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POGONOPHORA FROM THE INDIAN SEAS

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Introduction

PHYLUM Pogonophora is generally placed in the assemblage of enterocoelous coelomates (Echinodermata-Hemichordata-Chordata Stem) combined by some authors under the name Deuterostomia (Beklemishev, 1944; Ivanov, 1955 *a*, *c*, 1956, 1960, 1963; De Beer, 1955; Petrunkevitch, 1955; Abrikossov, 1957; Alvardo, 1957; Marcus, 1958; Hyman, 1959; Southward, 1963; and others). The apparent resemblance of Pogonophora to tubicolous Polychæta to which stress was laid by Hartman (1951, 1954) has been explained by Ivanov (1956) as being of only superficial nature brought about by convergences attributable to a similar mode of life in a tube. The enterocoelous mode of formation of the coelom, the trisegmental composition of the body, the presence of an unpaired dorsal nerve cord, the absence of ventral nerve cords, the presence of the heart, the pericardial sac, the pair of coelomoducts in the first segment, the pair of gonads in the third segment and the development of a rudimentary metameric arrangement within the elongated third segment have been given by Ivanov (1956) as characters of sufficient importance to justify the inclusion of Pogonophora in the Deuterostomia. In addition, Ivanov (1956) and Southward (1963) have drawn attention to the homogeneous nature of the group, which earlier Hartman (1954) had considered to be a heterogeneous assemblage of aberrant Polychæta which "....may in time find their affinities with several families of sedentary polychætous annelids". Based on the numerous works of Ivanov (1949-63), and recent discoveries, Southward (1963) summarised that the questions that have aroused most interest in the study of Pogonophora are "The position of the group within the animal kingdom; the means of nutrition, since the alimentary canal has not been found; the dorso-ventral orientation of the animal", and in addition, "The problem of antiquity of Pogonophora has appeared as an argument in the continuing controversy about the age of the abyssal fauna" as may be found in the discussions on the subject given by Bruun (1957), Menzies and Imbric (1958) and Zenkevich and Brishtein (1960).

Pogonophora from the Indian Seas

In February-March, 1965 during the 71st and 72nd fishery cruises of the Indo-Norwegian Project Research Vessel *VARUNA*, while conducting deep-water exploratory bottom fishing operations along the continental shelf edge on the south-west coast of India between Cochin and Karwar, I was able to obtain specimens of Pogonophora from depths between 200 and 340 meters in the area off Cannanore-Mangalore. Some of the almost transparent chitinous tubes are broken, but the longest complete tube is 54 cm. long and has a diameter of 1·9 mm. at its mid-length. The paired elongate cork-screw-shaped tentacles in the specimens indicate that the specimens belong to the genus *Diplobrachia* Ivanov, 1960 (Family Polybrachiidæ Ivanov, 1960 of Order Thecanephria Ivanov, 1955). A description of the species, as well as details of associated organisms; temperature, salinity, oxygen and nutrient constituents of the water above the bottom from where the collections have been made; and a granulometric analysis of the sediments from which the tubes have been collected will be dealt with elsewhere.

The discovery that Pogonophora occurs along the continental shelf edge along the west coast of India may be of interest as these animals on account of the want of alimentary canal are known to occur in areas where there is concentration of suspended organic substances in the bottom layers, where the bottom current and the sea-floor relief may also be characteristic (Bruun, 1957; Kirkegaard, 1958; Southward, 1963). Savilov (1957) classed Pogonophora as detritus collecting forms, while Sokolova (1959) considered them as suspension feeders. Actual mode of obtaining food has not been observed, but different suggestions made as to the mode of feeding of these animals are: filtration of the suspended matter by the multi-tentaculate forms (Ivanov, 1955 *b*); collection of food from surface of deposits with the help of some sticky secretion (Southward, 1963); and the possibility of a relationship with bacteria to provide a source of soluble food (Jagersten, 1957).

The records of Pogonophora from the three major oceans of the world during the last ten years have disproved that extant Pogonophora are but relicts of a group of animals which

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flourished in all the oceans at some distant past. Besides drawing attention to the occurrence of pogonophorans in the continental shelf edge off our coast, this note is also aimed at giving a few pointers to would-be collectors.

The chitinous, almost transparent, tubes (banded dark and light in some, such as species of *Siboglinum* spp.) showing markings resembling annulations should be looked for in dredge and grab samples which may also contain tubes of Polychæta. Each tube will have a single animal and in the present material, they are found contracted, lying in the posterior half of the tube. In *Diplobrachia*, the free end of the tube can be easily identified as it invariably has polyzoans attached to it and in many tubes in the collection, a tubicolous polychæte is present in a separate fibrous tube adhering to one side. The polychæte tube is short, not more than 7 cm. long and is invariably encrusted with sand and shell bits. Such encrustations with epibionts are apparently met with in most pogonophoran tubes at the free end except in species of *Siboglinum* which have their tubes completely buried in the mud.

It is also likely that pogonophorans may occur in shallower waters of the continental shelf as at least one species. *Siboglinum caulleryi* Ivanov, 1957 *a*. has been collected from 22 meters from the Okhotsk Sea.

In the accompanying photograph (Fig. 1) a tube of *Diplobrachia* sp. in the collection is shown along with a partly damaged specimen taken out of the tube. From experience it has been found that if the tubes are merely placed in the preservative (formalin) the specimens are liable to be damaged, as the thick slimy substance in the tube where the contracted animal lies as well as the air pockets in the different parts of the tubes may prevent the easy penetration of the preservative to reach the animal tissues. It may be necessary to remove the animal from the tube and preserve it.

List of Known Pogonophora from the Indian Ocean

The first record of Pogonophora from the Indian Ocean was in 1960 when *Diplobrachia belajevi* was described by Ivanov collected from 580 meters depth east of Rodriguez Island. Since then, eleven more species belonging to four genera have been described by Ivanov (one in 1961 *a* and ten in 1963). To facilitate reference, these are listed below:

Phylum Pogonophora Johansson, 1937
Class Athecanephria Ivanov, 1955
Family Siboglanidæ Caullery, 1914
Genus *Siboglanioides* Ivanov, 1961 *b*
1. *S. dibranchia* Ivanov, 1961 *b*
(From Timor Sea at 2080 m depth; south of Bali Strait at 2810 m; and Arabian Sea at 3275 m).

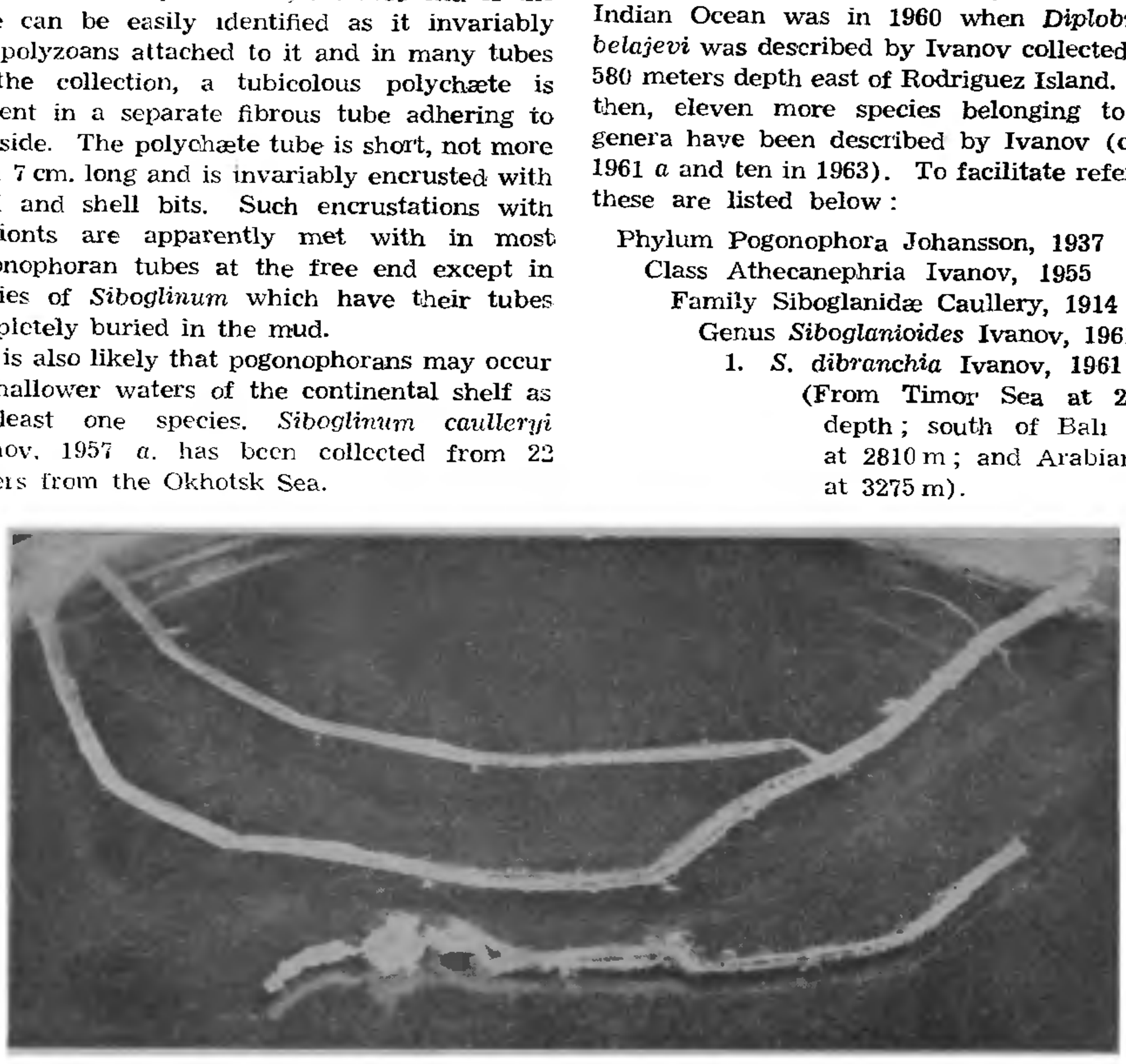

FIG. 1. Photograph showing a tube of the pogonophoran *Diplobrachia* sp., with the animal taken out in the foreground. (The anterior part of the animal—on the left side of the photo—is partly damaged), × 1.

Genus *Siboglinum* Caullery, 1914:
2. *S. arabicum* Ivanov, 1963
(From north of Socotra Island at 3285 m).

3. *S. ceylonicum* Ivanov, 1963
   (From west of Ceylon between 1920—2970 m).
4. *S. concinnum* Ivanov, 1963
   (From east of Zanzibar at 802 m).
5. *S. exile* Ivanov, 1963
   (From south of Sumatra at 626 m).
6. *S. silone* Ivanov, 1963
   (From Gulf of Aden at 900 m; and west of South India at 1300 m).
7. *S. subligatum* Ivanov, 1963
   (From north of Mauritius at 1740 m).
8. *S. Sumatrense* Ivanov, 1963
   (From south of Sumatra at 626 m).
9. *S. zanzibaricum* Ivanov, 1963
   (From east of Zanzibar at 2172 m).

Order Thecanephria Ivanov, 1955
Family Polybranchiidæ Ivanov, 1960
Genus *Diplobrachia* Ivanov, 1960

10. *D. belajevi* Ivanov, 1960
    (From east of Rodriguez Island at 580 m).
11. *D. Southwarde* Ivanov, 1963
    (From west of South India at 1300 m).

Family Lamellisabellidæ Uschakow, 1933
Genus *Lamellisabella* Uschakow, 1933

12. *L. minuta* Ivanov, 1963
    (From west of South India at 1300 m).

From the depth distribution of the known species from the Indian Ocean it will be evident that the present collections from 200 to 340 m. represent the shallowest depths from which Pogonophora have up to now been collected from this Ocean as all other species have been taken from waters deeper than 580 metres. The extremely patchy distribution of Pogonophora is mainly on account of their not having a mobile or free-swimming stage in the life-history. As Southward and Southward (1963) have suggested, there may be some association between the great abundance of Pogonophora in some areas "and an imbalance in the production cycle of plankton in the waters above, caused by upwelling, with consequent organic enrichment of the bottom deposits". On the west and east coasts of India, areas of upwelling are known during certain seasons, and it is likely that these areas may sustain populations of Pogonophora at the bottom.

The phylum is represented in all the oceans including the Arctic and Antarctic. The described species stand at slightly over 70 belonging to 15 genera. Professor A. V. Ivanov's contribution to the advancement of knowledge regarding this group can be gauged from the fact that over 52 species have been described by him in addition to adding valuable information on the morphology, histology and embryology of several species. For a list of the described species and unnamed records reference is invited to Southward (1963).

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ADDENDUM

Since this note went to press, I have been able to collect more material of Pogonophora from the continental shelf along the south-west

coast of India between Quilon and Mangalore. Specimens of both the genera *Diplobrachia* and *Siboglinum* were obtained during the 75th Fishery Cruise of the Indo-Norwegian Project Research Vessel *VARUNA* from depths as shallow as 9 metres between Quilon and Cochin. I am told by fishermen who were shown the empty tubes of pogonophorans that during the south-west monsoon large quantities of empty tubes are washed ashore along certain beaches and this is not in the least surprising as the animals are found in dense congregations in certain areas close to the shore. Two points of interest are the occurrence of Pogonophora in very shallow waters of the littoral zone, and the apparent correlation in its occurrence in the continental shelf area and the areas of mud-bank formation and shrimp fishing grounds, along the south-west coast of India. Detailed investigations are under progress.

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ORIGIN OF *AMARANTHUS DUBIUS*

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AMARANTHUS DUBIUS Mart. ex Thellung, though indigenous to tropical North America, has spread with man throughout tropics where it is used for its grain and as a vegetable.[1] In India its introduction seems to be recent, since it is neither recorded by Hooker,[2] nor is mentioned in any of the regional floras.[3-7] However, it is a popular pot herb and has now become an escape in and around Lucknow where it is fast becoming a weed. Haploid chromosome number of the species is 32 (Fig. 2) and is the only natural tetraploid species reported so far in the genus.[8]

On the basis of his studies on F_1 *A. dubius* × *A. spinosus*, Grant[9] postulated that *A. spinosus* Linn. is one of the parents of *A. dubius*. We have not only studied a large number of individuals of the above hybrid ($2n = 49$), but also the ensuing amphiploid ($2n = 98$). In the light of our cytogenetic studies together with morphological comparison between the taxa concerned, the foregoing suggestion of Grant,[9] regarding the role of *A. spinosus* in the origin of *A. dubius*, has been examined here.

Studies on a number of populations of *A. spinosus* and *A. dubius* reveal the presence of 17 (Fig. 1) and 32 (Fig. 2) bivalents respectively in pollen mother cells. Fertility in both is normal. The F_1 hybrid *A. dubius* × *A. spinosus* arises spontaneously wherever and whenever the two species grow in sufficient proximity. These individuals possess $2n = 49$ and at metaphase I more than 50% pollen mother cells show $17_{II} + 15_{I}$ (Fig. 3). While bivalents disjoin normally, univalents are distributed irregularly. Fertility is about 4%. In strong contrast to F_1, the amphiploid regularly forms 49 bivalents (Fig. 4) with an occasional loosely associated quadrivalent. Further course of meiosis and fertility are normal.

The formation of 17_{II} in F_1 is the result of pairing between *spinosus* genome ($n = 17$) and 17 chromosomes (out of 32) of *A. dubius*, leaving the remaining 15 *dubius* chromosomes unpaired. The presence of 17_{II} in the hybrid would ordinarily indicate that in *A. dubius* 17 chromosomes are homologous with the *spinosus* genome of $n = 17$. On this basis, Grant made the suggestion that *A. spinosus* is one of the parents of *A. dubius*. However, this suggestion is not supported by the situation found in the amphiploid *A. dubius-spinosus* ($n = 49$). In case the 17 bivalents of F_1 hybrid were organized between homologous chromosomes, then one should have encountered a high number of quadrivalents in the amphiploid. Far from a corresponding number of quadrivalents in the amphiploid, we found at the most just one quadrivalent and that too loosely associated. Therefore the 17 bivalents in F_1 are between homologous chromosomes, and evidently there ensues 96% sterility because of the disharmonious combinations resulting from differentially homologous chromosomes coupled with the irregular distribution of univalents. On the other hand, amphiploid is fertile because of the preferential pairing between the entirely homologous chromosomes followed by regular disjunction.

It emerges from the above that the genome of *A. spinosus* and the chromosomes of *A. dubius*, that pair with it, are not identical with each