the external sexual characters are controlled, is produced by the thoracic ganglion in this species. From the results observed in this study, the effects by *P. paguri* seem to be somewhat weaker than those caused by *P. socialis*.

Table 1. Correlation between the damage of some internal organs and the modifications of the external characters in the male host. Each numeral in square indicates number of specimens.

		Nerve			Liver			Pleopod			Extra appendage eruption
		H	M	S	H	M	S	H	M	S	
Gonad	H	1	1	2	2	1	1	0	1	2	3
	M	7	5	11	2	16	5	11	6	6	8
	S	0	0	2	2	1	0	1	0	2	1
Nerve	H				0	6	2	2	0	5	2
	M				0	4	2	2	3	1	4
	S				6	8	2	7	4	7	6
Liver	H							2	2	3	2
	M							8	4	6	9
	S							2	1	3	2
Pleopod	H										6
	M										3
	S										3

H: heavily affected, M: moderately affected,
S: slightly affected or normal.

Summary

The following results were obtained by studying *E. lanugionsus* parasitized by either of two rhizocephalan parasites, *Peltogaster paguri* and *Peltogasterella socialis*.

External sexual characters in the abdominal appendages were modified by parasitism in the male, but not so distinctly in the female. On the other hand, the damage of the gonads was heavier in the female than in the male. Some of the male hosts possessed nearly normal testes in which a complete process of spermatogenesis was performed. All of the parasitized females were completely sterile. No correlation between the damage of the gonads or thoracic ganglion and the modifications of the external sexual characters was recognizable in the present host.

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