PELAGIC TUNICATES AND CHAETOGNATHS COLLECTED DURING THE CRUISES TO THE NEW YAMATO BANK IN THE SEA OF JAPAN*

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With 12 Text-figures, 6 Tables and 1 Chart

The surveying ship of the Maizuru Marine Observatory visited in April, July and September 1950 the submarine New Yamato Bank in the Sea of Japan. Mr. I. YAMAZI of the Seto Marine Biological Laboratory and Mr. H. MAÉDA of the Kôbe University were on board in these cruises and hauled many plankton samples; and from these samples Miss Y. MORI of the Seto Marine Biological Laboratory picked up appendicularians and chaetognaths for me. Most of these plankton samples were collected from the superficial layer by a small cruise net, while a small part was hauled up from the deeper layer by KITAHARA's standard net, a modified HENSEN's net, with ca. 20 cm mouth diameter and ca. 1 m long. The former material comprises a small quantity of appendicularians and chaetognaths, while the latter material is very rich in these animals and has offered me several rare and interesting forms. All the data pertaining to these materials are given in the tables at the end of this article. In the following, I propose to give some systematic notes, and also the relation between the fauna and the hydrographical condition of the surveyed area.

Before going further, I wish to express my hearty thanks to Mr. I. YAMAZI, Mr. H. MAÉDA and Miss Y. MORI for their generous help. I am also very grateful to Prof. T. KOMAI for his kind guidance and incessant encouragement.

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I. SYSTEMATICALLY

A. PELAGIC TUNICATES.

The species found in the collection are as follows:

Ascidiacea: Tadpole larva

Thaliacea:
1. *Thalia democratica* FORSKÅL
2. *Doliolum* (*Dolioletta*) *nationalis* BORGERT

Appendicularia:
1. *Oikopleura* (*Coecaria*) *longicauda* (VOGT)
2. „ („) *fusiformis* FOL
3. „ („) „ f. *cornutogastra* (AIDA)
4. „ („) *gracilis* LOHMANN
5. *Oikopleura* (*Vexillaria*) *dioica* FOL
6. „ („) *rufescens* FOL
7. „ („) *parva* LOHMANN
8. „ („) *cophocerca* GEGENBAUR
9. „ („) *labradoriensis* LOHMANN
10. *Megalocercus huxleyi* (RITTER)
11. *Stegosoma magnum* (LANGERHANS)
12. *Pelagopleura* sp.
13. *Fritillaria* (*Acrocercus*) *haplostoma* FOL
14. „ („) *magna* LOHMANN
15. „ („) *formica* f. *digitata* LOHMANN & BÜCKMANN
16. „ („) *charybdae* LOHMANN
17. „ (*Eurycercus*) *pellucida* (BUSCH)
18. „ („) *borealis* f. *sargassi-intermedia* (LOHMANN) ....small individuals.

18a. „ („) *borealis* f. *sargassi* (LOHMANN) .....large individuals.

19. „ („) *tenella* LOHMANN
20. „ („) *venusta* LOHMANN
21. *Appendicularia sicula* FOL

An ascidian larva was obtained in Maizuru Bay. An aggregated form of *Thalia democratica* was found once among the July samples at St. 2. *Doliolum nationalis* occurred at the frequency of 36% in the vertical hauls. Among appendicularians, *Oik. longicauda* is the commonest, next come in frequency *Oik. fusiformis* and *Oik. rufescens*. *Frit. haplostoma*, *Frit. formica* and

Table 1. Population of pelagic tunicates. In six columns of the haul, the left sign indicates the frequency and the right one shows the quantity.
Frequency ● ··· 70 %+, ○ ··· 30–70 %, + ··· 30 %–.
Quantity ● ··· 30 individuals / a haul +,
○ ··· 10–30 individuals / a haul,
\+ ··· 10 individuals / a haul–.

(in offshore waters)

	April		July		September		Summary	
	Vertical haul	Superf. haul	Vertical haul	Superf. haul	Vertical haul	Superf. haul	Frequency	Quantity
Doliolum nationalis			○+	++	++		○+ +	++ +
Oikopleura longicauda	●●	●○	●●	○+	●●	●+	●●● ●●○	●●+ ●○+
〃 *fusiformis*			●○	●+	●○	●+	●● ●●	○+ ○+
〃 〃 f. *cornutogastra*			++		○+	++	○+ ++	++ +
〃 *gracilis*			++		○+		○ +	+ +
〃 *dioica*	○+	○+	++	○+	++		○○+ ○+	+++ ++
〃 *rufescens*			●○		●○	●+	●● ●	○+ ○
〃 *parva*			○+		○+		○ ○	+ +
〃 *cophocerca*			○+		○+	++	○+ ○	++ +
〃 *labradoriensis*	○+						○	+
Megalocercus huxleyi			++			++	+ +	+ +
Stegosoma magnum					++	++	+ +	+ +
Pelagopleura sp.						++	+	+
Fritillaria haplostoma			●+		●●	+○	●+ ●	●+ ○
〃 *magna*			++				+	+
〃 *formica*			●+		●+	++	●+ ●	++ +
〃 *charybdae*			○+		○+		○ ○	+ +
〃 *pellucida*			●○		●+	++	●+ ●	○+ +
〃 *borealis* f. *sargassi-intermedia*			●+	++	○+		●+ ○	++ +
〃 *tenella*			○●		●+		● ○	● +
〃 *venusta*			○+		○+		○ ○	+ +
Appendicularia sicula			++	++	++		++ +	++ +

Frit. pellucida were also met with frequently, but not in large number except the first one which were sometimes found in an enormously dense association in the coastal waters. As to the other species see Table 1 (p. 3).

The variation in size is an interesting item on the morphology of appendicularians, although we are still ignorant of the exact cause of the phenomenon. Among the present materials, *Oik. dioica*, *Frit. haplostoma* and *Frit. borealis* f. *sargassi* present such variation. It is noteworthy that individuals hauled at stations far off the coast are usually larger than those collected from the coastal waters; this is true at least for *Frit. haplostoma* and *Oik. dioica*. Specimens of *Oik. dioica* collected from the oceanic waters during the present surveys are all large, sometimes reaching 3.3 mm in tail length, and with the whole genital products ejected already. The specimens of *Frit. borealis* comprise large and small individuals of f. *sargassi* intermingled. Forma *intermedia* is represented only by small individuals and includes several specimens referable to f. *prolifera* LOHMANN in which the testis is forked anteriorly and embraces the ovary between.

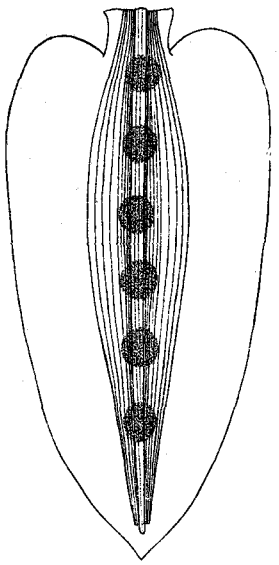

Fig. 1. *Frit. formica.* Tail with 6 pigment flecks.

It is well known that *Oik. longicauda* is occasionally coloured bright red or violet, while fritillarians is rarely coloured. Among the present materials, I met with two cases of colouring in fritillarians. The first case is of *Frit. pellucida* which is coloured reddish orange along the dorso-anterior margin of the hood and on the ventral surface of the anterior half of the trunk. The second case is of *Frit. formica* which is coloured reddish orange around the testis, besides six remarkable pigment flecks arranged in a row along the chorda of the tail (Fig. 1).

Some Taxonomic Notes on Appendicularia

(1) *Oikopleura fusiformis* f. *cornutogastra* AIDA (1907)

(Fig. 2)

In my 1940 paper, I expressed the opinion that *Oik. cornutogastra* AIDA

is merely a synonym of *Oik. fusiformis* FOL. Later (1942), however, in my paper dealing with the material collected from the waters surrounding the Palao Islands, I referred *Oik. cornutogastra* to a distinct species, although I knew the presence of some intermediate forms between this species and *Oik. fusiformis*. The present materials make me go back to my original view that *Oik. cornutogastra* cannot be considered as a distinct species. It is true that

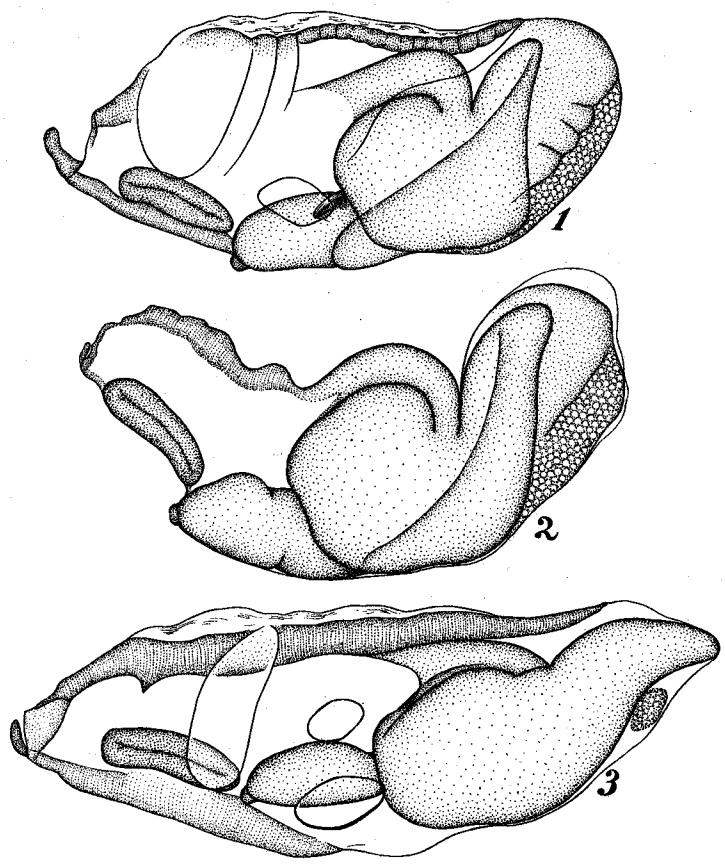

Fig. 2. *Oik. fusiformis*. 1—f. *cornutogastra* without dorsal notch; 2—An intermediate form with dorsal notch; 3—f. *typica*. ×110.

Oik. cornutogastra and *Oik. fusiformis*, as for the form of the cardiac protuberance of the left stomach lobe, are united by a complete series of intermediate forms. THOMPSON (1948) maintains as a characteristic of *Oik. cornutogastra* the existence of a notch on the dorsal side between the oikoplast epithelium and the genital region, where a curled velum may be formed from

a fold of the thin epithelium. This notch is found in many specimens. It should be noticed, however, that there are specimens which have the notch and the left stomach lobe of *fusiformis*-type, and also those having the left stomach lobe of typical *cornutogastra*-type, but no notch. In structure of the oikoplast epithelium and in the appearance of the tail musculature these two forms are identical. Slight differences in the measurement of the tail musculature cannot be accepted as a decisive specific difference, as there is a wide range of variation in the breadth of the tail musculature in *Frit. borealis* f. *sargassi*, *Frit. formica* and also in *Frit. haplostoma*, although the range is not so wide in the latter two species as in the first species. Besides, it is a noticeable fact that the typical *Oik. cornutogastra* has scarcely mature gonad filling up the posterior portion of the trunk. Practically all specimens have only a small amount of ovarial and testicular tissues. Some individuals having a *cornutogastra*-type left stomach lobe were found to be fully mature. In these cases, however, I could not find any dorsal notch between the oikoplast epithelium and the genital region. The gonad in these individuals is quite the same in appearance as that in *Oik. fusiformis*; it covers the lateral sides of the alimentary organ. These facts seem to indicate that the dorsal notch is formed in old individuals by the ejection of genital products. If so, the only feature which characterizes *Oik. cornutogastra* is the shape of the left stomach-lobe, and this feature, as mentioned above, is far from being distinctive.

In spite of these facts, there are some individuals provided with the left stomach lobe like *cornutogastra* which represents the terminal member of a series of variation against typical *Oik. fusiformis*. So I prefer, at present, to treat *Oik. cornutogastra* AIDA as a forma of *Oik. fusiformis* FOL.

(2) *Oikopleura gracilis* LOHMANN 1896

(Fig. 3)

This species occurred in July and September at the frequency of 27% and in a small number, 22 in total. Trunk 400–460μ long, tail 1590–2000μ long in mature specimens. Tail musculature 150–180μ wide, chorda 22–27% of musculature in breadth at the middle. Endostyle relatively broad, and situated much nearer the anus than the mouth. Left stomach lobe roughly rectangular, with comparatively straight dorsal edge.

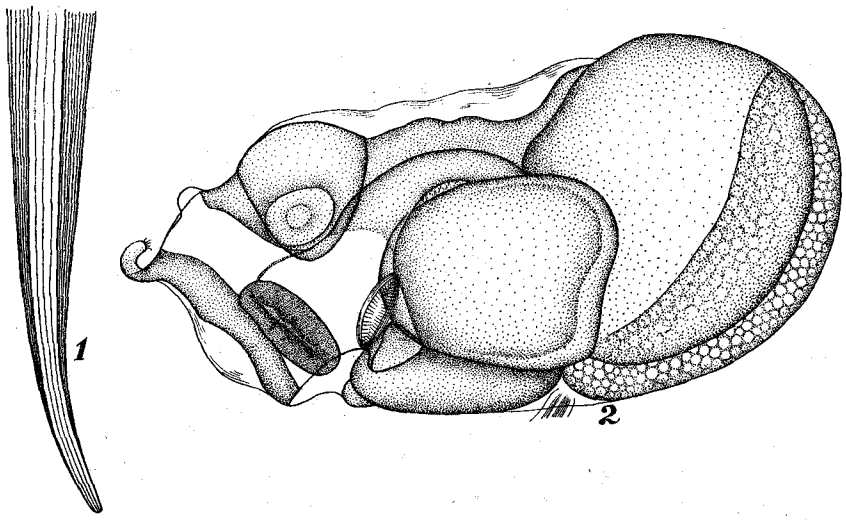

Fig. 3. *Oik. gracilis.* 1—Tip of tail musculature; 2—Left side of trunk. ×200.

(3) *Oikopleura parva* LOHMANN 1896

(Fig. 4)

Oikopleura najadis UEBEL ?

The present species under a casual examination simulates a small individual of *Oik. rufescens* FOL, as the stomach lobe is roundish and there are a pair of buccal gland cells. However, the species may be distinguished easily from the latter species by the following characteristics. 1) Trunk rather elongate in *Oik. parva,* while it is somewhat roundish in *Oik. rufescens.* 2) Oikoplast epithelium reaches scarcely the posterior end of the oesophagus in *Oik. parva,* whereas it reaches far beyond the posterior end of the stomach in *Oik. rufescens.* 3) While the gonad is situated on the dorso-posterior side of the alimentary organ in *Oik. parva,* it is found in *Oik. rufescens* on the posterior side of the stomach. 4) The buccal gland is larger in *Oik. rufescens* than in *Oik. parva.* 5) *Oik. parva* has a longer tail and narrower musculature. (See the table of the next page.)

The only difference between *Oik. parva* and *Oik. najadis* seems to be in the appearance of the tail musculature which is much wider in the latter than in the former, reaching 4-5 times the width of chorda. It is not impossible, however, that this characteristic is merely due to the difference in preservation.

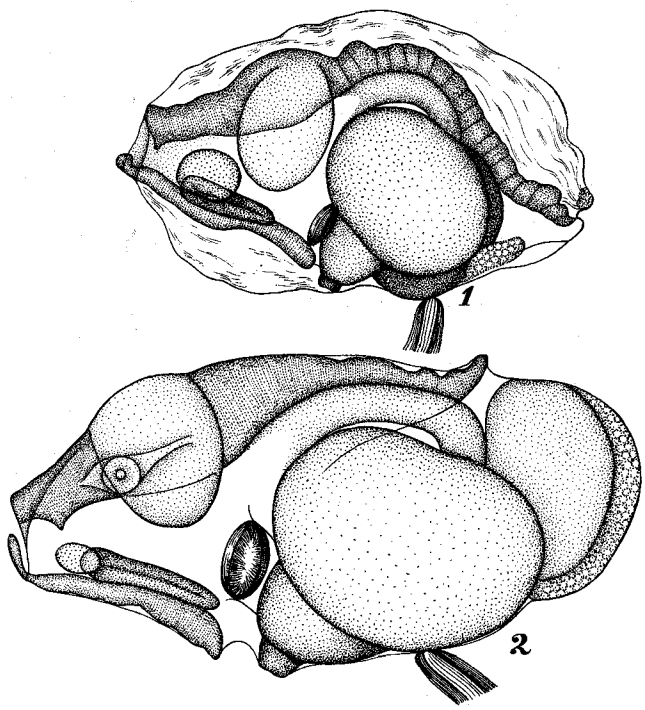

Fig. 4. 1—*Oik. rufescens*; 2—*Oik. parva*. ×110.

	Oik. rufescens	*Oik. parva*				
Trunk length (B) μ	590	630	660	710	780	800
Tail length (T) μ	2670	4290	4790	4430	4430	4930
Width of Tail Musculature (M) μ	220-260	190	250	220	260	270
$\frac{C}{M} \times 100$ (C–Width of Chorda)	32-33		61	52		51
$\frac{M}{T} \times 100$	9.0	4.4	5.2	5.0	5.6	5.5
$\frac{T}{B}$	4.5	6.8	7.3	6.2	5.7	6.2

(4) *Oikopleura cophocerca* GEGENBAUR 1885

In small young individuals there are only from two to four subchordal cells. Individuals with four subchordal cells may be confused with the preceding species and also with *Oik. najadis* UEBEL, while those having five subchordal cells remind us of *Oik. mediterranea* LOHMANN 1899 from Messina.

(5) *Fritillaria magna* LOHMANN 1896

(Fig. 5)

A giant specimen was found in the sample hauled at Station 2 in July. The posterior half of the trunk is mutilated considerably. The anterior half of the trunk, from the mouth to the posterior end of the alimentary organ, measures 1570μ in length. The tail is 5740μ in length, the breadth of the musculature reaches 270μ and the chorda is about 14% of the musculature in width.

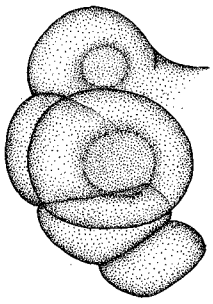

Fig. 5. *Frit. magna.* Group of glandular appendages on intestine. ×200.

Hood conspicuous, endostyle curled dorsally. There is a trace of glandular sac at each lateral side of the trunk on the level of the branchial aperture. A group of glandular appendages are found on the intestine (or on the pyloric portion of the stomach?). Tail fin terminates in a single pointed end as in *Frit. haplostoma,* but the chorda does not reach beyond the posterior end of the muscle. There are several cells scattered near the posterior end of the tail musculature as in *Pelagopleura verticalis,* although it is not certain whether the existence of such cells is a regular characteristic of this species or not. About a dozen of round nuclei are arranged in a row along the chorda.

(6) *Fritillaria charybdae* LOHMANN 1899

(Figs. 6 and 7)

Fifteen specimens were hauled from nine stations in July and September. At a glance, this species closely resembles *Frit. fraudax* LOHMANN. The most perfectly preserved individual is 1320μ in length and 590μ in width of the trunk, and 3300μ in tail length. Trunk somewhat rectangular in shape and

compressed dorso-ventrally. General structure of the trunk is nearly the same as that in *Frit. fraudax*, except the difference in the appearance of the alimentary organ and that of the gonad. Branchial aperture elongate, much longer than wide. There are several glandular appendages on the intestine, distal ends of which are usually divided into a few prominences. Stomach has a

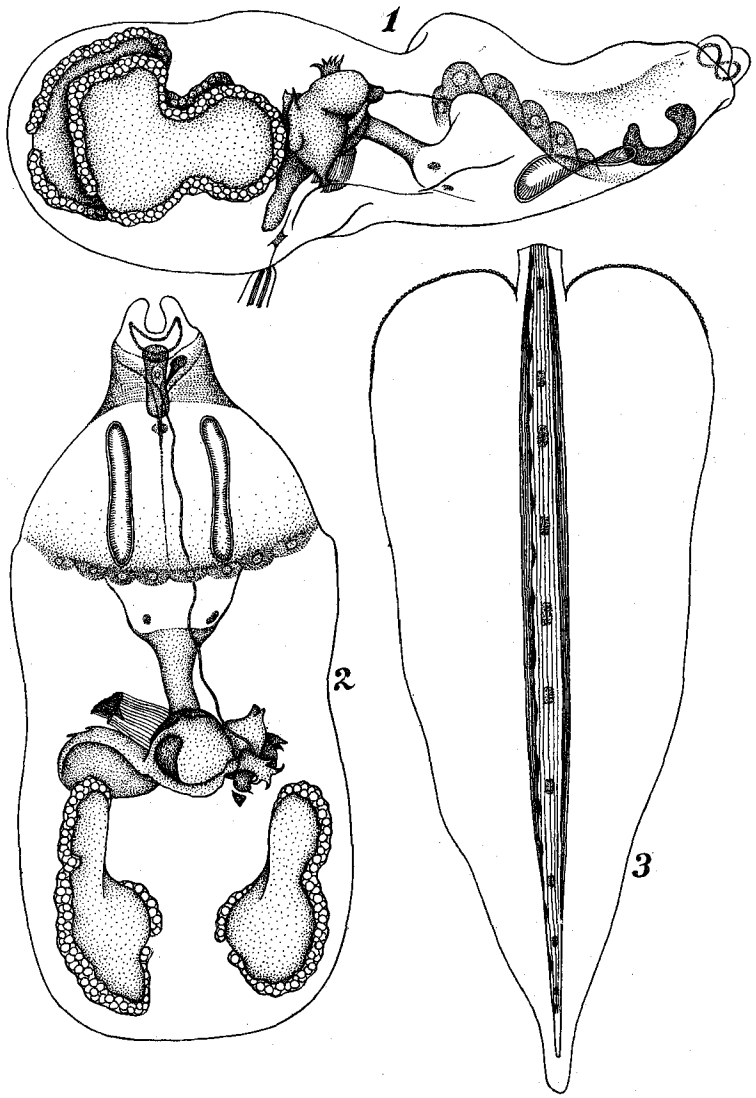

Fig. 6. *Frit. charybdae*. 1—Right side of trunk, ×75; 2—Dorsal side of trunk, ×75; 3.—Tail, ×35.

huge glandular appendage on the left side. This appendage is flat and roughly oval in shape, attached tightly to stomach by its two arms, of which the terminal parts are spread out and cover the stomach. Two flat gonads are situated vertically, and arranged parallel to each other. Each gonad consists of a large testicular mass and a string-like ovary, fringing the testis along its whole margin except a small space at the posterior portion. The middle part of each gonad is slightly narrowed.

Tail musculature very thin, slightly wider than chorda which reaches beyond the posterior end of the musculature. Tail fin is very wide and ends in a bluntly pointed end. About ten nuclei are distinctly found, arranged in a row along the chorda.

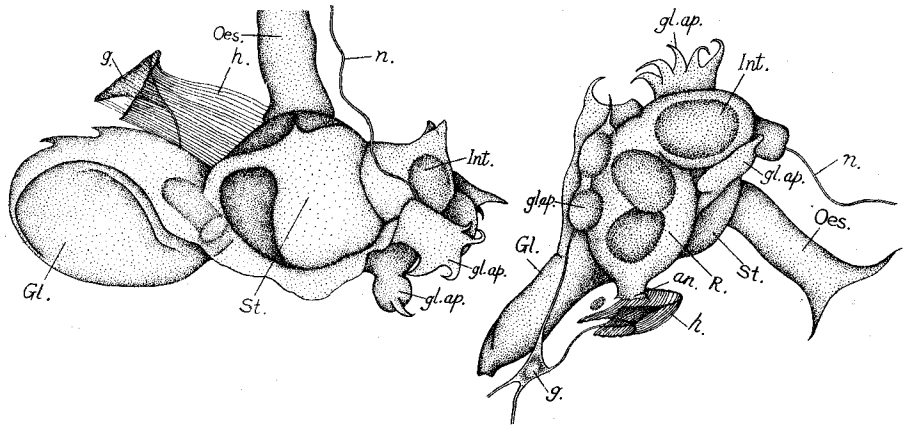

Fig. 7. *Frit. charybdae.* Alimentary organ; Left—dorsal, Right—right side, ×150. *an.*—anus, *g.*—ganglion, *Gl.*—huge glandular appendage of stomach, *gl. ap.*—glandular appendage of intestine, *h.*—heart, *Int.*—intestine, *n.*—nerve, *Oes.*—Oesophagus, *R.*—rectum, *St.*—stomach.

Remarks: The presence of a huge glandular appendage on the left side of the stomach and the existence of a pair of gonads are the characteristics differentiating the present species from most fritillarians known to date. ***Frit. fraudax, Frit. antarctica*** LOHMANN, ***Frit. helenae*** BÜCKMANN and ***Frit. drygalski*** LOHMANN resemble the present species and evidently form together with the present species a special group in the genus, although they all differ distinctly from this species in the number of gonads. ***Frit. urticans*** FOL has paired gonads, but their shape differs considerably from that of the present species. In ***Frit. urticans,*** the ovary is situated in front of the testis.

(7) *Fritillaria tenella* LOHMANN 1896

(Figs. 8 and 9)

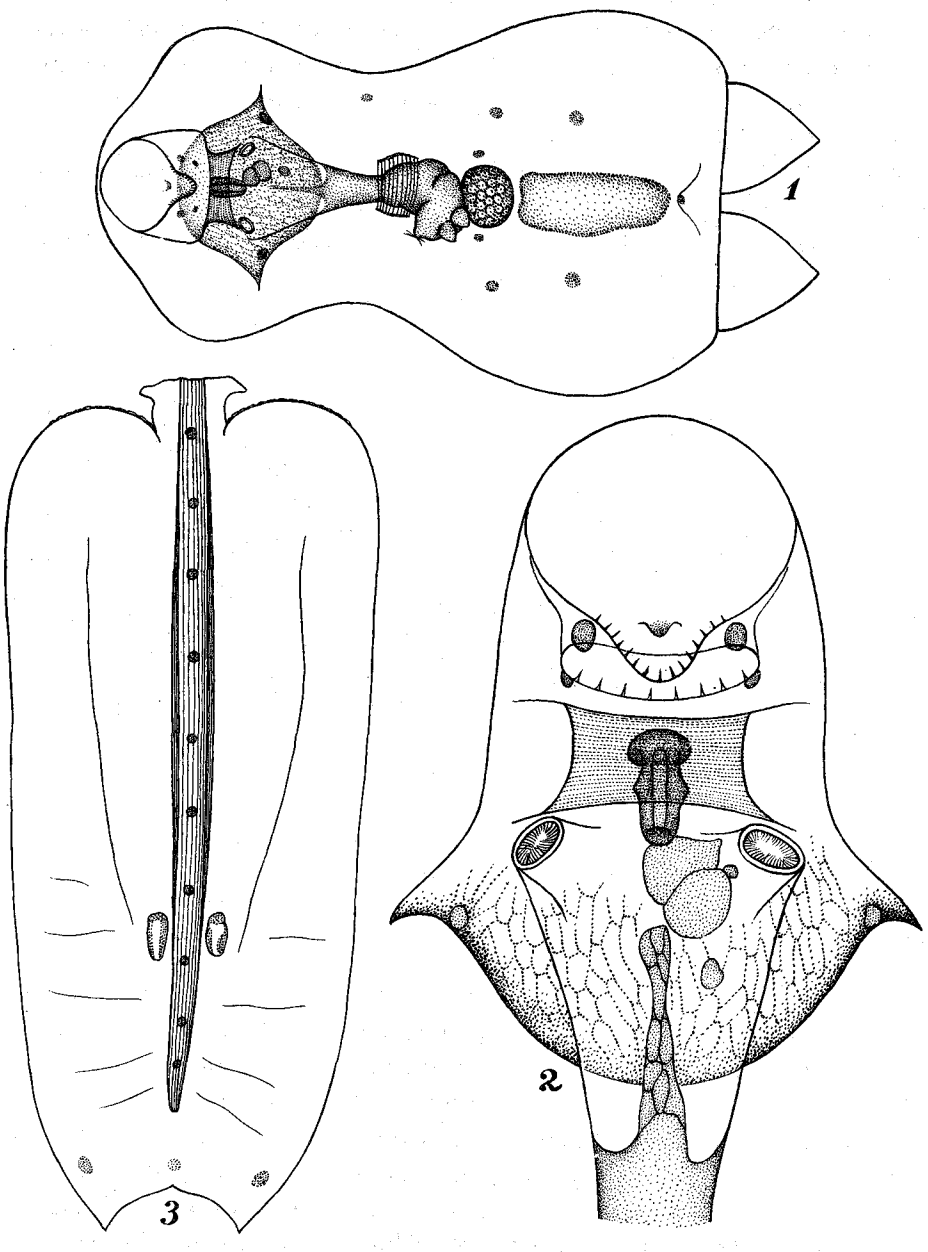

Fig. 8. *Frit. tenella.* 1—Dorsal side of trunk, ×35; 2—Anterior part of trunk, ventral, ×110; 3—Tail, ×35.

This relatively rare species occurs in abundance in the present material. I wish to give here exact descriptions of perfectly preserved specimens. mature specimens measure ca. 760μ in length and 450μ in width of the trunk. Trunk compressed dorso-ventrally; the anterior portion of the trunk forms a remarkable hood, the posterior end of the trunk is truncate and provided with a pair of large triangular protuberances. The middle portion of the trunk is somewhat narrowed. There are many gland cells scattered over the trunk:

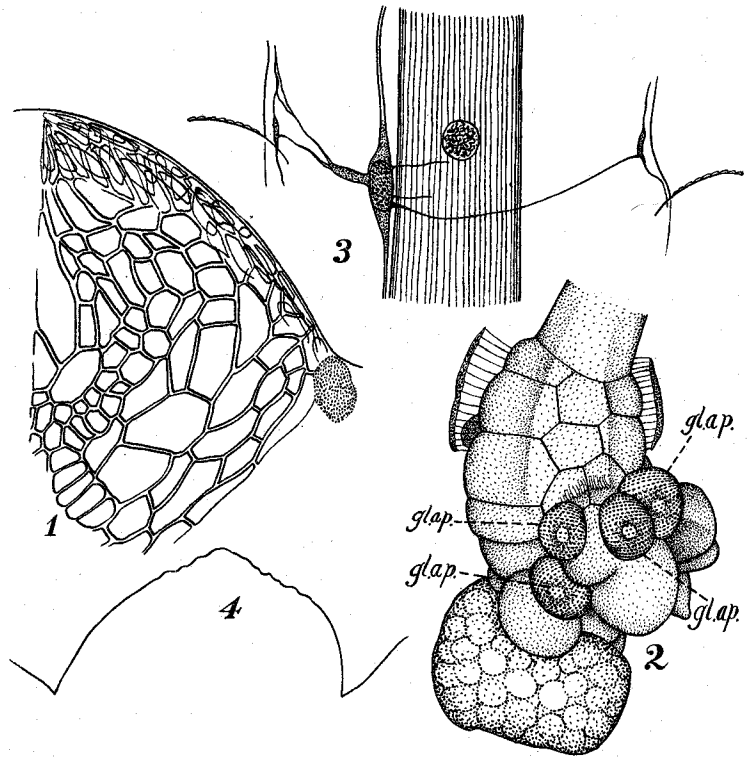

Fig. 9. *Frit. tenella.* 1—Oikoplast epithelium, left half, ×200; 2—Alimentary organ, dorsal, ×110; 3—Basal ganglion of tail, ×200; 4—Posterior incision of tail fin, ×110. *gl. ap.*—glandular appendage.

paired cells—two pairs near the mouth, one cell on each postero-lateral side of oikoplast epithelium, a dorsal pair and a ventral pair on the level of the middle of the testis; unpaired cells—a dorso-median one on the mouth, one on the left floor of pharynx behind the pharyngeal cells which are usually two in number, although they may be three in some individuals, a dorso-median cell above the oesophagus and also one near the posterior end of the trunk.

Several wall-cells of the intestine protrude out somewhat irregularly from the surface, of which at least four seem to be glandular appendages. Ovary spherical and situated in front of the median elongate testis. Tail 3340μ in length, fin very wide and cut widely at the posterior end. Margin of the incision smooth, or partly bluntly serrated in some specimens. Tail musculature narrow, scarcely wider than chorda, ten round nuclei arranged in a row along the chorda. A pair of comparatively large glands situated one on each lateral side of the musculature about a quarter of its length from the posterior end. Each gland consists of an anterior cell and two lateral cells. Three gland cells are observable along the posterior margin of the fin in perfectly preserved specimens.

(8) *Fritillaria venusta* LOHMANN 1896

(Figs. 10 and 11)

Fritillaria venusta: LOHMANN (1896) Plankton-Exped., pp. 46–47.
Fritillaria bicornis: LOHMANN (1896) Plankton-Exped., pp. 47–48.
Fritillaria inverta: ESSENBERG (1926).
? *Fritillaria venusta*: ESSENBERG (1926).
Fritillaria venusta: TOKIOKA (1940).
Fritillaria bicornis: THOMPSON (1948).

It is a curious fact that there is neither description nor figure of the mature gonad of *Frit. venusta*. When we compare *Frit. venusta* with *Frit. bicornis*, we find apart from the difference in structure of the gonad practically no difference. According to the descriptions and figures given by LOHMANN, the tail of *Frit. venusta* has a pair of small protuberances at the middle of the posterior incision, while *Frit. bicornis* lacks this structure; *Frit. venusta* has a pair of round prominences on each side of the pointed posterior end of the trunk, whereas the posterior end of the trunk is truncate and without any prominence in *Frit. bicornis*. These structures are, however, somewhat different in THOMPSON's material. *Frit. bicornis* collected from the South Eastern Australian Region and examined by THOMPSON has the median processes in the posterior incision of the tail fin and a large posterior triangular prominence on the truncate posterior margin of the trunk. My material includes many perfectly preserved individuals which have a tail typical of *venusta* and a trunk of *bicornis*-type, although the trunk is provided with a pair of large posterior prominences just like in the case in *Frit. venusta*. These facts may justify the idea that *Frit. venusta* is identical with *Frit. bicornis*. *Frit. venusta* described by LOHMANN seems to be individuals with immature gonad, while *Frit. bicornis*

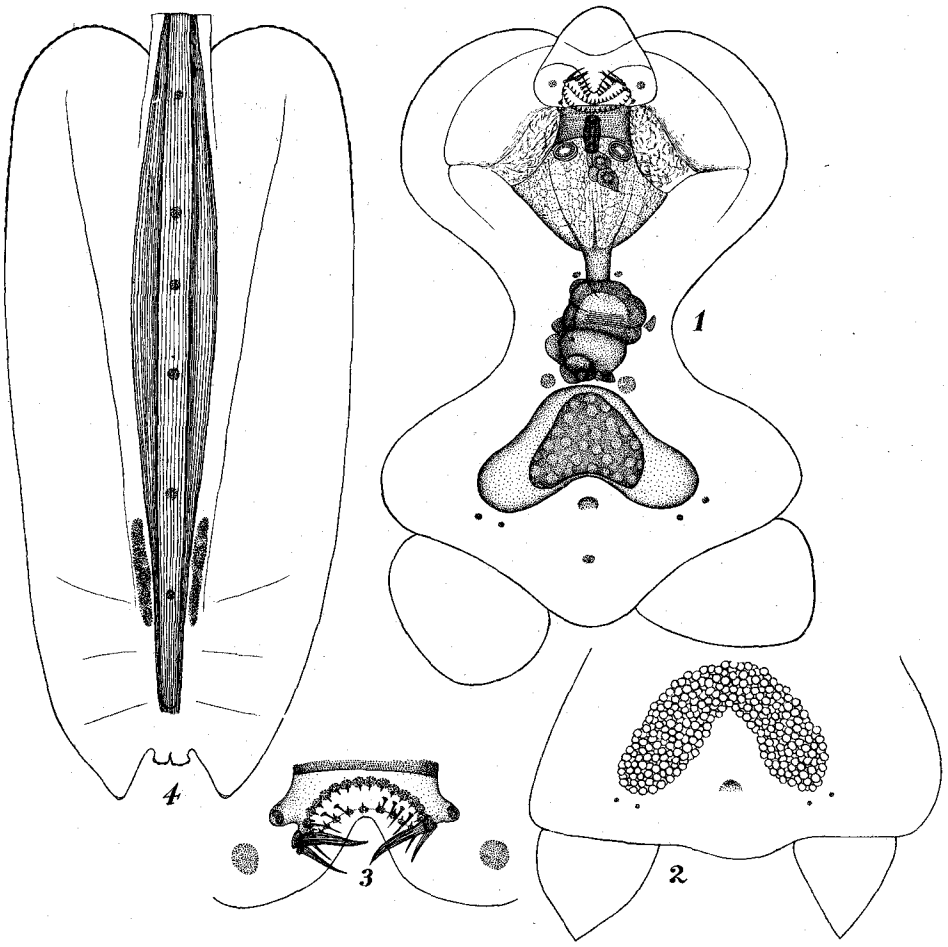

Fig. 10. *Frit. venusta.* 1 — Dorsal side of trunk, ×45; 2 — Posterior part of trunk, with truncate margin, ×45; 3—Mouth, ×150; 4—Tail, ×35.

described by him seems to be individuals with mature gonad but missing in the posterior prominences of the trunk and having imperfectly preserved tail. I prefer to call these two forms by the name of *Frit. venusta* on account of page priority.

Pharyngeal cells are usually four. Alimentary system has no glandular appendages. The posterior part of the trunk varies considerably in shape from triangular to nearly truncate. Two pairs of gland cells in the mouth part, one below the oesophagus and one behind the alimentary organ, a pair at each postero-lateral corner of the gonad and two median cells behind the gonad. Tail musculature three times as wide as chorda at the middle and with round nuclei arranged in a row. Chorda does not reach the posterior

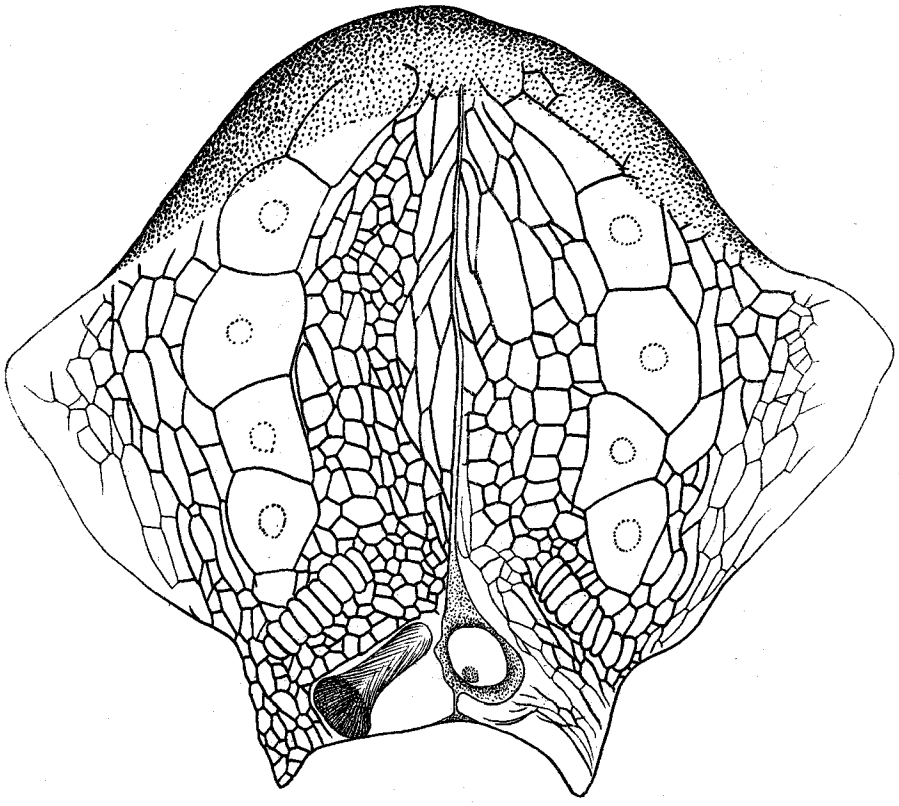

Fig. 11. *Frit. venusta.* Oikoplast epithelium, ×200.

end of the musculature. In finely preserved specimens an inconspicuous gland is observable on each side of the tail musculature near the posterior end.

B. CHAETOGNATHS

The following 14 species are found in the material:

1. *Sagitta enflata* GRASSI
2. „ *elegans* VERRILL
3. „ *bipunctata* QUOY et GAIMARD
4. „ *ferox* DONCASTER
5. „ *bedoti* BÉRANECK
6. „ *serratodentata* KROHN
7. „ *regularis* AIDA
8. „ *neglecta* AIDA
9. „ *crassa* TOKIOKA
10. „ „ f. *naikaiensis* TOKIOKA

11. *Sagitta delicata* TOKIOKA
12. „ *minima* GRASSI
13. *Pterosagitta draco* (KROHN)
14. *Krohnitta pacifica* (AIDA)

Sagitta enflata, Sag. bedoti, Sag. regularis and *Sag. minima* are common species. *Sag. crassa* f. *naikaiensis* is rather common in Maizuru Bay. *Sag. delicata* was observed in abundance in July once in that bay at St. 41. *Sag. serratodentata* is represented by f. *atlantica*.

Table 2. Population of chaetognaths. In six columns of the haul, the left sign indicates the frequency and the right one shows the quantity.
Frequency ● ··· 70 % +, ○ ··· 30 – 70 %, + ··· 30 % –.
Quantity ● ··· 30 individuals / a haul +,
○ ··· 10 – 30 individuals / a haul,
+ ··· 10 individuals / a haul –. (in offshore waters)

	April		July		September		Summary	
	Vertical haul	Superf. haul	Vertical haul	Superf. haul	Vertical haul	Superf. haul	Frequency	Quantity
Sagitta enflata	++		●○	++	●○	○+	●○+ ●+	○++ ○+
〃 *elegans*	++		++				+ +	+ +
〃 *bipunctata*	○+						○	+
〃 *ferox*			++		++		+ +	+ +
〃 *bedoti*	●+		●○	++	●+	++	●●+ ●+	○++ ++
〃 *serratodentata*			○+				○	+
〃 *regularis*			●●	++	●●	●+	●● ●+	●+ ●+
〃 *neglecta*			++	++	++		++ +	++ +
〃 *crassa*			++				+	+
〃 *crassa* f. *naikaiensis*	++	++		++			++ +	++ +
〃 *delicata*								
〃 *minima*	○+		●●		●○	○+	●○ ●○	●+ ○+
Pterosagitta draco			++				+	+
Krohnitta pacifica			○+		○+	++	○+ ○	++ +

I wish to refer here to specimens of *Spadella cephaloptera* BUSCH which were collected by Mr. I. YAMAZI in Nanao Bay on the coast of the Sea of Japan (Fig. 12). The formulae of these specimens are as follows:

Body length in mm.	Tail length in %	Hooks	Anterior teeth	Posterior teeth
2.5	52.3	8–9	3–3	1–1
2.7	55.4	8–8	2–2	0–0
3.0	51.2	8–8	3–3	1–1
3.0	48.6	8–8	3–3	1–1
3.0	48.6	8–8	3–3	1–1

There is no peculiarity in this table. There are, however, two points to be mentioned specially of these specimens: one is on the range of the lateral fin and the other on the shape of the seminal vesicle. The lateral fin begins at the tail septum in all Japanese specimens observed so far, while in the specimens from Nanao Bay the lateral fin begins at the anterior end of the seminal receptacle considerably in front of the septum. The seminal vesicle is roughly elliptical in outline in specimens hitherto collected from the Japanese waters, while the Nanao Bay specimens have the vesicle provided with a sharply pointed prominence protruded obliquely forward from the postero-lateral corner. These unmistakable characteristics seem to be sufficient to distinguish the present material as a special form of *Sp. cephaloptera*, although they scarcely deserve specific distinctions. I wish to name the present form f. *angulata* because of its angulated seminal vesicle.

II. FAUNISTIC

A. PELAGIC TUNICATES.

Most of the species described here are of warm oceanic species. *Oik. dioica* is abundant in inlet or stagnant waters. This was common in Maizuru Bay. The frequent occurrence of this species in the off-shore waters seems to be a characteristic of the appendicularian fauna in Japan Sea, differing from that on the Pacific Coast of Japan. The occurrence of *Oik. labradoriensis*, a cold water form, is a very interesting phenomenon, and will be referred to in the following chapter. Warm oceanic water appendicularians were much more abundant in July and September than in April, both in number of species and in individual numbers. Generally speaking, they are commoner in offshore waters than in costal or bay waters, although dense swarms of the species, such as *Frit. haplostoma*, may be found in coastal waters, and large but monotonic swarm of *Oik. dioica* occurs in the inlet waters. Appendicularians seem

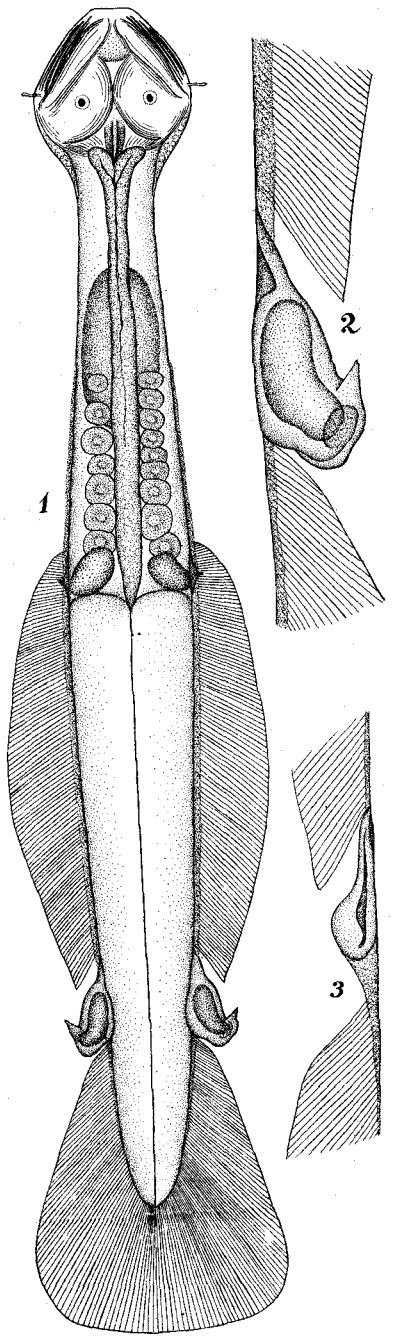

Fig. 12. *Spadella cephaloptera* f. *angulata* n. f. 1—Entire animal, dorsal, × 55; 2—Mature seminal vesicle, dorsal, × 150; 3—Immature seminal vesicle, dorsal, × 150.

to be scarce both in the superficial layer and in the depths. Twenty species were found in 38 vertical hauls, and 14 species in 80 superficial hauls and only 4 in two hauls below 150 m. Of course, the individual number decreases in parallel with the number of species, although there are considerable difference in the proportion of each species, between the superficial hauls and the vertical ones.

B. CHAETOGNATHS.

The same tendencies as shown in pelagic tunicates can be noticed also in chaetognaths. Most of the chaetognaths were of warm oceanic species. *Sag. elegans*, a cold water species, was found sparsely in the deep layer near the bank. In Maizuru Bay, *Sag. crassa* f. *naikaiensis* and *Sag. delicata* occur sometimes in a large number. *Sag. delicata* is the only chaetognath in the inner parts of several bays along the coast of Kii Peninsula, where *Sag. crassa* f. *naikaiensis* is entirely missing. It is a noteworthy fact that *Sag. delicata* and *Sag. crassa* f. *naikaiensis* occur in the same bay. This fact suggests that *Sag. delicata* does not represent a distinct species, but it is merely a form of *Sag. crassa*, standing in the same relation as f. *naikaiensis* with typical *Sag. crassa* which was recorded twice in the present material, in July at St. 2 and 3 near the bank. *Sag. delicata* is known also in Nanao Bay on the coast of Japan Sea. Chaetognaths were most abundant in July both in number of species and in individual numbers and least in

April. They are most numerous in the bay, because *Sag. crassa* f. *naikaiensis* and *Sag. delicata* are found there. They are scarce in the superficial layer and far less in the deeper layer below 150 m. Only 7 species occurred in the superficial hauls and 4 species in two hauls below 150 m. Of course, there are considerable differences, in the proportion of each species, between the vertical hauls and the superficial hauls.

III. SOME NOTES ON THE HYDROGRAPHICAL CONDITION AROUND THE BANK

There are two noteworthy findings among the present data. One is the occurrence of the cold water forms, *Oik. labradoriensis* and *Sag. elegans*, in the deeper water above the bank in April and July. Except one case in April, when *Sag. elegans* occurred in 50–0 m haul at St. 30, they were found below 150 m.

	April	July	September
Oik. labradoriensis	+	−	−
Sag. elegans	+	+	−

This fact seems to show the existence of the submerged cold current, probably the Liman Current, below the warm Tusima Current on the New Yamato Bank. The strength of this submerged cold current seems to be most vigorous in April reaching 50 m to the surface; it decreases somewhat in July and becomes very weak in September when the warm current is very strong and flows far into Maizuru Bay. The increase of the number of species in the bay in September indicates the strong influx of the oceanic water.

Another noticeable fact is the occurrence of *Sag. crassa* f. *typica* and f. *naikaiensis* and also of a considerable number of *Oik. dioica* in the offshore waters around the bank. These chaetognaths and appendicularian are known to live in Kiauchau Bay on the southern coast of Shantung Peninsula of North China, Yellow Sea, Southern and Eastern Coastal Waters of Tyôsen (=Korea). It is difficult to consider them to be originated from the coastal waters along the northern coast of Honsyû, for instances from Wakasa Bay or Maizuru Bay. It seems to be more probable that they are the drift forms carried from the coastal waters around Tyôsen. Thorough surveys extending from the New Yamato Bank to Tyôsen will be necessary to make out this point.

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NOTICES ON TABLES 3–6

In the column of species, the forms indicated with * are chiefly juvenile ones, the form with ** represents the smaller form and that with *** show the larger form.

Table 3. (Surface hauls)

April 26 – 28	Bay		Coastal Waters									Oceanic Waters												on Bank		Number of Stations Number/st.	
10 minutes haul (*5 min.)	1*	3*	8	9	11	13	14	15	16	16B	17	18	19	21	22	23	24	26	27	28	29	31	36	37	38		
Tadpole larva of Ascidians																											
Doliolum nationalis																											
Oikopleura longicauda			2			4	4	77	1	27	5	13	68	16	1	36	22	66	17	3	16	1	4	4	5	21	19
〃 *fusiformis*																											
〃 〃 f. *cornulogastra*																											
〃 *dioica*	12	3	9	6	1	4	2	1	2			1				2	1	5			2	1			1	16	3
〃 *rufescens*																											
〃 *cophocerca*													1													1	1
〃 sp.*																											
Megalocercus huxleyi																											
Stegosoma magnum																											
Pelagopleura sp.																											
Fritillaria haplostoma																											
〃 *formica*																											
〃 *pellucida*																											
〃 *borealis*																											
〃 〃 f. *sargassi-intermedia*																											
Appendicularia sicula																											
Sagitta enflata																											
〃 *bedoti*																											
〃 *regularis*																											
〃 *neglecta*																											
〃 *crassa* f. *naikaicnsis*														1												1	1
〃 *minima*																											
〃 sp.*													2		2											2	2
Krohnitta pacifica																											
Number of Pelagic Tunicates	12	3	11	6	1	8	6	78	3	27	5	14	69	16	1	38	23	71	17	3	18	2	4	4	6	5	
Number of Chaetognaths													2	1	2											Total	
Number of species	1	1	2	1	1	2	2	2	2	1	1	2	3	2	2	2	2	2	1	1	2	2	1	1	2		
(Mean)	1	(1)					2		(2)								5		(2)					2	(2)		

Table 4. (Surface hauls)

July 25 10 minutes haul (*3~5 min.)	Maizuru Bay						Coastal Wat.				Oceanic Waters									Stations on Bank						Number of Stations	Number/st.
	41*	42*	43*	44*	45*	46*	47*	48	49	50	53	54	19*	20	21	22	23	24	25	26	27	55	58*	57*	56*		
Todpole larva of Ascidians	1																									1	1
Doliolum nationalis																2	3	19				1			1	5	5
Oikopleura longicauda		2			6	1	4					4		3	4	2		2	2	5	3	2				13	3
〃 *fusiformis*		1		2	1	1	3		3	2	3	1	4	7	7	16	26	16	4	13	7	10	1	2	16	22	7
〃 〃 f. *cornutogastra*																											
〃 *dioica*	41	1	12	7	1		4			1	3	5	8	1	3	2		2				10		1	1	17	6
〃 *rufescens*																											
〃 *cophocerca*																											
〃 sp.*	1	1						1			2	4	3	4	1	3		1	1			1				12	2
Megalocercus huxleyi																											
Stegosoma magnum																											
Pelagopleura sp.																											
Fritillaria haplostoma																											
〃 *formica*																											
〃 *pellucida*																											
〃 *borealis*																											
〃 〃 f. *sargassi-intermedia*																						3				1	3
Appendicularia sicula											1	2	1					1								4	1
Sagitta enflata												1			1							1				3	1
〃 *bedoti*														1			1		1	1						4	1
〃 *regularis*													1													1	1
〃 *neglecta*																					1					1	1
〃 *crassa* f. *naikaiensis*	10	6	8	1						1	1	5	5									1				9	4
〃 *minima*																											
〃 sp.*														4					2							2	3
Krohnitta pacifica																											
Number of Pelagic Tunicates	43	5	12	9	8	2	11	1	3	3	9	16	16	15	15	25	29	41	7	18	10	27	1	3	18	Total 41	
Number of Chaetognaths	10	6	8	1						1	1	6	6	5	1		1		3	1	1	2					
Number of species	4	5	2	3	3	2	3	1	1	3	5	7	6	6	5	5	3	6	5	3	3	8	1	2	3		
(Mean)			6 (3)					5 (2)						11 (4)								10 (3)					

Table 5. (Surface hauls)

September 25–27	Maizuru Bay						Coastal Waters									Oceanic Waters							Stations on Bank							Number of Stations	Number/st.
10 minutes haul (* 5 min.)	32*	30*	1*	29*	2	28*	27*	3	4	5	26	7	8	25	9	10	24	23	22	21	11	12	20	13	14	15	16	17	18	19		
Tadpole larva of Ascidians																																
Doliolum nationalis																																
Oikopleura longicauda			2	5	5	2	3	7	11	8	1	11	10	2	3		1	7	5	1	11	8	10	15	9	9	27	9	33	4	27	8
〃 *fusiformis*	2		2				1	3	5		1	3	21	3				6	5	1	2	4		5		2	6		3	5	19	4
〃 〃 f. *cornutogastra*																										2	1	2			3	2
〃 *dikica*	1	1																													2	1
〃 *rufescens*	1									1		2	2	1	3	2	2	2	3	5		7		3	1	3	1	3	2	4	19	3
〃 *cophocerca*																						1									1	1
〃 sp.*						1					2	3		1	1	2	1	2	1	1		2	1	4	1		2	1		3	17	2
Megalocercus huxleyi																1	1											1			3	1
Stsgosoma magnum												1						1												1	3	1
Pelagopleura sp.																								1							1	1
Fritillaria haplostoma		38	9	81	2	7	26				3																				7	24
〃 *formica*																						3		1						1	3	2
〃 *pellucida*																								1		2					2	2
〃 *borealis*																																
〃 〃 f. *sargassi-intermedia*																																
Appendicularia sicula																																
Sagitta enflata				3							2				2			1	3	3		5	1	10			1			1	11	3
〃 *bedoti*												2																			1	2
〃 *regularis*	2			2				1		1				1	4	4		2	3	2	1	5	11	13	1	7	5	11	5	3	20	4
〃 *neglecta*																																
〃 *crassa* f. *naikaiensis*			1																												1	1
〃 *minima*													1	1	6				2	3		5		5			1	1		1	10	3
〃 sp.*						1						6			3	1	3	3	1	5	1	5		6	2	1		1	1	3	16	3
Krohnitta pacifica								1							1									2				1			4	1
Number of pelagic Tunicates	4	39	13	86	7	10	30	10	16	9	7	20	33	7	7	5	5	18	14	8	13	25	11	30	11	18	37	16	38	18	20	
Number of Chaetognaths	2		1	5		1		2		1	2	8	1	2	16	5	3	6	9	13	2	20	12	36	3	8	7	14	6	8	Total	
Number of species	4	2	4	4	2	4	3	4	2	3	5	7	4	6	8	5	5	8	8	8	4	10	4	12	5	7	8	9	5	10		
(Mean)			10 (3)							13 (5)									12 (7)							15 (8)						

Table 6. (Vertical hauls)

( ) indicates the depth in m.	April 26–28										July 25																								September 25–27												Number of Stations	Number/st.
	2	6 (50)	8	20 (50)	25 (150)	30 (50)	30 (150)	35 (50)	35 (150)	38 (150)	41	11 (75)	10 (150)	9 (150)	8 (150)	7 (150)	6 (150)	5 (150)	200–400	4 (150)	4 (350)	3 (150)	3 (350)	2 (150)	2 (350)	150–300	1 (150)	1 (350)	32 (10)	33 (50)	16 (150)	16 (350)	15 (150)	15 (350)	17 (150)	17 (350)	19 (150)	19 (350)		
Thalia democratica																							1																		1	1
Doliolum nationalis														2		2	6			3	7	2	1	7	1		1		1										1	12	3
Oikopleura longicauda		9	2	10	12	12	12	246	87	317		10	88	79	178	27	97	351		504	359	218	180	409	213	1	372	99	89	404	78	150	230	203	55	25	68	142	33	159
" *fusiformis*												1	18	14	3	1	14	16		17	6	29	12	26	44		46	21	2	104	12	31	26	35	4	6	3	8	24	21
" " f. *cornutogastra*																					3	3	7	8					4		2			1				7	4
" *gracilis*																						1		1			8	2		1	4		3		1	1		9	2
" *dioica*	7	3	1					9	2	6	26							1		3				4	1				110	2								10	3
" *rufescens*													1	1	1		1			13	2	34	31	49	49	1	15	7		44	15	33	17	21	11	4	1	1	21	17
" *parva*																				1	8		4	2	8			5		1			1		1			9	3
" *cophocerca*																		1		4	2	5		3	4		3			3		3	4	6			1	1	13	3
" *labradoriensis*							1		1	1																													3	1
" sp.*													1					3	1	2	9	6		24	14			5		12	6	7	16	14	2	5	1	7	17	8
Megalocercus huxleyi																							4	6	4														3	5
Stegosoma magnum																														4									1	4
Fritillaria haplostoma													1		1		2	1		7	9	4	4	5	2		22		331	619	10	4	38	22	2	1	1	4	20	38
" *magna*																								1															1	1
" *formica*														3		3	7	2		8	7	5	6	10	9		16	1		2	4	7	7	11		1	1	1	20	6
" *charybdae*																				1	2		1		1			1				1		2		2		4	9	2
" *pellucida*													37	105	1		13	7		8	26	18	12	33	30		41	11		10	14	6		20	4	6	3	6	21	20
" *borealis*												1		2			9	9		3	2	3	1	2	7		15			4	2	2	11	15				1	17	5
f. *sargassi-intermedia* **																																								
" " f. *sargassi* ***																						2	1														1		3	1
" *tenella*														1						42	94	36	43	142	111		133	57			8	15	7	12	5		4	2	16	45
" *venusta*																					4	2	1	14	14		3	5			9	10	6	5		1		2	13	6
" sp. *																			1	3	8	1		4	3			3		1		2	2	4				5	11	3
Appendicularia sicula													1																	1									2	1
Sagitta enflata								1	1			7	6	5	4		4	3		35	63	43	42	47	42		29	13	3	113	4	12	6	3	3	4	1	4	25	20
" *elegans*						2	1												1			1				1		2											5	2
" *bipunctata*		1			1	1																																	3	1
" *ferox*																					2					1												6	3	3
" *bedoti*		1	1		1	3	4	9	1	2		1	10	16	10	4	49	15	1	43	50	25	23	33	21	5	19	10		7	1	2	6	1	1		3	1	33	12
" *serratodentata*													2	1			2	1		1		1		1			1												8	1
" *regularis*												2	3	1		1	1	1		101	115	168	150	71	76	1	103	37		75	19	20	52	57	23	11	15	30	23	49
" *neglecta*														1							3	2	2				1						1						5	2
" *crassa*																							1	1															2	1
" " f. *naikaiensis*	66		1																										95										1	1
" *delicata*											216																													
" *minima*					1	1	5	10	9	4		10	73	130	91	7	53	96	1	233	248	301	320	348	164		285	53		11	4	13	8	29	9	13	4	2	30	85
" sp. *		2		1	1	1		10		8		1	3	1	4		7	18		13	11	10	2	10	16		9	5		3	5	1	6		3			6	26	6
Pterosagitta draco																											2												1	2
Krohnitta pacifica																	1				3	2			1		4	1	1	14	2	2	3		1			2	12	3
Number of Species	2	5	4	2	5	6	5	6	6	6	2	9	12	15	9	8	14	15	5	21	24	25	22	27	23	5	20	20	7	22	17	21	19	18	15	14	14	21	↑ in offshore waters	

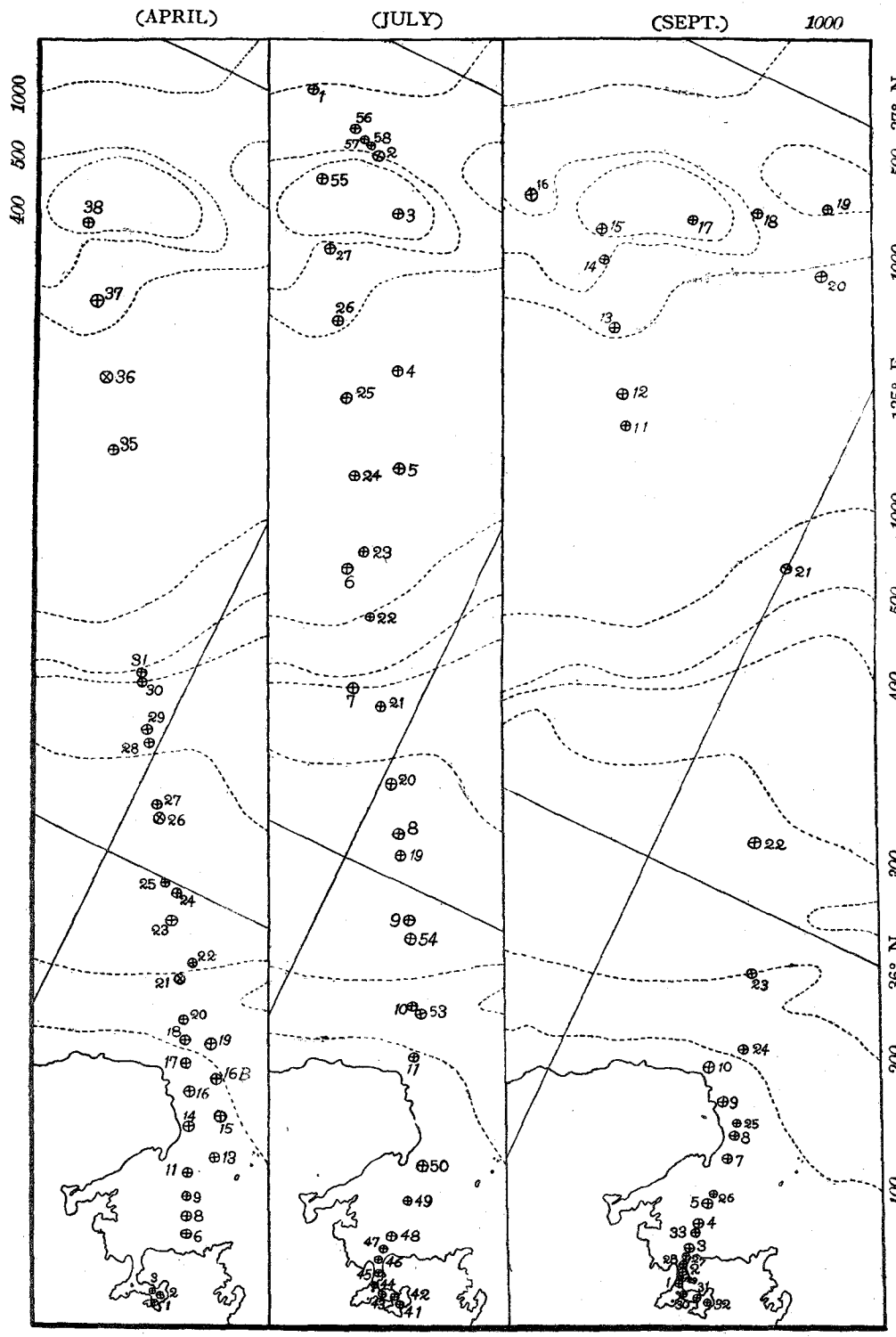

Chart 1. Map showing the stations.