

Control Site of Ovarian Development in the Optic Ganglion of the Prawn *Penaeus japonicus*

Kaworu Nakamura*

Keywords : *Penaeus japonicus*, optic ganglion, ovary controller

Abstract

Surgical operations were undertaken to identify the medulla relating to ovary inhibition in the optic ganglion of the prawn *Penaeus japonicus*. Local cuttings of the ganglion were treated upon the eyestalk of females. The cutting levels were externally adjusted to each site of the medullae. After 2 weeks rearing, the eyestalks were subjected to the histological certification of the operation, and further the gonadosomatic index(GSI) was calculated respectively to investigate the individual relation between the exerted site and the GSI. The group of all the medullae removal and eyestalk-ablated showed relatively high values of the GSI(2.63 ± 1.51 , mean \pm S. D.) compared to the values of the medulla externa removal(1.32 ± 0.41) or of that remained(0.8). Based on the relation of the GSI with the situation of its medulla operated, the medulla externa was considered to bear a principal part in the inhibitory mechanism of the ovarian development of the prawn.

There have been many reports since Panouse's experiments^{1,2)} about the participation of the eyestalk in the inhibitory mechanism of ovarian development of crustaceans. Nowadays, its principal site in the eyestalk is proven to be the sinus gland-x organ complex by the results from surgical examinations as extirpation, implantation and/or injection of its extracts³⁻¹⁰⁾. For the prawn *Penaeus japonicus*, however, there have been few trials of the identification of the system which behaves like a x organ¹¹⁾. This experiment was conducted to verify the site of the optic ganglion related to the function which inhibits ovarian development of the prawn *P. japonicus*. Thanks are due to Miss Nieves Aquino, graduate student, for her diligent assistance during rearing experiments.

Materials and Methods

Young females of 10-14g were chosen from the cultured prawns *Penaeus japonicus* for surgical operations of the eyestalks. Before the treatment, the internal anatomy of the eyestalk was undertaken to have a proper understanding of the construction and distribution of the optic ganglion. The observation was represented in Fig. 1, with one of the crossly cutting levels of the ganglion at the later experiments. Surgical cuttings were treated with

* Laboratory of Propagation Physiology, Faculty of Fisheries, Kagoshima University, 50-20 Shimoarata 4, Kagoshima, 890 Japan.

the cutting levels adjusted externally to each site of the medullae. The 30 individuals were operated with different levels of cutting. Further, completely eyestalk-ablated and intact prawns were prepared as the controls. Those operations were done using small scissors or hot pincettes as preventing bleeding as possible. The above prawns were reared individually in each 18l tank provided with filtering and aeration equipments. For feeding, pellets and fresh meat of prawns were given properly. After 2 weeks rearing, those eyestalks of the 11 operated and 5 eyestalk-ablated survivals were subjected to the histological certification of the enforcements. The fixative was Bouin, and PAS-haematoxylin was employed in staining. At the sampling, the body wt. and ovary wt. were recorded to calculate the gonadosomatic index(GSI) of each prawn and to investigate the individual relation between the exerted site and the GSI.

Results and Discussion

Situation of Optic Ganglion

The optic ganglion is localized in the center of the eye, the inner part of the compound-eye and beneath the dorsal optic calathus. From distal to proximal, the lamina ganglionaris and medullae as externa, interna and terminalis which compose the ganglion are arranged. These neuropiles except the medulla terminalis show respectively a finger bowl-like shape of different sizes. Their cup openings tend towards posterior, lateral or

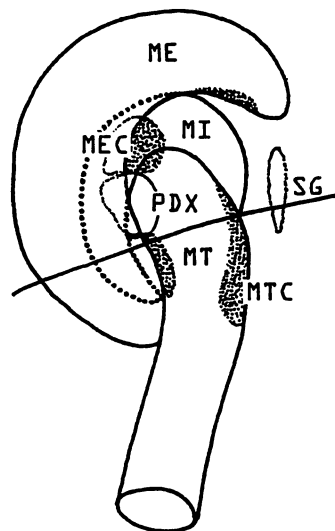


Fig.1 Dorsal view of the right optic ganglion of the prawn *Penaeus japonicus*. Transversal line in the figure indicates one of the cutting levels of the operation. ME, medulla externa; MEC, medulla externa cells; MI, medulla interna; MT, medulla terminalis; MTC, medulla terminalis cells; PDX, pars distalis x-organ; SG, sinus gland.

dorsal, respectively. The medulla terminalis looks like a rod which is the end of the optic tract from the supraesophageal ganglion, that is, brain. There are observed relatively large groups of cells on the surface of each medulla of externa and terminalis. Their distributions are shown in Fig. 1. On the inner dorsal of the distal portion of the medulla terminalis, the pars distalis x-organ(PDX) is situated. Contrary to the position of the PDX, the sinus gland lies at the external space of this medulla.

Effects of Operations on Ovarian Development

The surgical experiments were accompanied with an extreme mortality. About 63% of locally operated prawns were died at almost early period of the rearing. This high mortality seems to have occurred due to the weakening after copious bleeding at the operation(water temperature was the optimum condition as 23-26°C during the 2 weeks rearing). It was technically difficult in this experiment to prevent the bleeding from the cutting section. Reversely, the mortality of the eyestalk-ablated was 17% (6 at the initial, 5 alive at the final). Its operation was successful by application of a devised technique as compressing the stalk-portion with hot pincette, and the ablation was conducted entirely without bleeding.

The results of the GSI together with the initial and final body wts. are shown in Table 1. It was revealed by the histological observations that the specimens of the locally cutting

Table 1 Body wt., gonadosomatic index (GSI) and treatment of the prawns subjected to the locally cutting operation or removal of the eyestalk.

Sample No.	Initial body wt.	Final body wt.	GSI	Cutting level
1	11.88	14.65	1.8	m. terminalis* ¹
2	12.81	13.33	1.3	m. externa
3	10.81	12.65	1.0	m. externa
4	13.29	14.64	2.1	m. externa
5	11.05	11.43	1.0	m. externa
6	11.96	12.67	1.6	m. terminalis* ¹
7	13.21	14.20	0.8	lamina* ²
8	13.46	14.86	1.2	m. externa
9	12.88	14.10	0.8	lamina* ²
10	11.17	12.93	4.3	m. terminalis* ¹
11	10.86	12.73	0.9	lamina* ²
12	10.03	10.38	1.8	stalk
13	12.24	12.86	3.0	
14	13.95	14.93	1.5	
15	14.49	17.08	5.9	
16	12.00	13.02	2.9	

*¹, equal to all medullae removal.

*², equal to the medulla externa (all medullae) remained.

operation would be properly divided into 3 different groups according to each medulla condition; all medullae removal (No. 1, 6 and 10 in Table 1), medulla externa removal (No. 2, 3, 4, 5 and 8) and medulla externa remained, that is, all medullae remained (No. 7, 9 and 11). The mean \pm S. D. value of the 2 groups put together of the all medullae removal and eyestalk-removal was calculated as 2.63 ± 1.51 . Those of the medulla externa removal and medulla externa remained were 1.32 ± 0.41 and 0.8, respectively. The intact showed wholly less value than that of the medulla externa remained. The range of the value of the medulla externa removal was 1.0-2.1 which was nearly between the values of the other groups. And there was no significant difference statistically between the groups of the all medullae removal+eyestalk removal and medulla externa removal. These results indicate that the medulla externa participated in the inhibitory mechanism of the ovarian development of the prawn. On the dorsal surface of this medulla, a population of cells is grouped on a relatively large scale as shown in Fig. 2. The group is supposed sufficiently to behave as the x organ itself or its principal constituent in the eyestalk of the prawn *P. japonicus*. The less value of the medulla externa removal than that of the eyestalk-removal seems to occur due to the weakening by copious bleeding after the operation. Its approximate value will be obtained if the improved operation is undertaken without bleeding. In Fig. 3, the ovaries of the medulla

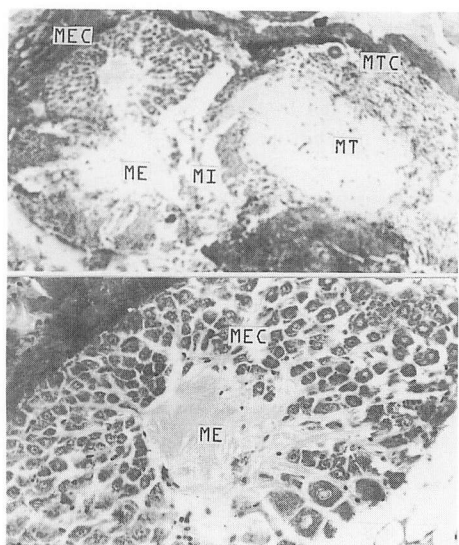


Fig. 2 Horizontal section of the optic ganglion. Upper, the arrangement of the medullae, externa, interna and terminalis, and a localization of the cell group of the medulla externa. Lower, the cell group magnified of the medulla externa. ME, medulla externa; MEC, medulla externa cell group; MI, medulla interna; MT, medulla terminalis; MTC, medulla terminalis cells.



Fig. 3 Ovaries of the prawns No. 4 and No. 15 treated with the medulla externa removal (upper) or the eyestalk-ablation (lower).

externa and eyestalk removals are presented. The longer rearing than the period of this experiment will yield more developed ovaries, especially for the group of the medulla externa removal provided that the improved operation is treated suppressing the regeneration of the exerted tissue. As for the operation effect on the molting, there occurred at least one molting individually during the 2 weeks rearing. A few of them showed further molting (No. 1 and 15 in Table 1). There were no tendencies of the molting frequency and gained weight at the molting among the groups. It needs the repeated experiment for recognition of the effects of the operations on the molting mechanism of the prawn.

References

- 1) J. Panouse (1943) : Influence de l'ablation du pédoncule oculaire sur la croissance de l'ovaire chez la crevette *Leander serratus*. *C. R. Acad. Sci.*, **217**, 553-555.
- 2) J. Panouse (1944) : L'action de la gland du sinus sur l'ovaire chez la crevette *Leander serratus*. *C. R. Acad. Sci.*, **218**, 293-294.
- 3) F. A. Brown and G. B. Jones (1947) : Hormonal inhibition of ovarian growth in the crayfish, *Cambarus*. *Anat. Rec.*, **99**, 657.
- 4) F. A. Brown and G. M. Jones (1949) : Ovarian inhibition by a sinus-gland principle in the fiddler crab. *Biol. Bull.*, **96**, 228-232.
- 5) K. Takewaki and Y. Yamamoto (1950) : Hormonal regulation of ovarian development in the shrimp, *Paratya compressa*. *Annot. Zool. Japon.*, **23**, 187-190.
- 6) D. B. Carlisle (1953) : Studies on *Lysmata seticaudata* RISSO (Crustacea Decapoda). V. The ovarian inhibiting hormone and hormonal inhibition of sex-reversal. *Pubbl. Staz. Zool. Napoli*, **24**, 355-372.
- 7) T. Aoto and H. Nishida (1956) : Effect of removal of the eyestalks on maturation of the oocyte in a hermaphroditic prawn, *Pandalus kessleri*. *J. Fac. Sci. Hokkaido Univ.*, Ser. VI, **12**, 412-425.
- 8) K. G. Adiyodi and R. G. Adiyodi (1970) : Endocrine control of reproduction in decapod crustacea. *Biol. Rev.*, **45**, 121-165.
- 9) A. Bomirski and E. Klek (1974) : Action of eyestalks on the ovary in *Rhithropanopeus harrisi* and *Crangon crangon* (Crustacea: Decapoda). *Marine Biol.*, **24**, 329-337.
- 10) G. K. Kulkarni and R. Nagabhushanam (1980) : Role of ovary-inhibiting hormone from eyestalks of marine penaeid prawns (*Parapenaeopsis hardwickii*) during ovarian developmental cycle. *Aquaculture*, **19**, 13-19.
- 11) D. E. Bliss and J. H. Welsh (1952) : The neurosecretory system of brachyuran crustacea. *Biol. Bull.*, **103**, 157-169.