MORPHOLOGICAL ANOMALIES OF CHAETOGNATHA IN PETER THE GREAT BAY OF THE SEA OF JAPAN

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Introduction

The individual cases of occurrence of the morphologically abnormal animals in a plankton of the seas and oceans were transformed into the last years in the mass phenomenon in Far-Eastern Seas and adjacent waters of the Pacific Ocean (Kassatkina, 1995). As a result of our research of the most mass zoo- and phytoplankton groups was found out that there are many anomalies in *oikopleuras* (*Tunicata, Chordata*), *copepods* (*Crustacea, Arthropoda*) and *chaetognaths* (*Chaetognatha*), but the abnormal changes in phytoplankton were not found out (Kassatkina *et al.*, 1993). On the conclusion of the expert on *copepods Mischel Geptner* (the personal message) the *copepods* anomalies consist in destroyed muscle and these deviations have only the individual specimens of *copepods*. The other groups (*Oikopleura* and *Chaetognatha*) have also the destroyed muscles and moreover in *Chaetognatha* these deviations are displayed in separation of the head from the body (headless or absence of head), the changes of grasping spines and teeth apparatus and eye. Unfortunately *Oikopleura* can not be an indicator of the environmental change because after a loss of muscle these animals die and are lost from plankton ecosystem. The *chaetognaths* anomalous animals continue their existence even without the head, being indicators of any powerful effects of the environmental change (Kassatkina & Karpenko, 2000). The largest percent of the anomalous animals (among *Chaetognatha*) was observed in Kraternaya Bay (the Bay of an action volcano, Yankich Island from Ushishir Archipelago) samples, in the earthquake epicenter. Some anomalous chaetognaths animals were observed by Kassatkina A.P. in the plankton samples from the high Japanese Sea in 1968 (Kassatkina, 1995). The message on several specimens has arrived. Cases of their mass ruin from bacterial infection in the Black Sea and in the bays around Japan (Nagasawa, 1986; Nagasawa *et al.*, 1985) were even marked. However, the reasons of these cases were justified enough well: first – mechanical damage, second – an attack of the predatory *polychaete Tiphloscolex sp.* The messages about the mass appearance of earlier unknown, strange anomalies in Chaetognatha from Far-East Seas arrived since 1991 (Kassatkina *et al.*, 1993; Lapshina, 1993). The different assumptions were stated about the reasons of the mass anomaly occurrence but there was no exact data about their scales. We tried to make the aquarium experiment.

Following problems were put:

- to check up on a live material, whether these anomalous animals are a result of the network mechanical damage, as assumed by many planktonologists, or not;
- whether anomaly occurs not as a result of prey polychaete, but as effect of internal parasites, from which mass chaetognaths wreck in the Black Sea and at coast water of Japan was marked;
- to put on a card the place of finding of the abnormal animals.

Material and Technique

Following samples were used in this work. The plankton were collected in Peter the Great Bay (Fig. 1) by JUDAY-net (diameter of a source aperture 0.1 m^2, the mesh – 168 μm) with following vessels during trips: "Professor Levanidov" (samples were given by TINRO-Center: 1991-1998), "Okean" (samples were given by Far Eastern Regional Hydrometeorological Research Institute: 1994), "Academic Lavrentiev": trip Vladivostok – Niigata, 1995; "Lugovoe", 1999 (Pacific Oceanological Institute). The limiting depth of the plankton catches was 500 m. The vertical catches were carried out in layers (500-200, 200-100, 100-50, 50-0 m) and in coastal waters with a smaller depth the samples took totally –

from the bottom to the surface. The samples were fixed in 4% formaldehyde. Besides the plankton samples were collected by authors in shallow with small boats by a NORPAC and JUDAY-net. In parallel with the total plankton samples the alive *chaetognaths* were sampled for aquarium supervision. The aquariums were the several sizes: for 30, 20, 10 and 1 liter, in them temperature and salinity on parameters of natural environment were supported. The processing was made under microscope MBS-10. In all were analyzed more than 40000 specimens *Chaetognatha*.

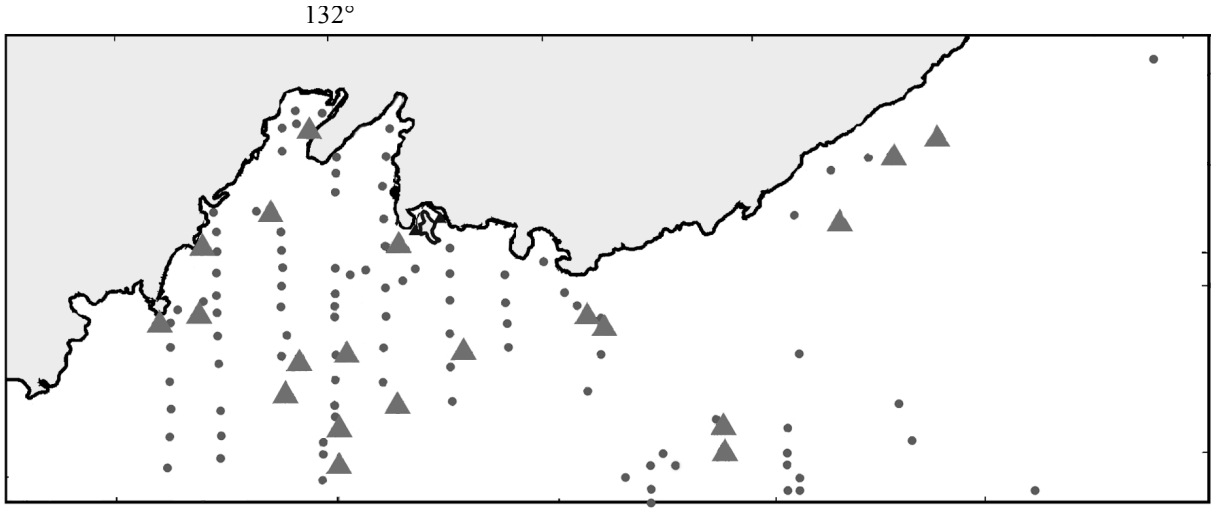

Fig. 1. Plankton stations in the south Primorye without abnormal chaetognaths (dot) and stations, where the abnormal chaetognaths (triangle) were observed

Results

Figs. 2 and 3 show the body form and eyes of normal and abnormal *chaetognaths*. The falling off process of a body part along "to a light band", begins from a vesicle appearance on this light band. Then such vesicle burst and a tissue turned up on this place. This process was on the body both parts: on the head body part and the other body part. Sometimes the disseverance process arise on the different body parts at the same time. A part of a body was separated by an above ventral ganglion for check of the time of the formation wale and the assumption that the abnormal animals are not as a result of mechanical network damage (Fig. 4). The healing and the formation of scar occurred during a day. This experience shows an error of a planktonologist's assumption that the abnormal animals arise in a time of collecting. That period from the network rise up to a moment of seston fixing is estimated at some minutes, for such short time can not arise on a body a formation, similar like abnormal ("helmet"; deformed hooks, eyes). After the separation of the head a tissue turns round quickly, usually during 5-10 minutes and connects then, however, the formation on this place of peculiar "helmet" instead of the head (Fig. 4), probably, requires greater time (it is possible, several days or weeks). In aquarium we did not observe a final process of "helmet" formation on the forward end instead of the head or a tail fin appearing on a separated tail place. It is interesting that a specimen with copepods near the anus but with "helmet" instead of the head was collected. The fallen off from body head with a part of a body continued to live (that was knowledge on the moved hooks), however, in aquarium this head died before another piece of this animal which was separated from her. A body of some animals with large number of light transverse bands fell off to the pieces and probably continued to subsist in aquarium so they were transparent. In a day their integuments became opacification and then began to decay. Therefore, a planktonologist assumption about an occurrence of anomalous chaetognaths as a result of mechanical damage is not correct. Besides researches have shown that probably the part of the abnormal animals is a result of a wrong embryonic development. An influence of the animals occurs at different stages of a development since specimens were collected not only without heads or tail segments, but also with deformed heads. The most frequently defects were in the area of trunk above a ventral ganglion as well as about neck but they happen also in tail segment. The abnormal animals are absolutely different from normal. Such animals look striped, like zebras so they have light stripes, since the defect places had no muscles. It is strange that an existence duration of abnormal specimens was about identical with the normal animals in

aquarium. It is interesting, after a head falling off, the animals continued ability to live – they bred spermatophores from seminal vesicles and did sprawning 1-2 eggs. We suppose that this process may be an abortion. One of such animal without the head lived four days longer in aquarium, than normal, without the external defects attributes animals. It is known (Sorokin & Wyskwarzev, 1973), that *Chaetognatha* can feed on dissolved organic matter and, probably, just this reason can explain such duration of life of the animals without the head.

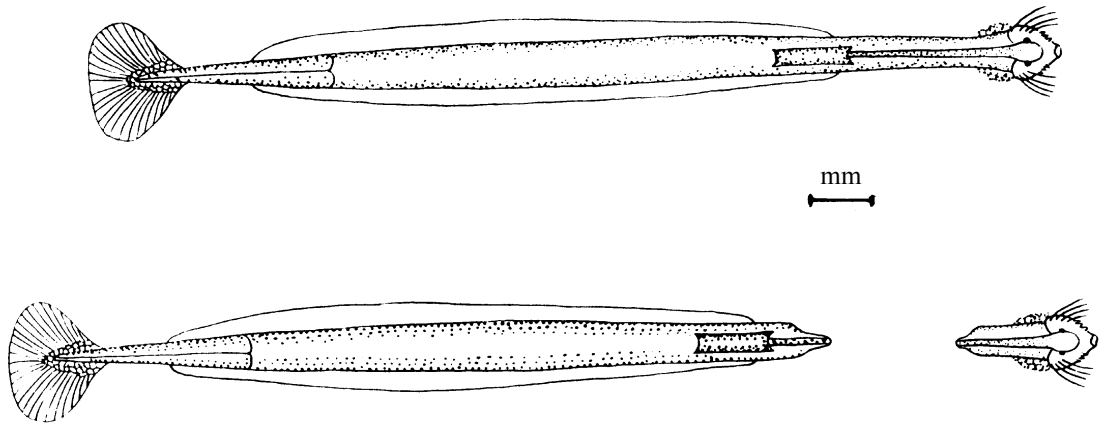

Fig. 2. The normal (above) and abnormal (headless, B) body forms of chaetognaths. The tail and head parts of this body are alive

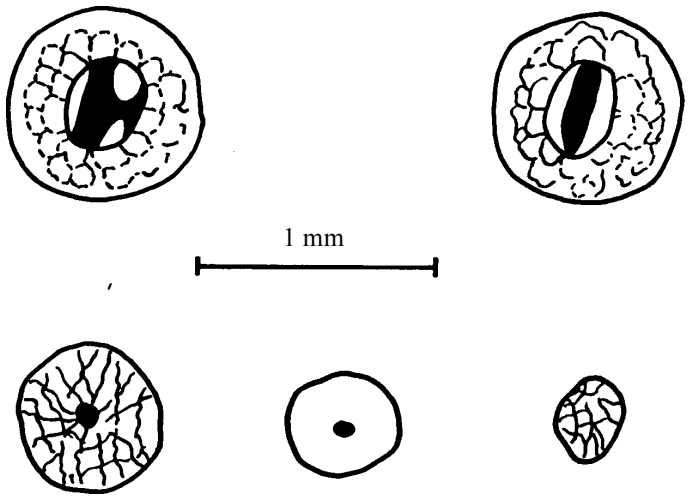

Fig. 3. The eyes of the normalous (upper row) and anomalous (lower row) specimens of epiplanktonic chaetognaths

The second question delivered before us also has the negative answer. In spite of the fact that planktonic polychaete of *Tiphloscolex sp.* were rather frequent in samples and in some were rather massive (were comparable on number of specimens with *chaetognatha*), however, cases of attack them to *chaetognaths* were not marked. It is necessary to mark morphological differences between headless *chaetognaths*: 1) epithelium around "helmet" of an abnormal *chaetognatha* is absent in a result of *Tiphloscolex sp.*'s attack (Qresland & Pleijel, 1991); 2) epithelium around "helmet" of abnormal *chaetognatha* (as a result of the geophysical activity) present (Fig. 4). So not all of headless *chaetognaths* are a result of *Tiphloscolex sp.*'s attack. There were marked *Chaetognatha* (sometimes up to 80% of all population), contained parasitic protista, found out in coelom of a cavity. However, such specimens, are

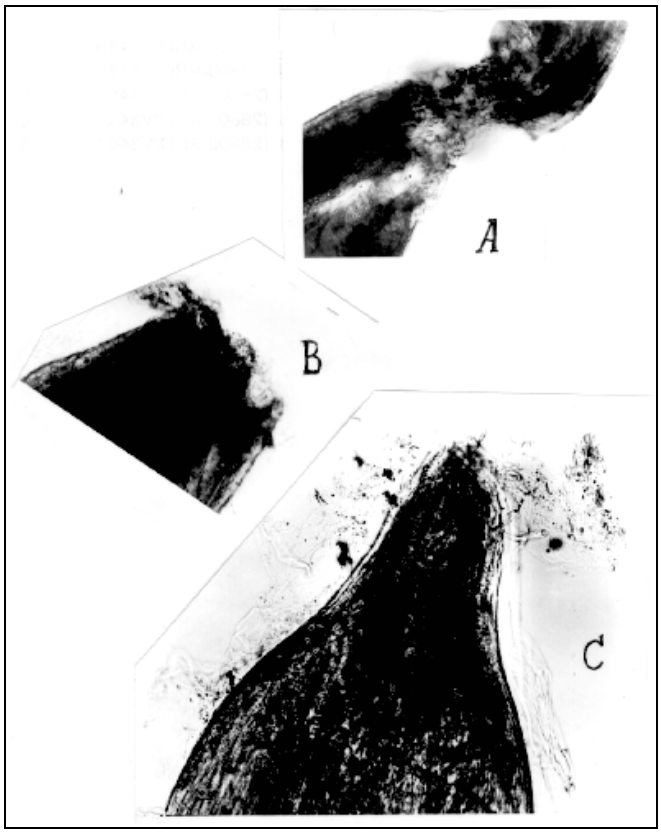

Fig. 4. The success phases of the transformation of the common chaetognath in anomalous specimens: A – the beginning of gap; B - the forward end after the gap; C – the formation the "helmet" on the healed toward end

not representative a picture similar with the new abnormal animals. A bacterium diseased leather looks turbid but the new abnormal animals have the transparent leather. The bacterium diseased specimens died during some hours but earlier, than the new abnormal without head animals.

The distribution of this phenomenon of the abnormal *chaetognaths* has large scope now (Fig. 1). Before the significant reorganization in plankton was observed the bacterium disease only specimens in urbanization zones. The described new phenomenon covers large regions, which are usually removed from urbanization zones and the pollution bearing rivers estuaries. It is of wonder that the anomalous animals appeared on standard plankton stations in waters prone to industrial and household pollution only in 1999. Before 1999 the abnormal *chaetognaths* were observed only in plankton samples from the regions of the deep fault. The greatest percentage and the absolute number of anomalous animals were found out in a layer of 500-200 m and the number of anomalous animals is sharply reduced as approaching with reduction of depth. The greatest number of anomalous *chaetognaths* relates to *Parasagitta septicoela* Kassatkina, 1971. *Parasagitta elegans* (Verrill, 1873) distributes near a coast so the anomalous animals of it are very rare. *Leptosagitta collariata* had the anomalous animals 3 times less than among these two species *Parasagitta.* The layer of 200-100 m at station with the same coordinates was found out 30% of the anomalous animals from total *chaetognaths* number. The layer of 100-0 m was found out the anomalous animals only 17% from total number of chaetognaths in population. It is interesting that *Parasagitta liturata (*Kassatkina, 1973) (epiplanktonic mass widespread species inhabiting waters from the Chuckchee Sea to the Japan Sea) was the only without anomalies in ocean but this species with the anomalies was found out in one point – in Kraternaya Bay (only. As far as the Kraternaya Bay is far from anthropogenic pollution region, it is to remains the assumption that the possible reason of occurrence of anomalies at *Parasagitta liturata* is sharp increase in the last years in geophysical and, in this connection, geochemical activity in earth crust. It is known (Izosov *et al.*, 2000) that Peter the Great Bay has the fault systems (Fig. 1). Some of them extend into industrial and household polluted regions but only sometimes the epicenters of earthquakes appeared on the deep fault (Bezverchniy & Sushkov, 1980). Therefore we could suppose that an anomalous animals appeared in the industrial and household polluted regions as a result of new geophysical activity of some deep fault in Peter the Great Bay.

Conclusions

The occurrence of anomalies in plankton of the Far East seas and north-western part of the Pacific ocean are not a result of mechanical damage, as assumed by some planktonologists, or the parasites influence (both external, and internal). It is the same abnormal phenomenon in the plankton biota that was described by Kassatkina A.P. (1995).

The chronology analysis of abnormal animals in plankton shows:

- the source causing plankton anomalies at a large depth is the most probable;

- a position of a causing anomalies source in the Sea of Japan is not a result of industrial and household pollution since their place was far from urbanized regions before 1999. It is possible that an appearance of abnormal animals in industrial and household polluted regions in 1999 is a result of an appearance of new geophysical activity of some deep fault in Peter the Great Bay.

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