Abstract

A small material of appendicularians collected in the Antarctic Seas was examined morphologically and taxonomically. Full descriptions are given for Antarctic or Subantarctic species so far described rather insufficiently, besides morphological and taxonomical notes on some others. Especially a taxonomical discussion is made on the oikopleurid-group involving *O. gaussica, O. valdiviae, O. drygalski* and *O. weddelli*, leading to a possible conclusion that these might belong to the single species, *O. gaussica.*

I. GENERAL INTRODUCTION

Examinations were made in search of pelagic tunicates in twenty-seven plankton samples, but one, collected by Dr. R. YOSHII of Kyoto University, on board the survey ship SOYA during her cruise of the Japanese Antarctic Research Expedition from October 1957 to February 1958. The studied material consists of one sample from the South China Sea, seven from the warm-water region of the Indian Ocean, five obtained in the area off the Cape of Good Hope to the cyclone zone, and fourteen from the Antarctic Seas. In the last two regions, the samples were collected by vertical haul of a plankton net, while in others they were gathered by filtrating the sea water for cooling the engine of the survey ship. The remaining one sample was collected on January 1, 1957 by Mr. NISHIYAMA when the SOYA was anchoring near East Ongul Island where the Japanese Base Camp is situated, and presented by Mr. K. UEMURA to the Osaka Museum of Natural History. This sample contains *Chaetoceros* chains very densely and several small ctenophores. Pelagic tunicates were found in two samples from the Indian Ocean, four from the area off the Cape to the cyclone zone and five from the Antarctic Seas. There is little to be mentioned about those found in the samples from the Indian Ocean, the South China Sea and the area from the Cape to the cyclone zone, except that a few of the cold-water species ***Fritillaria borealis*** f. ***typica*** appeared in one sample from the station, 47°41′ S × 31°48′ E, in the cyclone zone.

Table 1. Pelagic tunicates found in samples from the Indian Ocean.

Species	08°15′ S 76°15′ E (Nov. 17, 1957)	18°54′ S 60°39′ E (Nov. 20, 1957)
Thalia democratica f. *typica* sol.	1	
Oikopleura longicauda	7	
Oik. fusiformis		2
Oik. graciloides	2	
Oikopleura spp. (mutilated)	4	

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Table 2. Pelagic tunicates found in samples from the area off the Cape to the cyclone zone.

Species	35°09′ S 20°13′ E (Dec. 1, 1957)	35°09′ S 20°13′ E (Dec. 1, 1957)	47°41′ S 31°48′ E (Dec. 14, 1957)	47°41′ S 31°48′ E (Dec. 15, 1957)
Salpa cylindrica greg.	1			
Thalia democratica f. *typica* sol.	11		1	
embryo	1			
greg.	4			
Doliolum denticulatum	1			
Doliolum nationalis	22	66		
Doliolum spp. (mutilated)	6	3		
Oikopleura longicauda	9			
Oikopleura fusiformis	22	34		
Oikopleura rufescens	1			
Oikopleura spp. (mutilated)	34	16		1
Oikopleurid sp. (mutilated)	6			
Fritillaria borealis f. *typica*				3

Table 3. Pelagic tunicates found in samples from the Antarctic Seas.

Species	St. 1 66°51′ S 41°19′ E (Dec. 23, 1957) (200–0 m)	St. 2 67°59′ S 41°08′ E (Dec. 24, 1957) (200–0 m)	St. 3 67°04′ S 40°53′ E (Dec. 25, 1957) (400–0 m)	St. 4 67°04′ S 40°53′ E (Dec. 25, 1957) (400–0 m)	St. 5 67°03′ S 40°44′ E (Dec. 28, 1957) (250–0 m)
Oikopleura gaussica	1	7	3	1	10
Oikopleura sp. (mutilated)		1	1		
Pelagopleura magna	1		1		
Sinistero ffia scrippsi				1	
Fritillaria haplostoma		1			
Frit. haplostoma f. *glandularis* nov.			6	1	7
Frit. formica			2		1
Frit. antarctica			2		3
Frit. borealis f. *typica*		1	2	3	4
Frit. tenella				1	
Fritillaria spp. (mutilated)			1		1
Kowalevskaia tenuis				1	

Ten species of appendicularians occurred in samples from the Antarctic Seas as shown in Table 3. Of these, *Fritillaria haplostoma, Frit. formica, Frit. tenella* and *Kowalevskaia tenuis* are warm-water species, and *Oikopleura gaussica, Pelagopleura magna, Frit. borealis* f. *typica* and *Frit. antarctica* are cold-water forms. *Frit. borealis* f. *typica* of the latter group shows the bipolar distribution, while other

three are really endemic in the Antarctic waters. Occurrence of *Sinisteroffia scrippsi* is the second record of the species which was first collected from the Humboldt Current off Peru. Thus, it is uncertain whether this species is an Antarctic form. It is, however, not impossible that this belongs to the Antarctic species and then might have been carried far north to the lower latitudes by the Humboldt Current flowing north along the west coast of South America. A supposed new form *glandularis* of *Frit. haplostoma*, described for the first time in the present paper, is characterized by prominent gland cells on the tail fin, and its distribution is considered to be limited to the Antarctic Seas. Some problems concerning the Antarctic appendicularian fauna have already been mentioned in my previous note "Appendicularians of the Japanese Antarctic Research Expedition" in the Bulletin of the Marine Biological Station of Asamushi, Tohoku University, Vol. X, No. 4, 1962, pp. 241-245. No matter what they may be, the most important and essential point must be the exactitude of the identification. From the point of this view, taxonomical studies were made strictly on the present material and the results comprising some new findings are given in the following pages. Before starting detailed descriptions, I want to express here my hearty tanks to Dr. R. Yoshii for his kind offer of this valuable material for my study.

II. DESCRIPTIONS

1. Oikopleura (Vexillaria) gaussica LOHMANN, 1905

(Plates 1—3)

LOHMANN, H. (1905): Die Appendicularien des arktischen und antarktischen Gebiets, ihre Beziehungen zueinander und zu den Arten des Gebiets der warmen Ströme. Zool. Jahrb., Suppl. VIII, pp. 359-360, Pl. 12, figs. 2, 4 and 7.

Nine specimens were examined closely; the largest of all has the trunk 3,260 μ long and the tail 12,610 μ long. The trunk is ovoidal, considerably elongate and with the oikoplast epithelium whose dorso-posterior edge attains the level of the posterior margin of the alimentary organ in smaller individuals, but falls before it reaches near the posterior margin of the organ in larger ones. The posterior body surface out of the oikoplast epithelium is finely papillated at least in larger individuals; the distance between papillae ranges from 13 to 25 μ, generally 16-17 μ. The height/length ratio of the epithelium fluctuates in the range of 0.48 to 0.59 in examined specimens. The arrangement of cells on the epithelium

Table 4. Measurements on Oikopleura gaussica.

Sp. No.	Trunk length	Tail length	Oik.-Epithel. h/l	Number of subchordal cells	g.h./h.g.r.	St.
1	200μ			6 (vacuolar)		3
2	270	1450μ	0.50	8	17%	5
3	460		0.53	7		2
4	850			7 (4+3)		2
5	1200			14 (vacuolar)		3
6	1570	8300	0.48	8 (oval)	34	5
7	1780	9350	0.59	8 (4+4, flattened)	73	2
8	2170	11300		10 (vacuolar)	34	5
9	3260	12610		7		1

h.....height. g.h. .....gonad height.
l .....length. h.g.r.....height of genital region of trunk.

(Plate 1) resembles most closely that of *O. valdiviae* reported by BÜCKMANN. Besides EISEN's cell group, there are two distinct rosettes in the dorso-posterior portion, one in MARTINI's field and the other in the large dorsal cell group. These two rosettes are defined clearly on an individual with a 850 μ long trunk, though they are not so clear as in larger individuals. On the epithelium of a 460 μ long trunk examined, however, no other characteristic arrangement of cells, except EISEN's cell group, was found. The buccal glands are large, oval in small to medium (ca. 1,200 μ in trunk length) individuals, but become more or less lobated along the periphery in larger individuals as seen in Plate 3-e. The endostyle is rather elongate. The alimentary organ occupies the posterior half of the trunk. The left stomach lobe is roughly oval in outline, without any blind-sac, being slightly elongate antero-posteriorly, and the oesophagus enters the lobe at its dorso-posterior edge (Plate 2-c). In Plate 2-a and 2-b, the loop of the alimentary canal is rather loose and is viewed slightly from the ventral side so that the outline of the left stomach lobe looks a little shorter and the oesophageal opening to the stomach seems as if it were moved more posteriorly. The anus opens fairly before the anterior edge of the stomach. The rectum is nearly horizontal. The gonad retains a triangular shape even in the most matured individual (Plate 2-c) in this material which is 1,780 μ in trunk length; in other larger individuals with trunk length 1,570-3,260 μ the gonad is still smaller, its height is less than 34% of that of the genital region of the trunk. On the individual with a 270 μ long trunk the gonad is rudimentary, its height being only 17% of that of the genital region. The largest gonad observed, its height attaining to 73% of that of the genital region, consists of a band of testis curved to form a triangle opened at the dorsal apex and encircling a triangular ovarian lobe within (Plate 3-f, g and h).

In larger individuals, the maximal width of tail musculature is 9.5-9.7% of the tail length. The width of chorda to that of musculature differs markedly as the latter varies much with the state of contraction; it may be only 29% in some individuals, whereas it amounts to 46% in others. Subchordal cells are 6 to 14 in examined specimens, they are most frequently oval and vacuolar, though they may be flattened along the margin of the musculature as seen in Specimen No. 7 (Plate 3-c, d). In some specimens these cells may be divided into two groups, proximal and distal, each comprising nearly the same number of cells.

Remarks: There are four described species of *Oikopleura* reported from the Antarctic Seas: *O. gaussica* LOHMANN, *O. valdiviae* LOHMANN 1905, *O. drygalski* LOHMANN 1926 and *O. weddelli* LOHMANN 1928. Seven other species, *O. falklandica, O. frigida, O. magellanica, O. meteori, O. oblonga, O. rigata* and *O. simplex*, are found in the paper by LOHMANN and HENTSCHEL (1939), but these are *nomen nudum* and must be excluded from taxonomic studies, though they may indicate a great variablility of some plankton animals occurring in the Antarctic Seas.

Of the four described Antarctic oikopleurids *O. drygalski* was described on the basis of a few imperfectly preserved specimens. They are much smaller than *O. gaussica* and *O. valdiviae*, less than 1,160 μ in trunk length, and yet they are provided with a fully mature gonad which does not assume a plate-like appear-

ance but forms a roundish mass. The left stomach lobe is roundish in outline like that of *O. gaussica* and *O. valdiviae.* The oikoplast-epithelium is rather short, with the posterior part of the intestine exposed; details of cell arrangement are not known. Subchordal cells are spindle-shaped and 4 in number. The shortness of the oikoplast-epithelium seems to be related to the maturity. In nearly all oikopleurids the oikoplast-epithelium occupies larger part of the trunk surface in younger individuals than in grown-ups. Small difference such as whether the posterior half of the alimentary organ is exposed or covered by oikoplast-epithelium, is considered insignificant in separating species. Difference to some extent may be partly due to slight displacement of alimentary organ forced by the pressure of mature gonad. The fewness of subchordal cells might be attributable to the smallness of the specimens. The arrangement of "Häutungskörper" of fine granular or fibrillar structure as found in the posterior to the row of giant cells on the surface of "House Anlage", was pointed out by LOHMANN as one of the significant features in separating species. I, of course, recognize that there are essential types of arrangement, but at the same time I think that details of the arrangement show a considerably wide range of variation and the structure changes with the development of "House Anlage". Thus, I am inclined to neglect slight differences in the arrangement and structure of "Häutungskörper". From this point of view, I feel it difficult to admit the validity of *O. weddelli* of which only three small, up to 600 μ in trunk length, immature specimens are known and which was separated from *O. gaussica* and *O. valdiviae* by the difference in "Häutungskörper". This resembles most closely *O. valdiviae* in having a similar oikoplast-epithelium and a tail with ten capsular subchordal cells and with a wide musculature.

The gonads of *O. gaussica* and *O. valdiviae* are plate-shaped in younger stages, but become to form compact masses in a fully mature state. In a smaller genital space, such masses must be united into a single mass consisting of two testicular ones and a single ovarian one embraced by the former. In dealing with many appendicularian specimens, we are often impressed by the fact that in the same species some specimens are still sexually immature in spite of their big body-size, while others of much smaller body-size may be full matured. It is most likely that Antarctic oikopleurids can not be exceptional in this aspect. Thus, I feel the possibility that *O. drygalski* is nothing but an individual of *O. gaussica* or *valdiviae* sexually matured in spite of such a small body. There remain a couple of species, *O. gaussica* and *O. valdiviae.* These two species resemble each other very closely. The left stomach lobe has a roundish outline, and cardiac coecum is absent in both species. LOHMANN stated that the lobe is a little smaller in *valdiviae* than in *gaussica,* but at the same time mentioned the variability of *valdiviae.* According to LOHMANN's (partly given by BÜCKMANN) descriptions, the oikoplast-epithelium is slightly shorter in *gaussica* than in *valdiviae,* the height/length ratio of the epithelium measured on his figures is 0.56 in *gaussica* and 0.45 in *valdiviae.* In my present material, the ratio is 0.48, 0.50, 0.53 and 0.59 respectively in four examined specimens. This seems to show that the relative height of the epithelium is fairly variable and the difference of such a degree

as found in LOHMANN's figures seems to be taxonomically insignificant. Rather, I note that in *valdiviae*, a rosette is formed in the large dorsal cell group besides that in MARTIN's field, while it is missing in *gaussica*. However, such special cell arrangements on the oikoplast-epithelium develop with the growth of the animal as mentioned already in the descriptions of the present specimens. The posterior rosette may be missing in shorter epithelia as well as in younger ones. I am rather sceptical about the significance of the difference in the arrangement of "Häutungskörper" between the two species. Both species grow up to the similar body size, 3,500 μ to 3,900 μ in trunk length, and bear a flat plate-shaped gonad which may become compact masses in fully matured individuals. The buccal gland is large in both species, frequently compressed in *valdiviae*.

The tail musculature is rather narrow in *gaussica*, but it is wide enough in *valdiviae*, about four times as wide as chorda. Subchordal cells are seven to ten in number, flattened and vacuolate, and may be divided into proximal and distal groups in *valdiviae*. On the other hand, *gaussica* has a row of paired cells which are flattened and placed side by side in close contact; fourteen pairs of such cells are shown in LOHMANN's figure. It is possible that the description of tail of *O. gaussica* was made on specimens in a somewhat contracted state in which the musculature might have become much narrower and subchordal cells flattened on the plane perpendicular to that of the tail fin and might have been folded towards the chorda so that a single cell looked like a pair of cells in contact along the periphery of the musculature but keeping a space to embrace the chorda. In my specimens subchordal cells range from 6 to 14 and they are oval or capsular in specimens with wide musculature, while in those with narrow, contracted musculature they are strongly compressed along the margin of the musculature on the plane perpendicular to that of the tail fin (Plate 3-c, d). Thus, the structure of tail in some specimens bears a resemblance to *valdiviae*, but to *gaussica* in others. While, the structure of trunk seems to fluctuate from the side of *gaussica* to that of *valdiviae* quite independently of the tail structure and include some intermediate states between the two. For these reasons, I am at present inclined to consider that *O. gaussica* and *O. valdiviae* are quite identical with each other, and the specific name *gaussica* should be retained after the page priority. It is noteworthy that UDVARDY (1958) reported only a single Antarctic oikopleurid, *O. valdiviae*, from the Antarctic waters south of 60° S during the Swedish Antarctic Expedition.

2. Pelagopleura magna LOHMANN, 1926

(Plates 4-5)

Two specimens in the material. The individual from Station 3 is very large; the trunk is 6,000 μ in length and the tail is 18,260 μ in length, about three times as much the trunk length. The trunk is remarkably elongate. The oikoplast-epithelium covers the anterior half of the body, its posterior edge reaches the level of oesophageal opening to the pharynx, and thus the oesophagus, stomach and intestine are all exposed, except the oval rectum which is mostly

under th epithelium. The oikoplast-epithelium (Plate 4-c) is provided with very prominent large dorsal cell group above EISEN's cell group, but is devoid of MARTINI's cell group. The row of giant cells consists of about 16 cells. The endostyle is very slender, the spiracles are tremendously large. The stomach is laterally compressed and roughly elongate oval in outline, slightly narrowed in the anterior half. The surface is nearly smooth, except for a groove running through the centre on each side. The pyloric end is marked off from the rest by containing a prominent ovoid faecal mass. The intestine is thin and of a considerable length. The oesophagus opens near the middle of the dorsal edge of stomach. Both testis and ovary are rather membranous. The testis stretches along the lateral and rear walls of the posterior half of trunk covering both sides of the ventral half of the stomach, and becomes conspicuously narrower at the posterior bending point. It has a deep ventral cleft near the anterior end on each side. The ovary is situated inside the testis, much shorter than the latter and scarcely covering the stomach. The posterior bending point is remarkably narrow, too. The tail musculature is rather narrow, the width is about 8.3% of the tail length. The anterior end of the tail fin is rounded and does not show a ledge from which is commonly seen in fritillarians. There are six glandular patches on the fin as shown in Plate 5-d, e. The musculature covers the whole length of the chorda.

The individual from Station 1 is much smaller. It is only 300 μ in trunk length and 680 μ in tail length which is only 2.3 times the trunk length. Anterior two-thirds of the trunk is covered by oikoplast-epithelium and the short intestine and very voluminous rectum are nearly under the epithelium. The stomach consists of a spherical posterior half and a slightly smaller pyloric portion which is also spherical and contains a roundish faecal mass. The oesophagus enters the posterior half of the stomach at its dorso-posterior corner. This appearance of the alimentary canal reminds us of that of *Folia*. However, the canal is situated on the median plane of the trunk and the animal is devoid of buccal glands; thus, this specimen must be a young form of a pelagopleurid, most probably *P. magna*. No gonad is observed in this specimen.

Remarks: There is another described species of *Pelagopleura* from the Antarctic Seas, *Pelagopleura antarctica* (BÜCKMANN, 1924). This is characterized by the shape of the stomach and details of the oikoplast-epithelium. The stomach has a distinct blind sac in the postero-ventral corner, and the large dorsal cell group of the oikoplast-epithelium comprises numerous cells instead of a few elongate giant cells. The gonad is situated ventral to the stomach in younger stages. In LOHMANN's original figure, *P. magna* has a rudimentary gonad which is situated in the postero-ventral corner of the stomach. Thus, I am not certain whether the situation of rudimentary gonad can be a significant specific character. As to the distribution of gland cell groups on the tail fin, a wide range of variation is known in another species, *P. verticalis* (LOHMANN) (TOKIOKA 1960, pp. 428-429, fig. 15), and thus it seems dangerous to lay the ground of identification on this aspect. The endostyle seems to be much shorter in this species than in *P. magna*. Summing up the above-mentioned features, it may safely be said that two distinct

species of *Pelagopleura* are discriminated in the Antarctic Seas.

3. Sinisteroffia scrippsi TOKIOKA, 1957

(Plate 6)

A single specimen was collected at Station 4. The trunk is considerably compressed dorso-ventrally and roughly elongate oval in dorsal view. It is 2,060 μ in length, 790 μ wide and 600 μ high in maximum. The tail is 8,290 μ in length which is about four times the length of the trunk. The oikoplast-epithelium covers the anterior half of the trunk. The row of giant cells consists of ca. 16 cells, praeoval cells in front of the giant cell row are arranged roughly in six rows, postoval cells behind the three rows of small kiddle-builders are arranged in three rows. EISEN's cell group is formed, with a few elongate cells in the centre. No rosette is found in the dorso-posterior field bordered by the row of giant cells and EISEN's cell group. There is a roundish window-like structure on the dorso-median line of the "House Anlage" near its posterior edge just above the oesophageal opening. The endostyle is of a moderate length. Spiracles are oval, rather small. The appearance of alimentary organ resembles that of the smaller individual collected off Peru (TOKIOKA, 1957, p. 361, Pl. I fig. F). The posterior portion of the stomach is marked off from the rest by narrowing rather abruptly along the ventral margin. The oesophagus opens to the stomach on the dorsal edge, with its posterior margin just in the middle. The intestine is relatively short. The stomach is situated along the left lateral wall of the trunk and nearly the whole alimentary organ is exposed out of the oikoplast-epithelium on the lateral side. Thus, the plate-shaped gonad occupies the posterior part of the trunk quite apart from the alimentary organ. Ovary and testis are not differentiated yet.

The maximal width of the tail musculature is 730 μ, about 8.8% of the tail length; the width of chorda is 33.8% of the musculature at the level near the middle. Amphichordal cells are small, 30-34 on respective sides (Plate 6-d, e); they are mostly spherical or spindle-shaped, but a few are elongate. The tip of the chorda is not exposed.

Remarks: The present specimen is still sexually immature with this large size against the fact that the 1,690 μ (in trunk length) specimen collected off Peru was fully matured. Probably this is due to the lower water temperature in the Antarctic waters.

4. Fritillaria (*Acrocercus*) *haplostoma* f. *glandularis* nov.

(Plate 7)

A single specimen of typical *haplostoma* was found in the sample collected at Station 2. The tail of this specimen had seven pairs of fine gland cells arranged in a row along the fin margin on each side.

Other specimens also bear a colse resemblance to *haplostoma*. In two measured individuals, the trunk is 1,000 μ and 950 μ and the tail is 1,980 μ and

2,110 μ long respectively. In one specimen, the trunk is very slender, the width is 22.4% of the length at the pharyngeal region in maximum and 14.5% at the level of the middle of testis. The pharyngeal region is very short, occupying about 1/4.4 of the total trunk length, and is covered by a large hood on the dorsal side. The lower lip is divided into two lateral lobes, while the dorsal lip seems to protrude anteriorly as a single lobe. The endostyle is narrow to moderately wide, curved dorsals strongly. Spiracles are round and situated close to each other, in one specimen they are found nearly in contact with each other. One pharyngeal gland cell may be found between the spiracles in some specimens or this may be missing in others; besides there are one or two minute glandular cells between the spiracles and the oesophageal opening. The stomach is situated far apart from the posterior edge of the pharynx, it is ovoid in shape and furnished with a few gland cells on the surface. The intestine bears two, dorsal and ventral, very distinct glandular appendages. The ovary anterior and spherical, the testis posterior and elongate. In some specimens the postero-lateral corners of the testis are connected by a linear structure respectively to a small depression near each postero-lateral corner of the trunk; an orifice may be found on the ventral median line near the posterior end of the trunk. Probably this may be a genital aperture formed by rupture and allows the massive ejection of male or female genital products.

The tail fin is wide, 140-180 μ on each lateral half in examined specimens, becoming narrower in the distal portion ending in a bluntly pointed tip. The tail musculature is narrow, 73 μ wide, in the 2,110 μ long tail, and consists of 8-10 muscle bands; this is about three times as wide as chorda near the middle of the tail. The musculature covers the whole length of chorda, and thus the tip of the latter is never exposed. There is a series of minute gland cells along each lateral margin of the fin. Two much larger and more compact gland cells are found on the right side of the fin; they are roundish, 17-23 μ in diameter, and are about 180 μ apart from each other in an examined specimen. They may be missing in some individuals. In a single specimen two such cells were found on each side of the fin.

Remarks: The form described here shows no essential difference from *haplostoma* in the structure of the trunk. However, the structure of the tail seems to differ significantly. The absolute absence of the exposed distal portion of chorda and the presence of two remarkable gland cells mostly on the right side of the fin are unique to the present form. As *Fritillaria haplostoma* is well known by its great range of variation, it is highly possible that the present form represents merely an ecological form of *haplostoma* and bears no specific significance. However, it seems to be worthwhile to record the present specimens as a distinct form until the detailed studies of the variability of *haplostoma* are completed. For this reason, the specimens are treated here as a new form and named *glandularis* on the basis of the presence of remarkable gland cells on the tail fin.

5. *Fritillaria* (*Acrocercus*) *formica* Fol, 1872

(Plate 9-a)

The trunk is 820 μ long and the tail is 1,680 μ long in a single specimen from Station 5. The trunk is rather elongate for this species and there is a considerable space between the posterior end of the pharyngeal region and the anterior edge of the stomach. However, the characteristics of *Frit. formica* are distinct in that both dorsal and ventral lips are divided into lateral lobes and that the endostyle is exceedingly wide. Two pharyngeal gland cells are present between the spiracles. Two distinct glandular appendages are found on the intestine. There is a small round aperture on the ventral median line near the posterior end of the trunk. This may be a hole through which part of genital products were ejected. A thin elongate appendage is attached to the posterior border of the trunk and a vestigial fragment of such an appendage is found near by. It is impossible that a species of the subgenus *Acrocercus* has any protuberances on the posterior margin of the trunk. It is highly probable that these appendages are not genuine protuberances, but tubules everted out through a pit which are corresponding to the linear structures connecting postero-lateral corners of the testis to pits as mentioned in the preceding form; in other words, these tubules may have served as a kind of sperm duct, although the massive ejection of sperms may have been carried out through the ventral median orifice. I have described and illustrated a young specimen of this species from the Japanese waters which bears a pair of fine protuberances along the posterior border of the trunk (Tokioka, 1950: Droplets from the Plankton Net. VI. Notes on the posterior protuberances found in some fritillarians. Publ. Seto Mar. Biol. Lab., I (3), p. 155, Text-fig. 8). These protuberances must be entirely of the same nature as those described here.

The tail musculature is unusually narrower than in the individuals found in the tropical waters; it is only 82 μ wide in the 1,680 μ long tail and consists of ten muscle bands; the tip is pointed and the distal end of chorda does not go beyond the musculature.

Remarks: Enormously elongate trunk and narrower tail musculature are remarkable features of the specimen from the Antarctic Seas; especially the latter feature may be significant in distinguishing the Antarctic specimen as a separate form.

6. *Fritillaria* (*Acrocercus*) *antarctica* Lohmann, 1905

(Plate 8)

Specimen number	Trunk length	Tail length	Width of musculature
1	290 μ	1,410 μ	37 μ
2	340	880	
3	360	1,040	20

The trunk is roughly rectangular in outline, compressed dorso-ventrally.

The anterior half is occupied by pharynx covered dorsally with a prominent hood. The dorsal lip is protruded out in a single triangular lobe. The endostyle is narrow, strongly curved. The oikoplast-epithelium is furnished with two pairs of elongate elliptical groups of cells and bordered posteriorly with a transverse row of eight large cells. Spiracles are very large and round. No significant pharyngeal gland cells are present. The stomach and intestine are arranged side by side on the transverse axis. The intestine bears two prominent glandular appendages. The stomach has a prominent protuberance near the left posterior corner, with or without an additional glandular appendage. There are two small gland cells on the ventral floor near the stomach protuberance in the specimen from Station 3 (Plate 8-i). The rectum has a prominent glandular prominence directed posteriorly, with one glandular appendage, and with or without a few small accessory appendages. In the specimen having a 290 μ long trunk, a string-shaped rudimentary gonad is found on the dorso-posterior side of the alimentary organ. This is constricted near respective ends to form a small spherical terminal nodule; these nodules may be rudimentary ovaries.

The tail is very long in a better preserved specimen (Specimen No. 1). The fin is very broad, 370 μ wide in the 1,410 μ long tail. The posterior end is remarkably narrow and bluntly pointed. The musculature is very narrow, 20-37 μ, which is only 10% of the fin width. The distal end of chorda is not exposed. About ten pairs of minute gland cells are arranged in a row along each lateral margin of the tail fin.

Remarks: Most parts of the descriptions given here are applicable to *Fritillaria fraudax* LOHMANN, 1896. The structure of the pharynx, the appearance of stomach and the general feature of alimentary organ are quite common to *fraudax* and *antarctica*. LOHMANN (1926) emphasized the difference in the appearance of stomach between these two species, but I would rather emphasize the rectum which is furnished with glandular appendages more complicatedly in *antarctica* than in *fraudax*. Moreover, the narrowness of tail musculature in *antarctica* is noticeable as pointed out by BÜCKMANN; the musculature is much wider in *fraudax*. It must be noticed, however, that the tail musculatue of *Frit. formica* collected in the Antarctic Seas is much narrower than in specimens from the tropical waters. The rudimentary gonad of Specimen No. 1 reminds us of *Frit. gracilis* LOHMONN, 1896. The appearance of tail furnished with a number of paired gland cells on the fin and penetrated by a narrower musculature seem to support this resemblance. Nevertheless, the structure of the alimentary organ of this individual is quite identical with that of other individuals, and this is a different point from typical *gracilis*. As I have had no chance of examining sexually matured specimens and have then no right to mention on the gonad, I cannot give any decisive opinion as to the validity of *Frit. antarctica*. I can only emphasize again the close affinity between this species and *Frit. fraudax*.

7. *Fritillaria* (*Eurycercus*) *borealis* f. *typica* LOHMANN

(Plate 9-b)

The structure of the trunk is typical of *Frit. borealis* f. *typica*. That is, the pharyngeal region is roundish in outline and covered with a large hood on the dorsal side; the ventral lip is deeply cut into two lateral lobes, while the dorsal lip is protruded anteriorly as a single lobe; spiracles are very small. Oikoplast-epithelium has a pair of elongate elliptical cell groups and is bordered posteriorly by larger cells. The stomach and the intestine, which is furnished with three to four glandular appendages, are arranged obliquely antero-posteriorly. Spherical ovary and elongate and median testis are arranged antero-posteriorly. The 500 μ (in trunk length) individual from Station 4 has a fine slender appendage on the posterior border of the trunk (Plate 9-b), this is probably the structure everted out and served as a kind of sperm duct as mentioned already in the description of *Frit. formica* (p. 12).

The maximal width of tail musculature is 110 μ in the individual with 880 μ long trunk. The distal end of the musculature is bluntly pointed. In the individual with 500 μ long trunk, the cut at the distal end of fin is rather indistinct, probably due to shrinkage.

8. *Fritillaria* (*Eurycercus*) *tenella* LOHMANN, 1896

(Plate 9-c)

A single specimen from Station 4. The trunk is 560 μ in length. Three pharyngeal gland cells are found just behind the endostyle between small spiracles. The alimentary organ bears several surface protuberances, although these are somewhat fewer than usual. The tail fin is very broad and widely cut in at the distal end, the musculature is narrow. A pair of glands on the fin embraces the musculature in between, each consisting of a few cells arranged to form an elongate saccule opening posteriorly (Plate 9-c).

9. *Kowalevskaia tenuis* FOL, 1872

A single specimen from Staion 4. The trunk is 590 μ in length. The strongly dorso-ventrally compressed pharynx against the voluminous spherical stomach consisting of fewer and larger cells, the absence of endostyle, and the presence of a pair of enormously large external gill apertures and two rows of small ciliated conical protuberances arranged on the dorsal wall and one row on each ventro-lateral wall of the pharynx are enough to prove that the specimen belongs to genus *Kowalevskaia;* further specific identification is, however, somewhat uncertain, since the specimen is not perfectly preserved.

III. GENERAL REMARKS

Throughout the descriptions given above, it is to be noticed that there are some Antarctic species very closely related to certain warm-water species or considered to represent ecological forms of the latter. *Frit. antarctica* is an example of the former, while *Frit. haplostoma* f. *glandularis* exemplifies the latter. As is known from Table 3, Antarctic endemic species were found together with some warm-water species in the same sample. It is not certain whether those were distributed vertically quite separately or occurred in a mingled state; anyhow, it is doubtless that chemical and physical differences throughout the hauled layers from 200-400 m deep to the surface are very slight in the Antarctic Seas. There are two possibilities, one is that some of the Antarctic endemic species may be nothing but a regional ecological form of a certain warm-water species, and the other is that Antarctic specimens of some warm-water species are already specialized to be an ecological form or regional variety of that species as in the cases of *Frit. haplostoma* and *Frit. formica*. To solve this problem, further statistical studies on many specimens are desired.

References

LOHMANN, H. (1896): Die Appendicularien der Plankton-Expedition. Ergebn. Plankton-Exped. **2** E c, 148, 24 pls.

——— (1905): Die Appendicularien des arktischen und antarktischen Gebiets, ihre Beziehungen zueinander und zu der Arten des Gebists der warmen Ström. Zool. Jahrb. Suppl., 8, 353–382.

——— (1914): Die Appendicularien der Valdivia-Expedition. Verhandl. Deutsch. Zool. Gesellschaft, 1914, 157–192, 11 text-figs.

——— (1928): Beiträge zur Planktonbevölkerung der Weddellsee nach den Ergebnissen der Deutschen Antarktischen Expedition 1911–1912. Die Appedicularien-Bevölkerung der Weddellsee. Internat. Rev. gesam. Hydrobiol. Hydrograph., **20**, 13–72.

——— (1931): Die Appendicularien der Deutschen Tiefsee-Expedition. Deutschen Tiefsee-Exped., **21**, Part 1.

LOHMANM, H. and Ad. BÜCKMANN (1926): Die Appendicularien der Deutschen Südpolar-Expedition 1901–03. Ergebn. Deutsch. Südpol.-Exped., **18** (Zool. **10**), 63–231, 55 text-figs.

LOHMANN, H. and E. HENTSCHEL (1939): Die Appendicularien im Südatlantischen Ozean. D. A. E. "Meteor" 1925/27, **13**, No. 3, 153–243.

THOMPSON, H. (1948): Pelagic tunicates of Australia., 196, 75 pls., 19 text-figs., Melbourne.

——— (1954): Pelagic tunicates. B. A. N. Z. Antarctic Research Exped. 1929–31, Rep. Ser. B, **1**, Part 4, 183–185.

TOKIOKA, T. (1940): Some additional notes on the Japanese appendicularian fauna. Rec. Oceanogr. Works in Japan, **11**, No. 1, 1–26, 22 text-figs.

——— (1950): Droplets from the Plankton Net. VI. Notes on the posterior protuberances found in some fritillarians. Publ. Seto Mar. Biol. Lab., **1**, No. 3, 153–155, text-figs. 7–8.

——— (1951): Pelagic tunicates and chaetognaths collected during the cruises to the New Yamato Bank in the Sea of Japan. Publ. Seto Mar. Biol. Lab., **2**, No. 1, 1–25, 12 text-figs.

——— (1955a): General consideration on Japanese appendicularian fauna. Publ. Seto Mar. Biol. Lab., **4**, Nos. 2–3, 251–261, 6 text-figs.

——— (1955b): On some plankton animals collected by the Syunkotu Maru in May-June 1954. III. Appendicularians. Bull. Biogeographical Soc. Japan, **16–19**, 251–255, 3 text-figs.

——— (1956): ***Fritillaria arafoera*** n. sp., a form of the sibling species: ***Fritillaria haplostoma*** – complex (Appendicularia : Chordata). Pacific Science, **10**, No. 4, 403–406, 1 text-fig.

——— (1957): Two new appendicularians from the eastern Pacific, with notes on the morphology of ***Fritillaria aequatorialis*** and ***Tectillaria fertilis***. Trans. American Microscop. Soc., **76**, No. 4, 359–365, 4 text-figs.

——— (1960): Studies on the distribution of appendicularians and some thaliaceans of the North Pacific, with some morphological notes. Publ. Seto Mar. Biol. Lab., 8, No. 2, 351–443, 16 text-figs.

——— (1962): Appendicularians of the Japanese Antarctic Research Expedition. Bull. Mar. Biol. Sta. Asamushi, **10**, No. 4, 241–245.

UDVARDY, M. D. F. (1958): Appendicularia. Further Zool. Res. Swedish Antarc. Exped. 1901–03, **5**, No. 1, 15, 9 text-figs.

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