On the Physiology of Melanophores of the Marine Isopod, *Idotea japonica*, II. Effects of Chromatophorotropic Substances of *Crangon affinis*[1)]

By

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(*With 3 Text-figures*)

The author has reported that the head extract of the isopod, *Idotea japonica*, brings about melanophore expansion in its body, and that the melanophore expanding substance existing in the extract is contained in the accessory sinus gland, ordinary sinus gland and brain (Oguro, 1959). Differing from many other isopods hitherto studied, in which extracts of the head contain melanophore-concentrating substance only, no such substance was demonstrated in any part of the present species. Recently the author had an opportunity to obtain many living specimens of the shrimp, *Crangon affinis*. Using this shrimp, the present study was carried out to ascertain whether the exceptional behavior of the melanophores of *Idotea japonica* in response to its own head extract is due to some specific characters of the activator, of the reactor, or of both.

Before describing the text, the author wishes to express his cordial thanks to Professor Tohru Uchida for his kind guidance and revision of the manuscript. He is also indebted to Dr. Tomoji Aoto for his encouragement given to the author.

Materials and methods: As the materials adult males of the isopod, *Idotea japonica* and the shrimp, *Crangon affinis*, were used. For obtaining extracts, objective organs were removed and ground in filtered sea water. After centrifuging, the supernatant was used as extract of the organ. Five-onehundredths ml of the extract, which corresponds to one organ of a donor individual, was injected into one recipient. The method for determining the melanophore condition was the same as that described in the previous paper (Oguro, 1959). In each section of the following experiments, 30 recipients were used.

Experimental results

Before testing the effect of extracts of *Crangon affinis* upon the isopod, the effects of extracts of the shrimp upon itself were examined. When the eyestalks were removed bilaterally, the shrimp exhibited a moderate coloration, just whitish gray, usually the telson being rather dark.

1) Such eyestalk-less shrimp began to blanch at 30 minutes following injection of the eyestalk extract. 2) When the eyestalk-less animals were injected

1) Contributions from the Akkeshi Marine Biological Station, No 111.

Jour. Fac. Sci. Hokkaido Univ. Ser. VI, Zool., 14, 1960.

with extracts of the post-commissure organ, the shrimp began to darken especially in the telson.

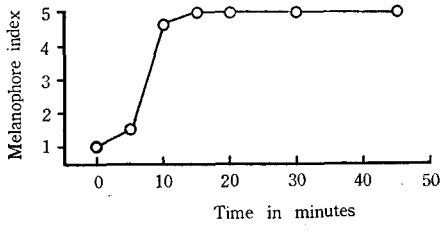
These results are in good agreement with the received conception concerning the chromatophorotropin-chromatophore relationship in the other species of *Crangon* (Brown, 1939, 1940, 1946).

1. Effects upon *Idotea japonica* of extract of *Crangon*-eyestalk

When the eyestalk extract of the shrimp was injected into pale *Idotea japonica* whose melanophores were fully concentrated, the melanophores began to expand 2–3 minutes later. The process of the expansion was very prompt and uniform. The melanophores of *Idotea japonica* which received the injection reached maximum expansion more rapidly than those with the injection of the head extract of the isopod. The melanophore index of these animals exhibited 5 at 10 minutes after the injection (Fig. 1). On the other hand, when the eyestalk extract of the shrimp was injected into dark *Idotea japonica* whose melanophores were fully expanded by means of blinding the eyes (Oguro, unpubl.), no change was detected in the melanophore condition in continuous observation of 3 hours. That is, the extract has not any melanophore-concentrating action.

2. Effects of extract of post-commissure organ of *Crangon affinis* upon *Idotea japonica*

When extract of the post-commissure organ was injected into *Idotea japonica* with expanded melanophores, no change occurred in the melanophore condition in the trunk. On the other hand, this injection brought about a remarkable effect upon the melanophores of the telson. Ten minutes after the injection, most of the expanded melanophores in the telson of dark *Idotea japonica*



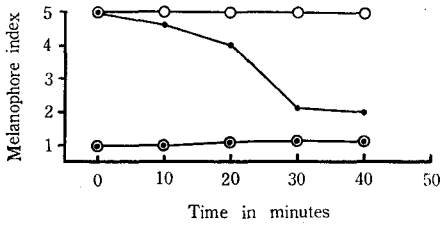


Fig. 1. Response of melanophores of *Idotea japonica* to eyestalk extract of *Crangon affinis*. (Left)

Fig. 2. Responses of melanophores of *Idotea japonica* to extract of post-commissure organ of *Crangon affinis*. (Right) ○ Trunk • Telson

began to concentrate; the melanophore index showed 2 on an average at 30–45 minutes later (Fig. 2). Through this period, however, some melanophores of several animals remained unchanged, retaining continuous maximum expansion mostly in the central part and post-lateral fringes of the telson. Thus, the telson

of some *Idotea japonica* receiving the injection of extract of the post-commissure organ exhibited a mosaic figure (Fig. 3). At the same time, the melanophores of the trunk did not show any change (Fig. 2).

On the other hand, no change occurred in the state of the melanophores when the extract was injected into pale *Idotea japonica* whose melanophores were fully concentrated (Fig. 2).

3. Effects of extract of *Idotea*-head upon *Crangon affinis*

The eyestalk-less shrimps were injected with the head extract of the isopod. The shrimps thus treated became pale about 30 minutes after the injection. At

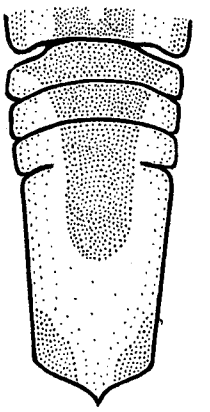


Fig. 3. A mosaic figure of telson of *Idotea japonica*, caused by differential responses of melanophores to extract of post-commissure organ of *Crangon affinis*.

1 hour after, injected animals were clearly distinguishable from uninjected ones by the paleness of their body color. These blanched shrimps were, however, darker than the individuals receiving the eyestalk extract of the shrimp. That is to say, the eyestalk extract of *Crangon affinis* is more effective than the head extract of *Idotea japonica*, in inducing the concentration of dark chromatophores of *Crangon affinis*.

Discussion

A considerable number of studies have been carried out in order to obtain knowledge whether or not the chromatophorotropin-chromatophore system is the same in different varieties of crustaceans. However, no clear-cut conclusion has been obtained in isopods as shown in Table 1. According to Brown (1952), the majority of isopods forms together with the Natantia, Astacura and Mysidacea one group, of which the sinus glands contain a substance causing concentration of their own dark chromatophores. Contrary to that conception, however, it was found recently that in some isopods sinus glands contain melanophore -expanding substance only (Enami, 1941; Fingerman, 1956; Oguro, 1959).

Table 1. A review of the reported results obtained by the injection of head (sinus gland) extract. + & − in the result-column indicate chromatophore -expansion and -concentration, respectively. * exhibits that original paper was unavailable.

Donor	Recipient	Result	Investigator
	Isopoda → Isopoda		
Ligia baudiniana	same	−	Kleinholz, 1937
Sphaeroma serratum	same	−	Okay, 1945 *
Armadillidium granulatum	same	−	
Ligia italica	same	−	
Idothea baltica	same	−	
Idothea neglecta	same	−	Suneson, 1947
		−(+)	Carstam & Suneson, 1949
		+	Enami, 1941
Ligia exotica	same	+	Nagano, 1949
		+	Fingerman, 1956
Idotea japonica	same	+	Oguro, 1959
	Isopoda → Decapoda		
Oniscus muraris	*Leander adspersus*	+	Ståhl, 1938
Porcellio scaber		+	
Idothea baltica		+	
Mesidothea entomon		−	
Idothea neglecta		+	Suneson, 1947
Idothea neglecta		+(−)	Carstam & Suneson, 1949
Trachelipus rathkei	*Cambarus* sp.	+	McWhinnie & Sweeney, 1955
	Decapoda → Isopoda		
Leander	*Idothea baltica*	+	Koller & Meyer, 1930
Crangon		+	
Cambarus clarkii	*Ligia*	+	Kleitman, 1940 *
Cambarus clarkii	*Ligia exotica*	+	Enami, 1941
Leander adspersus	*Idothea neglecta*	+	Suneson, 1947
		+	Carstam & Suneson, 1949
Cambarus sp.	*Trachelipus rathkei*	+	McWhinnie & Sweeney, 1955

From among abundant literature hitherto published, two papers are now picked up for discussion, which concern two representative species, in which the head extracts are known to contain melanophore-expanding and -concentrating substance, respectively. According to McWhinnie and Sweeney (1955), working with the isopod, *Trachelipus rathkei*, *Trachelipus*-blanching substance extracted from its own sinus gland brings about darkening of *Cambarus* sp. and *Cambarus* -blanching substance existing in the eyestalk of itself causes *Trachelipus rathkei* to darken. On the other hand, *Cambarus*-blanching substances both in the eyestalk of *Cambarus clarkii* and in the head of *Ligia exotica* bring about invariable darkening of *Ligia exotica* (Enami, 1941). What conclusion is to be deduced from these results? *Trachelipus rathkei* and *Cambarus* sp. are unlike each other not only in their chromatophorotropins but also in their reactive systems, as

already pointed out by McWhinnie and Sweeney (1955). On the other hand, it might be suggested that the chromatophorotropins of *Cambarus clarkii* and *Ligia exotica* are very similar in function, while their reactive systems differ with each other, though the suggestion is rather tentative because there was in Enami's paper no datum indicating the effect of the head extract of *Ligia exotica* upon the crayfish.

The author found in the present experiment that the head extract of *Idotea japonica*, which has ability to expand its own melanophores, elicits blanching in the shrimp, though not very remarkable. Reversely, extract of *Crangon*-eyestalk causes expansion of the melanophores of the isopod. These results may lead to the conclusion that both activators existing in *Crangon*-eyestalk and *Idotea* -head show functional similarity, while reactors of both the animals respectively respond oppositely. It cannot be concluded from these results, however, that these two activators are also similar in nature, because it has been shown that *Palaemonetes*-blanching substance which darkens *Uca* is really different from *Uca*-darkening substance obtained from *Uca* itself (Carlson, 1936; Brown and Scudamore, 1940).

It is also postulated from the third experiment that in response to the functionally similar activators, the melanophores of *Idotea japonica* react oppositely to the dark chromatophores of *Crangon affinis*: the melanophores in the most part, not in the whole part, of the telson of *Idotea japonica* were forced by *Crangon*-darkening substance to concentrate. Further, it was suggested that there exist at least two different types of melanophores in *Idotea japonica*.

Finally, it would be mentioned that as the results of the present experiment were introduced by applying crude extracts of objective organs, the purification of the chromatophorotropins and tests using purified substances are desired in future studies.

Summary

In order to explain the specific behavior of the melanophores of *Idotea japonica* in response to its own head extract, characters of both the chromatophorotropins and chromatophores were studied by reciprocal injections of chromatophorotropic substances between *Idotea japonica* and *Crangon affinis*. The head extract of *Idotea japonica*, which has been shown to contain melanophore-expanding factor for itself, brought about slight blanching of *Crangon affinis*. The eyestalk extract of *Crangon affinis* forced this shrimp to blanch, but the isopod to darken. On the other hand, extracts of the post-commissure organ of *Crangon affinis* caused darkening of the shrimp, but blanching of the most part of the telson of *Idotea japonica*.

From these results, it was surmised that chromatophorotropins of both the animals resemble each other functionally, while generally the chromatophores of these two animals react oppositely.

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