

## Three new species, two new genera, and new family Biphragmosagittidae (Chaetognatha) from Southwest Pacific Ocean

### Три новых вида, два новых рода и новое семейство Biphragmosagittidae (Chaetognatha) из юго-восточной части Тихого океана

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Resuming published and own data, a revision of classification of Chaetognatha is presented. The family Sagittidae Claus & Grobben, 1905 is given a rank of subclass, Sagittiones, characterised, in particular, by the presence of two pairs of sac-like gelatinous structures or two pairs of fins. Besides the order Aphragmophora Tokioka, 1965, it contains the new order Biphragmosagittiformes **ord. nov.**, which is a unique group of Chaetognatha with an unusual combination of morphological characters: the transverse muscles present in both the trunk and the tail sections of the body; the seminal vesicles simple, without internal complex compartments; the presence of two pairs of lateral fins. The only family assigned to the new order, Biphragmosagittidae **fam. nov.**, contains two genera. Diagnoses of the two new genera, *Biphragmosagitta* **gen. nov.** (type species *B. tarasovi* **sp. nov.** and *B. angusticephala* **sp. nov.**) and *Biphragmosagittigata* **gen. nov.** (type species *B. fastigata* **sp. nov.**), detailed descriptions and pictures of the three new species are presented.

На основе литературных и собственных данных проведена ревизия типа Chaetognatha. Ранг семейства Sagittidae повышен до подкласса, Sagittiones, который охарактеризован, в частности, наличием двух пар мешковидных желеобразных структур или двух пар плавников. Помимо отряда Aphragmophora Токиока, 1965, этот подкласс содержит новый отряд Biphragmosagittiformes **ord. nov.**, который является уникальной группой Chaetognatha с необычным сочетанием морфологических признаков: 1) поперечная мускулатура имеется в полости туловищного и хвостового отделов, простые семенные мешочки без внутренних сложных камер; 2) две пары боковых плавников. Единственное семейство нового отряда, Biphragmosagittidae **fam. nov.**, содержит два новых рода. Приведены их диагнозы, а также диагнозы включенных видов – *Biphragmosagitta* **gen. nov.** (типовой вид *B. tarasovi* **sp. nov.** и *B. angusticephala* **sp. nov.**) и *Biphragmosagittigata* **gen. nov.** (типовой вид *B. fastigata* **sp. nov.**) с детальными описаниями и изображениями.

**Key words:** classification, Chaetognatha, Eukrohnioides, Sagittiones, Biphragmosagittiformes, Biphragmosagittidae, new subclasses, new order, new family, new genera, new species

**Ключевые слова:** классификация, Chaetognatha, Eukrohnioides, Sagittiones, Biphragmosagittiformes, Biphragmosagittidae, новые подклассы, новый отряд, новое семейство, новые роды, новые виды

## INTRODUCTION

While the phylogenetic position of Chaetognatha has become central to the question of early bilaterian evolution, the internal systematics of the phylum are still not clear (Papillon et al., 2006). The history of taxonomy of Chaetognatha was reviewed in details in some in early publications (e.g. Ritter-Záhony, 1911; Kuhl, 1938; Hyman, 1959; Beauchamp, 1960). Tokioka (1965a, 1965b) revised the classification based on the data on presence/absence of the transverse coelomic muscles (the so-called phragmes, or phragma). He considered that, from a morphological point of view, the most fundamental character was the presence or absence of the phragmes, and thus defined the established orders, Phragmophora and Aphragmophora. Since then, Chaetognatha has been typically divided into two orders, Phragmophora and Aphragmophora, each comprising three families (Pierrot-Bults, 2004). However Tokioka (1965a, 1965b) did not take into consideration morphological features of *Krohnittella* Germain & Joubin, 1912, a rare genus that does not have a transverse musculature but, by most other characters, displays a clear similarity to *Heterokrohnia* Ritter-Záhony, 1911. This is why, later, Bieri (1974) did not accept the Tokioka's scheme (Tokioka, 1965a, 1965b) with the two orders, Phragmophora and Aphragmophora. Dallot and Ibanez (1972) analysed 32 characters and received different conclusions on taxonomic relationships within the phylum: the order Aphragmophora Tokioka, 1965 contained a single family, Sagittidae, with two pairs of fins while genera with one pair of lateral fins, *Pterosagitta* Costa, 1869 and *Krohnitta* Ritter-Záhony, 1910, that had been given rank of families of their own by Tokioka (1965a) were excluded.

Casanova (1985, 1986) published on findings of new genera and species *Archeterokrohnia rubra* Casanova, 1986 and a new species *Heterokrohnia murina* Casanova, 1986 with a description of their reproduc-

tive organs. Based on these descriptions he subdivided the phylum Chaetognatha, the class Sagittoidea, into two subclasses – Syngonata (with the ducts connecting the ovaries in the trunk section of the body and the testes in the tail section) and Chorismogonata (with no ducts connecting the genitals present). The Syngonata thus included only a single order Biphragmophora Casanova, 1985 with a single family Heterokrohniidae Casanova, 1985, and the Chorismogonata – two orders, Monophragmophora Casanova, 1985 (with families Spadellidae Tokioka, 1965 and Eukrohniidae Tokioka, 1965) and Aphragmophora Tokioka, 1965 (with families Sagittidae Claus & Grobben, 1905, Pterosagittidae Tokioka, 1965, Krohnittidae Tokioka, 1965). However, the morphological data presented by Casanova (1985) were not well supported by illustrative materials, and, in some case, contradict to earlier known data on gonadal structure (e.g. Elpat'evskiy, 1910, 1913, 1914) and some new discoveries Kassatkina & Stolyarova, 2008).

Molecular data showed (Papillon et al., 2004, 2006) that there are three main monophyletic groups: Sagittidae/Krohnittidae, Spadellidae/Pterosagittidae, and Eukrohniidae/Heterokrohniidae. In this scheme, the group of Aphragmophora without Pterosagittidae (Sagittidae/Krohnittidae) is monophyletic, the Spadellidae/Pterosagittidae and Eukrohniidae/Heterokrohniidae families are very likely clustered, the Krohnittidae and Pterosagittidae groups should no longer be considered as families as they are included in other groups designated as families, and the Syngonata/Chorismogonata and the Monophragmophora/Biphragmophora hypotheses were thus rejected. More recent data (Jennings et al. 2010) also support the main divergence between the Eukrohniidae+Heterokrohniidae and Spadellidae s.l. further supporting the main scheme of Tokioka (1965a, 1965b) based on the transverse muscles presence/absence data.

Salvini-Plawen (1986) gave reasons to consider Spadellidae as quite specialised

coastal chaetognaths rather than a group ancestral for all other Chaetognatha. Telford and Holland (1997) confirmed a distinct position of *Spadella* from all groups of Chaetognatha based on molecular data. Salvini-Plawen (1986) established three species groups and proposed two new genera based on the number of pairs of fins and the locations and presence/absence of the digitate adhesive organs. While Bowman & Bieri (1989) agreed that the presence of adhesive organs is taxonomically important, they questioned the importance of the number of lateral fin pairs. They point out that immature individuals of *Paraspadella* have only a single pair of fins, but, with sexual development, the fins become separated into anterior and posterior parts by the lateral growth of the vagina.

The Von Salvini-Plawen's (1986) opinion on the ancestral state of the absence of the phragmes was not confirmed by palaeontological data. There was published a description of the genus *Parmia* Gnilovskaya, 1998 from southern Timan, northeast of the Russian Platform, – worm-like creatures inhabiting the ocean during the Late Riphean of an approximate age of about 1 Ga (Gnilovskaya et al., 2000, cited by Fedonkin, 2003). Though *Parmia* is interpreted as a probable predecessor of the annelid worms (Fendonkin, 2003) this may be the earliest chaetognath. I base this conclusion on the fact that the two well-preserved imprints of the animal (Fendonkin, 2003: figs 6, 7) clearly show a regular homonomous segmentation (7–11 segments per millimeter of body length) that may represent transverse muscles; any fins or sac-like gelatinous structures (SGS) are absent. Ancient Chaetognatha were obviously able to bend the body as it can be seen from the imprints but, having no fins or SGS, were probably bottom dwellers. Several other fossil chaetognath species have been described that appear to have originated in the Cambrian period (Vannier et al., 2007). Complete body fossils are known from the Lower Cambrian Maotianshan shales of

Yunnan, China (*Eognathacantha ercainella* Chen & Huang, 2002 and *Protosagitta spinosa* Hu, 2005) and the Middle Cambrian Burgess Shale of British Columbia (*Oesia disjuncta* Walcott, 1911) (Szaniawski, 2005; Vannier et al., 2007). A more recent chaetognath, *Paucijaculum samamithion* Schram, 1973 has been described from the Mazon Creek biota from the Pennsylvanian of Illinois (Schram, 1973). As it can be seen from the published pictures (e.g. that of *Protosagitta spinosa* in Vannier et al., 2007: fig. 1a), the chaetognaths from the Cambrian possessed the transverse muscles (phragmes).

In general, the chaetognath locomotory muscles exhibit astonishing variations. As described by Casanova and Duvert (2002), the transverse muscle, present in the less evolved genera living near or on the bottom, has two forms: either classical cross-striated or, in more or less benthic species, supercontracting. Supercontraction is supposed to be a derived character. The peculiarities of the primary, secondary and transverse muscles of the truly benthic chaetognaths are different from those of all the planktonic or benthoplanktonic chaetognaths. These data confirm well the importance of the transverse muscles structure for the taxonomy in the Chaetognatha revealed by Tokioka (1965a). Schemes by Casanova and Duvert (2002) show the degree of reduction of the transverse musculature and its evolution in one-pair-of-fin Chaetognatha (Casanova & Duvert, 2002: fig. 5, 2B).

Besides the transverse muscles structure and its presence/absence, the number of fins is also very important for understanding phylogeny and evolution of Chaetognatha; this character may even have a greater significance because the fin development and, respectively, the buoyancy, made it possible for Chaetognatha to colonise open waters of the ocean.

The most stable, during the development and the maturation, morphological character is, to my opinion, the number of pairs of lateral fins. It was noticed as early

as in first publications devoted to arrow worms (Krohn, 1853; Langerhans, 1880; Beraneck, 1895; Fowler, 1906).

Ancient Cambrian Chaetognatha did not possess fins but already had SGS as it can be seen, for example, in *P. spinosa* having specific flaps on sides of the body and at the terminal body end (Vannier et al., 2007: fig. 1). Due to the presence of SGS, Cambrian Chaetognatha might have been able to dwell in pelagic waters.

Sac-like gelatinous structures, which serve for the establishing neutral buoyancy, are not fins in a proper sense. A fin fold never has gelatinous filling as it occurs in SGS. In contrast to SGS, the fins are rudders adapted to strong surface flows in the ocean (Ghirardelli, 1968). Sac-like gelatinous structures may be located in different places of the body (on dorsal, ventral and lateral surfaces of the body) being separated by unequal gaps as it can be seen in *Abosagitta*, *Accedosagittaminuta*, *Pseudosagitta*, *Pseudeukrohnia*, *Protoeukrohnia*, *Praeukrohnia* and *Paraeukrohnia* (Kassatkina, 1998, 2001, 2002, 2003, 2006; Kassatkina & Stolyarova, 2006, 2010). However, lateral SGS only have a triangular-convex shape. Flattened margins of the SGS can serve as fins, for example, in *Paraeukrohnia*. It seems that the fins evolved from some SGS through their flattening and the appearance of rigid supporting elements, transversal and longitudinal, inside a SGS as can be seen in *Praeukrohnia fidus* (Kassatkina & Stolyarova, 2006) and *A. minuta* (Kassatkina, 1982). True fin rays are not similar to these transversal and longitudinal elements for they consist of elastoidin fibres as in agnathans and fish (Reisinger, 1968). In Pennsylvanian *Paucijaculum samamithion*, that is undoubtedly a chaetognath, large rays can be seen; some of them are located on the body aside of the fins while others, in the fin region (Schram, 1973). Most probably, the fins with rays present in extant species are the result of an intergradation of the fin fold and the rays.

As it was already mentioned above, the earlier opinion on the origin of Sagittidae with two pairs of fins from Chaetognatha with one pair of fins were caused by the insufficient knowledge at that time. Findings of finless both Eukrohniidae and Sagittidae (Kassatkina, 1998, 2001, 2002, 2003, 2006; Kassatkina & Stolyarova, 2006) provided additional arguments against this opinion. SGS could appear in different regions of the body; the presence of SGS instead of fins appears to be a plesiomorphic character retained in a few recent species (Kassatkina, 2006). Species with one pair and two pairs of fins could evolve independently in different chaetognath lineages. I suppose that the chaetognaths with one pair of fins and the chaetognaths with two pairs of fins represent independent clades originated from Protochaetognatha, which possesses neither fins nor SGS. Genetic data (Telford, Holland, 1993, 1997; Thuesen et al., 1993) support a considerable distinctiveness of the chaetognaths with one pair of fins from the chaetognaths with two pairs of fins.

In plankton samples from the southwestern part of the Pacific Ocean there were found unique Chaetognatha with an unusual combination of morphological characters: 1) the transverse muscles present in both the trunk and the tail sections of the body, the seminal vesicles simple, without internal complex compartments (that is characteristic of Heterokrohniidae with one pair of fins); 2) presence of two pairs of lateral fins (earlier considered to be typical only for Sagittidae). This made it necessary to revise the whole system of Chaetognatha and find a position of the new taxa in it. The high-level classification of Chaetognatha has been revised as given below with descriptions of two new genera (three new species) belonging in a new family assigned in a respective new monotypic order.

## MATERIAL AND METHODS

Plankton samples were collected by a hydrobiologist V.G. Tarasov from the

south-west Pacific Ocean during the cruises of Research Vessel (RV) "Academic Neskomeyanov", using a Jeddy net, in April 1990. Holotypes and paratypes are deposited in the collection of the Pacific Institute of Oceanography, Far East Division, Russian Academy of Sciences, Vladivostok.

## TAXONOMIC PART

### EUKROHNIONES new subclass

One pair of SGS on lateral fields of body or one pair of fins. Internal ring of corona ciliata (sometimes absent in bathypelagic species) without secretory cells. Eyes of everted type. Alveolar tissue commonly single-layer, containing of flat rhomboid cells. Teeth in two or one pairs of rows. Neck glands present. Eggs released into water, not adhesive to substrate, commonly in marsupial sacs hanging from opening of oviducts and carrying by individual.

### SPADELLIONES new subclass

One pair of SGS on lateral fields of body or one pair of fins. Pair of soft tentacles on sides of head in some species. Internal ring of corona ciliata without secretory cells in most species, and special adhesive organs present at tail section. Corona ciliate and eye reduced in some bathypelagic species. Eyes of inverted type. Alveolar tissue multi-layer, containing of large vesicular cells. Teeth in two pairs of rows. Neck glands absent. In Spadellidae Tokioka 1965, spermatophore released behind corona ciliate. Eggs released into water, commonly adhesive to substrate.

### SAGITTIONES new subclass

Two pairs of SGS on lateral fields of body or two pairs of fins. Internal ring of corona ciliata (sometimes absent in bathypelagic species) without secretory cells. Eyes of inverted type. Alveolar tissue multi-layer, containing of large vesicular cells. Teeth in

two pairs of rows. Neck glands absent. Eggs released into water, non-adhesive to substrate, marsupial sacs absent.

Two orders.

### Aphragmophora Tokioka, 1965

Transverse muscles absent; lateral body bending lacking. Epi-, meso-, and bathypelagic forms. Epipelagic forms closely approaching coast for spawning.

### Biphragmosagittiformes new order

Transverse muscles present; body bending in lateral directions. Small benthic forms, commonly on shelf.

One family.

### BIPHRAGMOSAGITTIDAE fam. nov.

Type genus: *Biphragmosagitta* gen. nov.

*Diagnosis.* Trunk and tail sections with transverse muscle (phragmes; apparently, supercontraction). Two pairs of lateral fins. Sac-like gelatinous structures at bases of lateral fins or elsewhere absent. Two pairs of rows of teeth on head.

Two genera.

### *Biphragmosagitta* gen. nov.

*Type species: Biphragmosagitta tarasovi* sp. nov.

*Diagnosis.* Corona ciliata located below eye level, sometimes on neck. Most part of posterior fins located on trunk in adult mature animals. Thick rays in fins present. No gut diverticula. Eyes present. Inner nuclear eye zone smaller than peripheric one. Hooks not serrated.

Two species.

**Comparative remarks.** The new genus differs from the other genera, *Biphragmosagittidae* in having the corona ciliata located below the eye level, sometimes on the neck.



***Biphragosagitta tarasovi* sp. nov.**

(Figs 1a–b, 2a–e, 4)

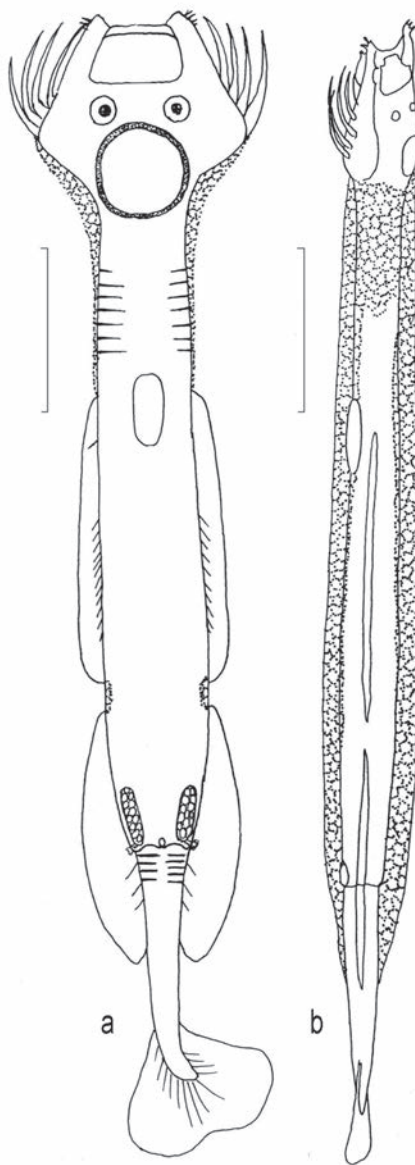
**Holotype.** Inventory No. PHRAG-1/1, south-west Pacific, 16°39'S 168°28'E. RV "Academic Nesmeyanov", station 1, sample 1 horizon 100–0 m over depth 1020 m, plankton sample using Jeddy net, 4 April 1990; Pacific Institute of Oceanography, Far East Division, Russian Academy of Sciences, Vladivostok.

**Paratypes.** Ten specimens from the same sample as holotype in the same collection.

**Description (holotype).** Transverse muscle (phragmes; apparently, supercontraction) in trunk being 13% of entire trunk length and, in tail, 4.8% of entire tail section length. Body rigid and muscular. Head 3 times as broad as neck. Trunk narrow; no considerable narrowing in region of seminal receptacles. Trunk region non-transparent, dark brown. Terminal end of body sharp.

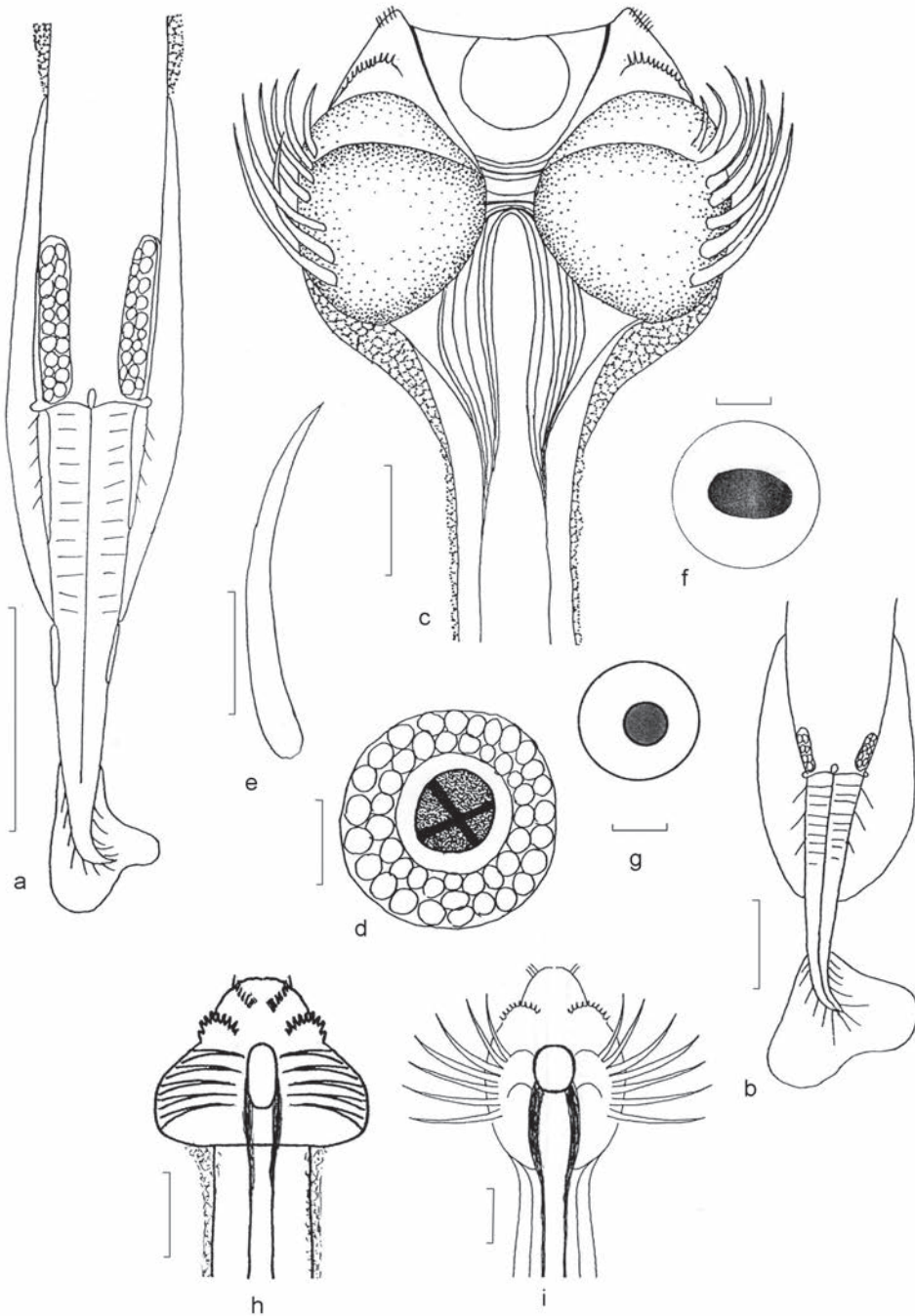
Body length 6.5 mm. Head region long, 14% of entire body length. Tail region 22.5%, ventral ganglion 6.6% of entire body length. Protuberances around mouth without papillae. Gut without diverticula. One pair of rows of hooks and two pairs of rows of teeth on head. Hooks (7 or 8 on each side) without unguiculi and not serrated. Front teeth (7 or 8 on each side) apically located. Posterior teeth (10 or 11 on each side) located on protuberances behind front teeth. All teeth of conical form as in *Sagitta*.

Anterior end of anterior lateral fins located in front of ventral ganglion posterior level. Part of fin situated at level of ventral ganglion 0.7 times as long as ganglion, 4.7% of body length. Length of anterior fins 27% of body length, about 1.2 times as long as posterior fins. Rays of anterior lateral fins short. Borders, anterior and posterior ends of anterior lateral fins lacking rays. Distance between anterior end of posterior fins and posterior end of anterior fins short, being 2.3% of body length. Length of posterior fins 22.9% of body length; trunk part of posterior fins is 1.3 times larger than tail part. Some short rays located on tail part of posterior fins. Tail fin about 5% of body length and 22.4% of tail length. Posterior



**Fig. 1.** *Biphragosagitta tarasovi* sp. nov. (holotype: specimen at 2nd maturity stage); habitus (a), lateral view (b). Scale bar: 1 mm.

end of tail fin concave (lyre-shaped) as in *Pseudosagitta lyra* (Krohn, 1853). Some of short rays present on tail part of posterior fins. Remaining part of posterior fins without rays. Ovaries short, about 8% of body length, containing numerous immature eggs set in two rows.



**Fig. 2.** *Biphragnosagitta tarasovi* sp. nov. (a–e): tail region in paratype at 4th maturity stage, ventral view (a), tail region in paratype at 1st maturity stage, ventral view (b), head region in holotype, ventral view (c), eye in holotype (d); hook in holotype (e); *Biphragnosagitta angusticephala* sp. nov. holotype (f–h): eye (f), head region, ventral view (i); *Biphragnosagitta fastigata fastigata* sp. nov. holotype: eye (g), head region, ventral view (h). Scale bar: 0.7 mm (a), 0.25 mm (b), 0.3 mm (c), 0.04 mm (d), 1 mm (e), 0.03 mm (f), 0.02 mm (g), 0.45 mm (h), 0.14 mm (i).

The specimen is at the 2nd maturity stage. It has a rounded corona ciliata located below the eye level, with its most part on the head, and a lesser part on the neck. The alveolar tissue is fringing neck, the ventral and dorsal body nearly to the middle tail region. The eyes are rounded, with a dark pigment zone in the center of the eye. There is a black crosslike structure inside the dark pigment zone.

**Remarks.** The paratype at the 1st maturity stage are without defects. Specimens at the 4th maturity stage have traces of the lysis of the muscles. This defect shows some resemblance to the abnormality of the chaetognath species which was described from a volcanic bay (Kraternaya Bay, Ushishir Island) (Kassatkina, 1995). There are variations of the transverse muscle extension into the cavity of the tail section: a specimen at the 2nd maturity stage (holotype) has the smallest extension (13% of tail section length); a specimen at the 1st maturity stage has a longer extension (32.7% of tail section length); a specimen at the 4th maturity stage has the longest extension (45.3% of tail section length) (paratypes). This fact can probably be interpreted by some influence of geophysical activity of this region in the south-west Pacific Ocean where the samples of this plankton chaetognath were collected.

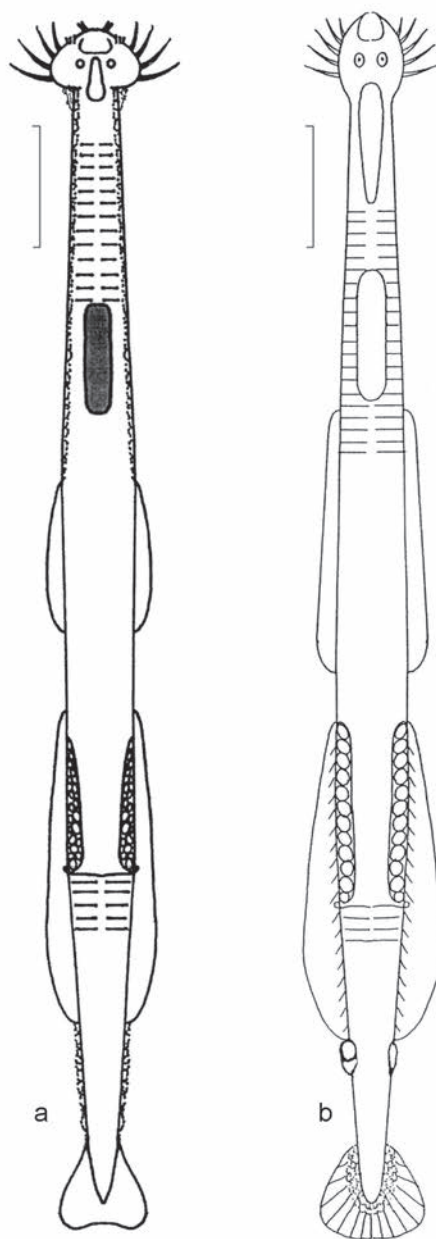
A specimen at the 4th maturity stage has elongate seminal vesicles contacting both pairs of lateral fins, but far from the tail fins. The seminal vesicles are very simple and differ from those in Sagittidae by the absence of any inner structure.

**Etymology.** This species is named after V.G. Tarasov, a hydrobiologist, who organized the cruises of RV "Academic Nesmeyanov" to the south-west Pacific Ocean.

***Biphragosagitta angusticephala*  
sp. nov.**

(Figs 2f–i, 3b)

**Holotype.** Inventory No. PHRAG-2/1, south-west Pacific, 16°28'S 168°18'E. RV "Aca-



**Fig. 3.** Habitus: **a**, *Biphragmofastigata fastigata* sp. nov. (specimen at 2rd maturity stage); **b**, *Biphragosagitta angusticephala* sp. nov. (specimen at 4rd maturity stage). Scale bar: 1 mm.

demic Nesmeyanov", station 2, sample 2, horizon 300–200 m over depth of 390 m, plankton sample using Jedy net, 5 April 1990; Pacific Institute of Oceanography, Far East Division, Russian Academy of Sciences, Vladivostok.



*Paratypes.* Five specimens from the same sample as holotype in the same collection.

*Description* (holotype). Transverse muscle (phragma, apparently supercontraction) in trunk 29.6% of entire trunk length, and transverse muscle in tail 16% of entire tail region length. Body rigid and muscular. Head narrow, as broad as trunk, but with slightly broader neck. Trunk narrow; no considerable narrowing in region of seminal receptacles. Trunk region non-transparent, dark brown. Terminal end of body not sharp.

Body length 5 mm. Head section short, 8% of entire body length. Tail section 24.8%, ventral ganglion 11% of entire body length. Protuberances around mouth without papillae. Gut without diverticula. One pair of rows of hooks, and two pairs of rows of teeth on head. Hooks (7 or 8 on each side) without unguiculi and not serrated. Front teeth (3 on left side and 2 on right side) apically located. Posterior teeth (16 or 17 on each side) located on protuberances behind front teeth. Anterior lateral fins without rays. Anterior end of anterior lateral fins located behind posterior level of ventral ganglion: distance 18 times shorter than length of ganglion (0.7% of body length).

Length of anterior fins 22% of body length, 1.2 times shorter than length of posterior fins. Distance between anterior end of posterior fins and posterior end of anterior fins short, 4% of body length. Length of posterior fins 26.7% of body length; trunk part of posterior fins nearly 1.5 times larger than tail part. Rays of posterior fins short. Borders and anterior ends of posterior lateral fins lacking rays. Tail fin about 5% of body length and 20% of tail part. Posterior end of tail fin without concavity. Whole tail fin pierced with rays. Ovaries 15.8% of body length, containing numerous mature eggs set in one row.

The specimen is at the 4th maturity stage. It has elongate seminal vesicles, contacting both pairs of lateral fins, but far from tail fins. The seminal vesicles are very simple and differ from those in Sagittidae by the absence of any inner structure. The

corona ciliata (elongated, without gyri) is located below the eye level, with its most part on the trunk, and the lesser part on the neck and head. Alveolar tissue fringes the terminal end of the body which is not sharp. The eyes are rounded, with a dark pigment zone in the center of the eye.

*Remarks.* There are variations of the transverse muscle extension into the cavity of the tail section: a specimen at the 4th maturity stage (holotype) has the smallest extension (16% of tail section length); a specimen at the 4th maturity stage (a paratype) has the longest extension (30% of tail section length).

*Comparison.* This new species differs from the other species, *B. tarasovi* sp. nov., in particular, in the position of the anterior fins relative to the ventral ganglion.

*Etymology.* From Latin: angustus (narrow) and cephalo (from Greek kephal, kephalo) (head).

### ***Biphragmofastigata* gen. nov.**

Type species: *Biphragmofastigata fastigata* sp. nov.

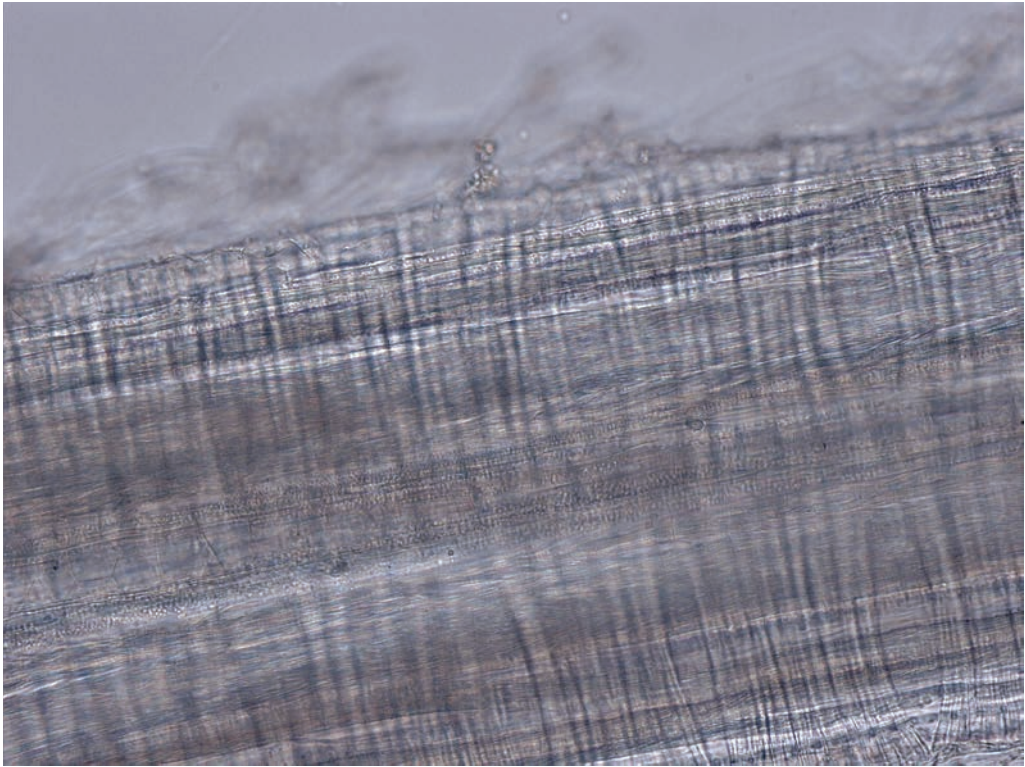
*Diagnosis.* Corona ciliata located at eye level or higher. Larger part of posterior fins located on trunk section in adult mature animals. Thick rays in fins absent. Gut diverticula absent. Inner nuclear eye zone smaller than peripheric one. Hooks not serrated.

One species.

**Comparative remarks.** The new genus differs from the other genus of the family Biphragmosagittidae, *Biphragmosagitta* gen. nov., in having the corona ciliata located at the eye level or higher, and the absence of thick rays in the fins.

### ***Biphragmofastigata fastigata* sp. nov.** (Figs 2g–h, 3a)

*Holotype.* Inventory No. PHRAG-3/1, 16°28'S 168°18'E, RV "Academic Nesmeyanov", station 2, sample 2 horizon 300–200 m over depth of 390 m, plankton sample using Jedy net, 5 April 1990; Pacific Institute of Oceanography, Far East Division, Russian Academy of Sciences, Vladivostok.



**Fig. 4.** *Biphragmosagitta tarasovi* sp. nov.: trunk region (ventral view), part with transverse muscles. Scale bar: 0.6 mm.

*Paratypes.* Four specimens from the same sample as holotype, in the same collection.

*Description* (holotype). Transverse muscle in trunk section 13% of entire trunk length, and transverse muscle in tail 5% of entire tail section length. Body transparent, rigid and muscular. Terminal end of body sharp. Trunk narrow; no considerable narrowing in region of seminal receptacles. Head trapezoidal, wide, broader than trunk.

Body length 4.9 mm. Head region short, 5% of entire body length. Tail section 27.9%, ventral ganglion 9% of entire body length. Protuberances around mouth without papillae. Gut without diverticula. One pair of rows of hooks and two pairs of rows of teeth on head. Hooks (6 on each side) without unguiculi and not serrated. Front teeth (5 on each side) apically located. Posterior teeth

(8 on each side) located on protuberances behind front teeth. All fins (anterior, posterior, lateral, and tail ones) without rays.

Length of anterior fins 12.7% of body length, 2 times shorter than length of posterior fins. Anterior end of anterior lateral fins located behind posterior level of ventral ganglion. This distance 1.5 times shorter than length of ganglion, and 6% of body length. Distance between anterior end of posterior fins and posterior end of anterior fins short, 6.6% of body length. Length of posterior fins 26.4% of body length; trunk part of posterior fins nearly 1.2 times larger than tail part. Length of trunk parts of posterior fins longer than anterior lateral fins. Tail fin about 3.5% of body length and 12.7% of tail part. Ovaries 10.6% of body length, containing numerous immature eggs set in two rows.

The specimen is at the 2nd maturity stage. The corona ciliata is short, without gyri and located almost entirely on the head, just behind the brain. Alveolar tissue fringes the neck and the trunk nearly to the anterior lateral fins. Alveolar tissue is also present on the tail region between the posterior lateral fins and the tail fin. The eyes are rounded, with a dark pigment zone in the center of the eye.

*Remarks.* There are variations of the degree of the transverse muscle extension into the cavity of the tail section. A specimen at the 2nd maturity stage (holotype) has the smallest extension (13% of tail section length); a specimen at the 1st maturity stage (a paratypes) has the longer extension (16% of tail section length).

*Etymology.* From Latin: *fastigata* means having a sharp-pointed end.

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