

## Appendicularia of Japanese Waters.

By

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*With 4 plates.*

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On every opportunity I have had for visiting the sea coast during the last five years, I have devoted a part of my time to the collecting of Appendicularia. Up to date, I have found 12 species, 7 of which belong to the genus *Oikopleura*, 3 to *Fritillaria*, 1 to *Stegosoma*, and 1 to *Kowalevskia*. A majority of these are known species, but three species of *Oikopleura* and one of *Fritillaria* seem to be new to science.

It will not be superfluous, I think, to describe in the following all the species taken, though some of them are the same as Atlantic species and are fully described. The Copelata of the Pacific Ocean are poorly known to the world and slight differences may be found between the Pacific and the Atlantic forms which are nevertheless undoubtedly the same species.

Owing to the fact that nearly all of the older literature on Appendicularia are inaccessible to me, I am obliged to refer only to the monographic work of LOHMANN—"Die Appendicularien" (Ergebnisse der Plankton Expedition)—and FOL's "Appendiculaires du détroit de Messine" and have strictly followed LOHMANN's classification. J. E. W. IHLE's paper on the anatomy and sys-



tematic of Appendicularia (Academisch Proefschrift. Leiden, 1906) has also remained out of my reach, and I greatly regret that I have not been able to benefit by it.

As my observations have been made on preserved specimens, I am unable to give the description of the shape and structure of the so called "Haus," which is hardly preservable and can thus be studied on the living animal only.

Here I wish to express my hearty thanks to Prof. I. IJIMA of the Imperial University of Tokyo, under whose supervision my investigation has been conducted, and to Prof. W. E. RITTER of the University of California, who has favoured me with many valuable suggestions.

Genus **Kowalevskia.**

*Kowalevskia tenuis* FOL (1872).

Pl. I., figs. 1-4.

Endostyle wanting. Dorsal and ventral wall of branchial cavity have two rows of triangular plates running from mouth to œsophagus. Atrial canal short; its outer opening and spiracle are large, lenticular. Mouth with a ring-form, unbroken lip. Branchial portion of trunk strongly compressed dorso-ventrally and sharply distinguishable from swollen gastro-genital region. With hood arising from the dorsal side of gastro-genital region and covering anteriorly the dorsal surface of branchial region. Oikoplastic epithelium covering the dorsal side of branchial, and front side of gastro-genital, region and forming at the lateral



and ventral sides of trunk a narrow zone along the lip; it has a large vertical process at the dorsal middle portion.

This curious Appendicularian is not rare on our coast. I have found it always among the swarm of *Noctiluca*, mixed with *Fritillaria haplostoma*. It can be easily distinguished from other species by the characteristic wavy movement of its long tail.

This species was first described by FOL. LOHMANN also found it among the Appendicularia of the Plankton Expedition. His Atlantic specimens differed from FOL's Messina specimens in three points: 1, in the possession of hood; 2, in the three large glandular dermal cells—two on the right and left and one in the middle of the ventral side of branchial region; and 3, in the antero-ventral and postero-dorsal position of stomach and rectum, which in the Messina specimens are situated right and left. Nevertheless, LOHMANN considered his specimens to be of the same species as FOL's. He supposed the difference in the relative position of stomach and rectum to be due either to preservation or to the fact that his specimens were all young. The hood and the three gland cells he assumed to have been overlooked by FOL.

The Japanese form has a hood but no glandular cells. The stomach and rectum in all my preserved specimens agree as to position with FOL's description. As I did not get young specimens, I can not decide whether the dorso-ventral position of rectum and stomach is caused by preservation or is a larval character; but from the absence of the glandular cells, I am inclined to believe that our species is different from LOHMANN's, but is the same as FOL's. I agree with LOHMANN in assuming that FOL had overlooked the presence of hood.



Thus, in the genus *Kowalevskia*, two species are known: one described by FOL from Messina and found also in our coast, and another described by LOHMANN from the Atlantic Ocean and characterized by the possession of three glandular cells.<sup>1)</sup>

### Genus **Fritillaria.**

This genus is poorly represented on the Japanese coast. I have obtained only three species—*haplostoma*, *pellucida* and *sargassi*. All these species are always found in the swarm of *Noctiluca* together with *Kowalevskia*. Their occurrence, according to my experience, always alternates with that of the genus *Oikopleura*: when *Fritillaria* appears, *Oikopleura* diminishes in number, and in the great crowd of the latter, the former is not found at all.

#### 1. *Fritillaria haplostoma* FOL (1872).

Pl. I., figs. 5–8.

Trunk long, slender; lip well developed in dorsal portion; with a large ciliated fossa (olfactory organ according to FOL) on the right side near otocyst. Stomach anterior to, and intestine on the right of, rectum. Intestine with two large, spherical, blind sacs on the dorsal and ventral sides. Spiracle and outer opening of atrial canal large, lenticular. Ovary spherical;

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1) Whether or not the view of GARSTANG ('92) that the Appendicularia described by MOSS ('68) is a *Kowalevskia* and a species distinct from *K. tenuis*, may be left out of the present consideration.



testis large and elliptical; the two organs separated from each other by a wide intervening space.

The inner surface of the lip is provided with two rows of cilia and two large tactile cells. The first row of cilia forms a ring situated at the middle of lip (*cr.*, fig. 8, Pl. I.). The cilia themselves are placed on the apex of an annular membranous ridge, the height of which varies with the length of the lip and is highest in the dorsal part. The second row of cilia is found in the antero-dorsal portion of endostyle (*src.*, fig. 8, Pl. I.). The two tactile cells are on the dorsal lateral wall, in the same vertical plane as the second row of cilia (*ta.*, fig. 8, Pl. I.).

The cells of the wall of stomach project outward and make the surface of the latter quite uneven.

The tail is wide and gradually tapers to the end. Its musculature is narrow and in breadth scarcely surpasses that of chorda.

The average length of my larger specimens is  $1235\ \mu$  in trunk and  $2450\ \mu$  in tail. The widest part of the tail measures  $420\ \mu$  and that of its musculature  $10\ \mu$  across.

## 2. *Eritillaria pellucida* BUSCH (1851).

Pl. I., figs. 9-14.

Trunk with two large processes at the posterior end. Stomach and rectum in transverse position, the former to the left of the latter. Spiracle and outer opening of the atrial canal round and small. Tail bifurcated at the end, and with two pairs of large glandular cells on the front surface.



This is a stout species. It has many epidermal unicellular glands on trunk: on the dorsal side, there are one in the middle of the posterior margin of hood and four in a longitudinal row in the middle of genital region, the second one in this row being a multicellular gland (*dg.*, figs. 9, 11, 12, Pl. I.). On the ventral side, there are: a pair near the anterior end of endostyle; another pair in front of heart; three in a transverse row along the posterior side of the alimentary mass; and a patch of large glandular cells (branchial gland of SALENSKY<sup>1)</sup>) at the posterior end of endostyle, extending postero-laterally to the right spiracle (*bg.*, fig. 11. Pl. I.).

The lip is well developed and its ventral portion is divided by a median notch into two lateral lobes, which are thick and have each a vertical row of tactile cells (fig. 10, Pl. I.). A membranous ridge arises from each of these lobes. It runs along the inner side of lip, and meeting its fellow of the opposite side in the middle of the dorsal lip, forms a transverse velum, the free margin of which is ciliated (*rl.*, fig. 10, Pl. I.).

The endostyle is very slender and long and makes sharp bending at two places, so that it appears box-like in side view.

The stomach and rectum are spherical. The intestine is not distinct. The ovary is spherical and lies behind the stomach. The testis is large and long and extends between the rectum and the posterior end of trunk.

The largest specimen I have measured was 2066  $\mu$  long in trunk and 2766  $\mu$  long in tail. Maximum breadth of tail 1000  $\mu$ , and that of its musculature 266  $\mu$ .

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1) W. SALENSKY. Études anatomique sur les Appendiculaires. Mémoires de l'Académie Impériale des Sciences de St. Petersburg, 1904.



3. *Fritillaria Ritteri*, nov. sp.

Pl. II., figs. 12-17.

Trunk broad and flat. Ventral lip separated by a deep median notch into two lateral lobes, to which a thick protoplasmic mass protrudes from the anterior margin of oikoplastic zone. Spiracle and outer opening of atrial canal small and round. Ovary round, small, situated on the posterior left side of rectum. Testis very large, extending from the posterior right side of rectum to the end of trunk in L-like form, so that the whole mass of genital glands is somewhat T-shaped. Tail bifurcated at end; at its base two deep notches between axis and wings.

The trunk of this species is very broad and flat, its thickness being equal to about half the breadth. The dorsal lip has on the inner wall a transverse row of plasmatic cells corresponding in position to the outer ciliated zone of other *Fritillaria*, but no ciliary processes were visible on it. The lateral lobes of the ventral lip form a jaw-like process quite similar to that of *Fritillaria borealis* LOHM. The ciliated fossa or olfactory organ, situated to the right of otocyst, is small but distinct. The endostyle is thick anteriorly and curves upward. The stomach lies on the anterior left side of rectum. The intestine is a short canal on the dorsal side of rectum.

The tail is bifurcated at the end; its musculature is very wide. The anterior end of the lateral wing of tail is separated by a deep, narrow notch from the median stem.



This species closely resembles *Fritillaria sargassi* described by LOHMANN, especially in the T-shaped genital glands; but the following facts have induced me to create it into a distinct species: 1, the presence of deep notches at the base of tail; 2, the perfectly straight course of œsophagus, not so inclined as in *F. sargassi*; and 3, the swelling in a less degree of the lateral lobes of ventral lip.

The largest specimen in my possession measures in trunk  $909\ \mu$  and in tail  $1490\ \mu$  long. Greatest breadth of tail  $690\ \mu$ ; that of its musculature  $236\ \mu$ .

### Genus **Oikopleura**.

#### 1. *Oikopleura longicauda* VOGT (1854).

Pl. III., figs. 1-7.

Buccal gland<sup>1)</sup> and EISEN's oikoplast<sup>2)</sup> wanting. Blind sac of the left stomach large, finger-shaped and ascending along the posterior wall of œsophagus. Spiracle close to endostyle. Genital gland covers the lateral side of alimentary canal; ovary simple and flat; testis paired. Two hoods, dorsal and ventral, cover the anterior part of trunk. Tail with side musculature and without subchordal cells.

This species may be easily distinguished by its two hoods, which cover the anterior part of the trunk and extend to the mouth, when well developed. The dorsal one of them

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1, 2. About these terms see LOHMANN'S "Das Gehäuse der Appendicularien," 1899.



arises from the posterior dorsal margin of the oikoplastepithelium; the ventral one is much smaller and arises from the posterior ventral margin of the epithelium between the two atrial apertures (fig. 3, Pl. III.).

The oikoplast epithelium of the anterior part of trunk covers only a small anterior part of the alimentary canal. EISEN's oikoplast is wanting, and the epithelial cells of FOL's oikoplast<sup>1)</sup> are small and of a similar size.

The upper and lower lips of mouth, which is shifted nearly to the dorsal aspect of the trunk, have each a remarkable ciliated band. The upper band is longer and consists of two lateral parts which are connected by a median zone of smaller cells with shorter cilia. The lower band exhibits largest cells with longest cilia in the middle part (see *cd.*, *cv.*, fig 4, Pl. III.).

The spiracle lies close to the posterior end of the endostyle and anal papilla. The atrial canal is short. The right and left lobes of stomach are of a similar size and are connected with each other by their whole breadth. The posterior blind-sac of the left stomach is of a finger-like shape and ascends upward along the posterior side of oesophagus (*bl.*, fig. 2, Pl. III.). Gigantic glandular cells of stomach are arranged at the base of the left stomach in a single row, and two or three of them are found at the top of the gastric blind pouch and also at the base of the connecting portion of the left and right stomach (figs. 2 and 7, Pl. III.). Both the intestine and rectum are short.

Testis is paired and extends, when fully developed, to the lateral side of the alimentary canal. Its posterior part, lying behind the alimentary canal, is divided into numerous lobes. The

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1) See likewise LOHMANN, *l. c.*



ovary is single and flat; it covers the lower hind part of testis.

The tail has wide muscular bands. No subchordal cells are present. The average ratio of the length of tail to its greatest breadth is 4.8:1, and that of its greatest breadth to the width of the musculature is 1.75:1.

The largest specimen I have obtained was 1200  $\mu$  long in trunk and 4060  $\mu$  long in tail.

## 2. *Oikopleura fusiformis* FOL (1872.).

Pl. III., figs. 8-12.

Buccal gland wanting. EISEN's oikoplast present. Blind sac of the left stomach very large and extends upward and backward after departing from œsophagus. Right stomach small, continuous with the small anterior and upper part of the left stomach. Spiracles widely separated from the endostyle. Genital glands cover the lateral side of the alimentary canal. Ovary simple and flat; testis paired. Tail with narrow muscular coating and without subchordal cells.

The trunk is elongate and its upper margin is nearly straight. Mouth shifted to the dorsal aspect of trunk.

The oikoplast epithelium covers only the anterior branchial region of the trunk, the greater part of the alimentary canal being free from it (fig 8, Pl. III.). The EISEN's oikoplast is cruciform, composed of four cells (*pm.*, fig. 8). The endostyle is short and widely separated from the atrial canal.



The branchial cavity is narrow. The oesophagus is slightly curved and opens at the middle of the dorsal side of the large, triangular, left stomach. The right stomach is small and is connected to the upper small portion of the anterior part of the left stomach (*rs.*, figs. 9 and 11). A row of gigantic glandular cells is found along the base of the left stomach (fig. 10). The intestine is long and pushes the rectum anteriorly, bringing it out of contact with the stomach.

The testis is paired and rectangular in form. It covers the greater part of the lateral side of alimentary canal. The ovary is unpaired and lies at the back of testis.

The tail and its musculature are both narrow. No subchordal cells are present. The ratio of the greatest breadth of tail to that of its musculature is 2.2:1, and that of length of tail to its greatest breadth is 7:1.

The largest specimen obtained was 937  $\mu$  in length of trunk and 4012  $\mu$  in length of tail.

### 3. *Oikopleura megastoma*, nov. sp.

Pl. III., figs. 13-18.

Buccal gland wanting. EISEN's oikoplast present. Mouth very large; branchial cavity spacious. Blind sac of the left stomach small and obliquely ascending upward and backward; its base widely separated from the opening of oesophagus. Atrial canal wanting, being represented by a single external aperture of the branchial cavity, situated at the posterior end of the elongated endostyle. Genital glands covering the lat-



eral aspect of the alimentary canal. Ovary unpaired and flat; testis paired when young, but united to a single mass in older stages. Tail and its musculature broad. No subchordal cells present.

The wall of the trunk is thin, and the branchial cavity and the mouth are spacious so that the trunk has a cylindrical shape.

The oikoplast epithelium covers only the branchial portion of the trunk; the œsophagus, the stomach and the intestine lying entirely behind it. In the lateral oikoplast zone there is a group of remarkably elongate, obliquely arranged cells, and also another group of large cells directly above these (fig. 13). The endostyle is slender and long; its posterior end lies close to the anal opening.

The atrial aperture of this species shows a peculiar feature. There is no atrial canal, and the branchial cavity communicates directly with the external world by a single aperture. This aperture has on the anterior side a small semicircular notch, the margin of which is thickened by the presence of ciliated cells (fig. 18). As this ciliated notch is similar in structure to the spiracle or the inner opening of the atrial canal of other species, the single aperture may be considered to have been formed by obliteration of the atrial canal and by union of the spiracle and the outer opening of the atrial canal, the ciliated notch representing the remnant of the spiracle.

The œsophagus is strongly curved and forms a semicircle (figs. 13 and 16). The left lobe of the stomach is flat and rectangular. It has a short finger-like blind-sac at the upper posterior corner, which does not lie close along the œsophagus but is widely separated from it (*bl.*, fig. 13). A row of large



glandular gastric cells borders the posterior lower margin of the left stomach, extending from the apex of the blind-sac (fig. 14). The right stomach is much smaller and is connected to the left at the upper anterior portion of the latter, similarly to the stomach of *Oik. fusiformis* (fig. 16). The two lobes of the stomach are widely separated from each other. The intestine and rectum are slender and long.

The genital glands in the immature condition form a triangular mass, lying between the two lobes of stomach. The single ovary occupies the central parts and the testes the lateral parts of the mass (figs. 17 and 18). In a little later stage, both testes send out many lobes from their inner opposite faces. In still more advanced stages, these lobes subdivide into smaller lobes and present a complex acini-like form and then the boundary between the two testes can no longer be distinguished.

The ovary is always flat and covers the whole back of the testes. The mass of the genital glands, after advanced development, is of a shield-like form; its lateral portions are somewhat inflected anteriorly and cover the whole lateral surfaces of the alimentary canal.

The tail and its muscular coating are broad. No subchordal cells are present. The ratio of tail length to its greatest breadth is 4.2:1; that of its greatest breadth to the breadth of the muscle, 1.5:1,

The largest specimen I have obtained measured 3214  $\mu$  in trunk length and 10428  $\mu$  in tail length.



4. *Oikopleura microstoma*, nov. sp.

Pl. II., figs. 1-5.

Buccal gland wanting. EISEN's oikoplast present. Blind-sac of the left stomach large and finger-like, ascending upward along the posterior wall of œsophagus. Spiracle widely separated from the posterior end of endostyle. Genital glands cover the lateral side of alimentary canal; testis paired; ovary unpaired and flat. Tail with broad musculature, without subchordal cells.

This species resembles *Oik. longicauda* in the form of alimentary canal and reproductive organs, but is distinguished by possessing EISEN's oikoplast, by the absence of hood, by the larger size of the epithelial cells of the lateral oikoplast and by the wide interspace between the endostyle and the spiracle.

The oikoplast epithelium extends over the anterior half of the alimentary canal. The EISEN's oikoplast is very small and is composed of two oblong cells. The epithelial cells of the lateral oikoplast zone are large (fig. 1, Pl. II.).

The mouth is very small and the branchial cavity is narrow. The atrial canal is narrow and short. The spiracle is widely removed from the endostyle and the anal opening. The left lobe of stomach has a large finger-shaped blind-sac, which ascends along the posterior side of the œsophagus. The right lobe is nearly equal to the left in size and is connected with the latter by its whole breadth. The gigantic glandular cells of stomach are found at the bottom of the left lobe in a single row; three



or four of them also occur at the bottom of the connecting portion of the two lobes (fig. 4, Pl. II.). The intestine arises from the lower posterior corner of the right lobe. It is a short canal opening to the right posterior side of the rectum (fig. 4). In all my specimens of this species—only 2 in number—the outer wall of the right stomach lobe and of the intestine has a long narrow inner fold, which extends from the upper side of the stomach to the lower side of the intestine and is visible in surface view as a peculiar line (fig. 2). Whether the presence of this fold forms a peculiarity of the species or is due to artificial change, I can not determine on account of the scantiness of the material.

The testis is paired. It covers in advanced stages nearly one half of the lateral side of the alimentary canal, and that part of it which lies behind the alimentary canal, becomes divided into a number of lobes like those of *Oik. longicauda*. The ovary is single and flat, and covers the back side of testis.

The tail has a wide musculature, but is without subchordal cells. The ratio of tail length to its greatest breadth, and that of its greatest breadth to the breadth of the musculature are respectively 5 : 1 and 1.5 : 1.

The larger specimens measure 1800  $\mu$  in the length of trunk and 6250  $\mu$  in that of tail.

5. *Oikopleura cornutogastra*, nov. sp.

Pl. II., figs. 6-11.

Buccal gland wanting. EISEN's oikoplast present. Blind-sac of stomach long and large, ascending obli-



quely upward and backward; entirely separated from œsophagus. Right lobe of stomach large; intestine long. Spiracle separated from the posterior end of endostyle by a short interspace.

The oikoplast epithelium extends posteriorly over the anterior small portion of the alimentary canal. The EISEN's oikoplast is small. The epithelial cells of the lateral oikoplast are small and of a similar size; among them, a small number of the larger cells compose a round group above the EISEN's oikoplast (fig. 6, Pl. II.).

The most characteristic feature of this species is the large blind-sac of the left stomach (*bl.*, fig. 7-10.). It is of the form of an elongate cone whose base is distinctly separated from the œsophagus, and shows in side view, when combined with stomach, a shape something like that of a shoe. The right stomach lobe is large and trapezoidal; it is about as broad as the left lobe, with which it is continuous by the entire breadth (fig. 7). The large glandular cells of the stomach are arranged in a single row along the base of the left stomach and extend to the middle of the connecting portion of the two lobes (fig. 8, 10). The intestine is long, arises from the lower posterior region of the right stomach and opens on the right of the posterior portion of the rectum (fig. 8).

Nothing can be said at present about the genital organs of this species, as I have found in my single specimen only a residue of them, the contents being entirely lost.

The tail has a slender muscular coating. No subchordal cells are found in it. The ratio of the length of tail to its greatest breadth is 5:1, and that of the greatest breadth of tail to the breadth of the muscular layer 2.5:1.



The length of trunk in the only specimen I have obtained measured 1049  $\mu$  and that of tail 3148  $\mu$ .

6. *Oikopleura rufescens* FOL (1872).

Pl. IV., figs. 1-6.

Buccal gland and EISEN's oikoplast well developed. Lefts tomach without a blind sac. Right stomach with a small nipple-shaped blind-sac at its lower middle portion. Intestine very short; rectum vertically standing. Atrial cavity very long and its outer aperture shifted nearly to the posterior margin of stomach. Genital glands do not cover the lateral side of alimentary canal; ovary single and thick; testis paired. Tail with slender muscular coating and with one subchordal cell.

The dorsal side of the trunk strongly curves upward over the œsophagus, so that, when the genital glands are well developed, there is formed a deep notch on the dorsum.

The oikoplast epithelium covers nearly the entire alimentary canal. The epithelial cells of the lateral oikoplast zone are roundish and all of a similar size (fig. 1, Pl. IV.). The buccal gland is large and spherical. The EISEN's oikoplast is remarkably well developed. The endostyle is short and its posterior extremity is widely separated from the anal papilla and the spiracle. The branchial cavity is narrow. The atrial canal is very long, its outer aperture lying near to the posterior margin of stomach.

The left stomach is circular and has at its posterior and



lower margin a row of gigantic glandular cells. The connecting portion between the right and the left stomach is spaceous and forms a distinct part of the stomach; it has three or four glandular cells at the bottom (*eps.*, figs. 2 and 5, Pl. IV.). The right stomach is large and may be divided into two portions, an anterior and a posterior. The anterior portion has a small roundish blind-sac on the lower side (*br.*, fig. 2). The posterior portion is not so spaceous as the anterior; the short intestine begins from its lower portion and runs directly inward to open into the round rectum, which stands vertically to the body-wall.

The Atlantic form of this species is said to have two median ovaries, but the majority of our form has a single ovary (fig. 4). Only one specimen out of the six I have had showed two ovaries. In advanced stages, the single ovary develops to a thick mass, wedging in between the two lateral testes (fig. 5). The testes are thick; the right one extends a little over the posterior portion of the right stomach (figs. 2 and 5), while the left one never extends over the lateral surface of the alimentary canal. This characteristic feature of the testes may be observed even in the very early stage of their development (fig. 4).

The tail is broad with a narrow muscular coating. It has one subchordal cell on the right side of the chorda.

The ratio of the length of tail to its greatest breadth is 5.8:1; that of the greatest breadth of tail to the width of musculature, 2:1.

The length of trunk in the largest specimen measures 1250  $\mu$  and that of tail 6875  $\mu$ .

Beautifully colored specimens apparently belonging to this



species, were often obtained. The tail contains a dense connective tissue, which is of a violet color along the margin and red in the middle of tail. The trunk is pale red. The paired ovary and testes are inclosed in a gelatinous substance. The subchordal cell of the tail I have failed to see, perhaps because of its being hidden by the thick connective tissue. In view of the identity in all other important characters, those individuals undoubtedly belong to this species and are probably to be considered to represent a variety of it.

7. *Oikopleura dioica* FOL (1872.).

Pl. IV., figs. 7-11.

Buccal gland and EISEN's oikoplast present. Œsophagus opens to the left stomach at the posterior upper corner; without diverticulum to stomach. Ovary and testis in different individuals. Tail with two subchordal cells and narrow muscular layer.

The oikoplast epithelium extends over the anterior half of the alimentary canal (fig. 7, Pl. IV.). The cells of the lateral oikoplast zone are large and spherical. The buccal gland is very small. The EISEN's oikoplast is large and circular, composed of four large cells. The endostyle is short; its posterior end situated in the neighborhood of spiracle.

This is the only species in my collection, in which I have observed the interposed layer<sup>1)</sup> in the 'Hausanlage.' It is represented by small dots arranged in five distinct rows, similarly on both sides of the trunk (fig. 9, Pl. IV.).

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1) "Einlagerung" of LOHMANN.



The left stomach is quadrate and joins the right stomach by its entire breadth. The œsophagus opens into it at the upper posterior corner. The œsophageal wall gradually passes into that of the stomach, which produces no diverticulum behind (fig. 7 and 9). The right stomach is larger than the left and may be divided into an anterior and a posterior portion. The former has a nipple-like diverticulum on the lower side; the latter expands into a spacious chamber behind the opening of the intestine (fig. 8). The intestine is short and arises from the lower anterior part of the posterior portion of the right stomach; it bends inward to join the short rectum at the lower side of the posterior end of this (fig. 10). A row of large glandular cells is found along the posterior and lower side of the left stomach (fig. 10); three or four more cells lie on the bottom of the right stomach diverticulum (*br.*, fig. 8).

The ovary or the testis, when fully developed, is hemispherical; both are always hollow in the central parts. Neither gland extends over the lateral surface of the alimentary canal, only covering to a small extent the posterior portion of the right stomach (fig. 8).

The tail and its musculature are both slender. Two subchordal cells, separated from each other, lie to the right of the chorda. The ratio of the length to the greatest breadth of tail is 6 : 1; that of the greatest breadth of tail to the width of musculature, 3.1 : 1.

The length of trunk in the largest specimen reaches 1111  $\mu$ , and that of tail in same, 3888  $\mu$ .

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The last two species, *Oikopleura dioica* and *rufescens*, make up a well circumscribed group within the genus *Oikopleura*. Dr. LOHMANN recognizes them as a group characterized essentially by the possession of a buccal gland, by the genital glands not extending over the lateral side of the alimentary canal, and by the absence of the blind-sac of the left stomach. Besides, there exists between the two species another common character which was not mentioned by him, viz., the presence of a small diverticulum on the right stomach lobe. As none of other known species of *Oikopleura* have this blind sac, it may be denoted as an important character of the small group in question.

### Genus *Stegosoma*.

*Stegosoma magnum* LANGHS. (1880.).

Pl. IV., figs. 12-17.

Stomach separated into two portions, left and right. Left portion large, connected to the right by a very narrow and short tube. Œsophagus opens at this connecting portion. Genital glands flat and thin, covering the upper and lower sides of alimentary canal. Ovary single; testis paired. Tail with narrow musculature and with a row of subchordal cells to the right of chorda.

The trunk is elongate and laterally compressed. The oikoplast epithelium covers only the branchial region and the entire alimentary canal is free from it (fig. 16, Pl. IV.). The buccal gland is small. The EISEN's oikoplast is well developed. The



epithelial cells of the lateral oikoplast zone are of various shapes and take a characteristic arrangement (fig. 16, Pl. IV.). The endostyle is short and widely separated from the anus and atrial canal.

The oesophagus is short and opens into the connection between the two lobes of stomach. The left stomach is large and triangular in shape, entirely encircled by a row of gigantic glandular cells (*ls.*, fig. 16, Pl. IV.). The right stomach is smaller and of a rectangular shape; it has the row of glandular cells at the anterior margin (*rs.*, fig. 12, Pl. IV.). The intestine is long and large, makes a right angle with the right stomach and opens at the posterior end of rectum on the right side.

The reproductive gland, in its early stage, is represented by a small patch between the two lobes of stomach. In later stages, it extends both anteriorly and posteriorly, and assumes a narrow ribbon-like form (fig. 14, Pl. IV.). After reaching its full length, the organ is broadest at its dorsal and ventral ends, and completely covers the alimentary canal on the upper and lower sides, so that this can not now be traced without dissecting (fig. 13, Pl. IV.).

The tail has a narrow muscular coating. It has many sub-chordal cells on the right side of the chorda, arranged in a single row with regular intervals. In all my specimens I have found a group of peculiar flat cells at the top of tail on both the dorsal and ventral surfaces. (fig. 15, Pl. IV.). The ratio of the length of tail to its greatest breadth is 5,5:1; that of the greatest breadth of tail to the width of its muscle, 2,1:1.

The specimen with the genital gland in the most advanced state of development has trunk-length of 1388  $\mu$  and tail-length of 5111  $\mu$ . One specimen which had lost the anterior half of its



trunk, had a tail of  $1323,5\ \mu$  length; the trunk in this specimen must have been at least  $3781\ \mu$  long by estimation.

*Remarks on the occurrence of Appendicularia  
in Japanese waters.*

The most common species on our Pacific coast are *Oik. longicauda*, *Oik. dioica* and *Oik. fusiformis*. These are found almost in all seasons and in every part of the coast. As they have been all recorded from the coast of Chili, a very wide range of distribution should be attributed to them in the northern as well as the southern Pacific.

*Kowalevskia tenuis* and *Fritillaria haplostoma* are also common visitors to the Pacific coast of Japan. They are both found during summer in the swarm of *Noctiluca*, and when this disappears, they disappear also.


*Frit. pellucida* always accompanies *Frit. haplostoma*, but is far less abundant than this species.

*Oik. rufescens* and *Stegosoma magnum* occur among the oceanic plankton organisms that approach our coast in mid-summer and early autumn. Once in the summer of 1897, to my own experience, an exceptionally great swarm of *Oik. rufescens* invaded the harbour of Misaki after a strong southern wind, thickly becrowding the surface water all over with the cast-off "houses."

*Oik. megastoma* is a rare species. It occurs simultaneously with *Stegosoma magnum*. Of *Oik. microstoma* I have obtained only two specimens, and of *Oik. cornutogastra* a single specimen in the Misaki harbour. Of *Frit. Ritteri*, two specimens were all that I obtained on the western coast of Kiushu. All these species therefore seem to be quite rare in the Japanese waters.



Even the most common species as *Oik. longicauda* can not be taken at all times throughout the year. Sometimes, especially in the cold season, when the north wind, i. e., the wind to seaward, predominates, the Copelata and other oceanic plankton fauna, if found at all, are exceedingly poor along the Pacific coast. It is always the south wind that brings them there. It is in summer, when that wind prevails and the Black Current sweeps nearer the land than in other seasons, that the Copelata are most richly represented along the Pacific coast of Japan.





## Explanation of Plates.

Abbreviations common to all figures.

<i>am.</i> .....	Fol's oikoplast.	<i>ia.</i> .....	Spiracle.
<i>an.</i> .....	Anus.	<i>l.</i> .....	Lip.
<i>ah.</i> .....	Anlage of 'Haus.'	<i>ll.</i> .....	Lobes of lip.
<i>ap.</i> .....	Anterior portion of the right lobe of stomach.	<i>ls.</i> .....	Left lobe of stomach.
<i>bl.</i> .....	Blind-sac of the left lobe of stomach.	<i>o.</i> .....	Ovary.
<i>br.</i> .....	Blind-sac of the right lobe of stomach.	<i>oa.</i> .....	Outer atrial aperture.
<i>bs.</i> .....	Blind-sac of intestine.	<i>oes.</i> .....	Oesophagus.
<i>cd.</i> .....	Ciliated band of the dorsal lip.	<i>oi.</i> .....	Oikoplast epithelium.
<i>cf.</i> .....	Ciliated fossa.	<i>ot.</i> .....	Otocyst.
<i>cn.</i> .....	Chorda nuclei.	<i>pm.</i> .....	Eisen's oikoplast.
<i>cps.</i> .....	Connecting portion of the two lobes of stomach.	<i>pp.</i> .....	Posterior portion of the right lobe of stomach.
<i>cr.</i> .....	Ring of cilia on the inner wall of lip.	<i>pt.</i> .....	Protoplasmic mass in the lateral lobe of ventral lip.
<i>cv.</i> .....	Ciliated band of the ventral lip.	<i>r.</i> .....	Rectum.
<i>dg.</i> .....	Epidermal gland of the dorsal surface.	<i>re.</i> .....	Transverse row of plasmatic cells.
<i>dv.</i> .....	Dorsal hood.	<i>rl.</i> .....	Ridge of lip.
<i>e.</i> .....	Endostyle.	<i>rs.</i> .....	Right lobe of stomach.
<i>eg.</i> .....	Buccal gland.	<i>s.</i> .....	Stomach.
<i>h.</i> .....	Hood.	<i>sc.</i> .....	Subchordal cells.
<i>he.</i> .....	Heart.	<i>src.</i> ... ..	Second row of cilia on top of endostyle.
<i>i.</i> .....	Intestine.	<i>t.</i> .....	Testis.
		<i>ta.</i> .....	Tactile cells.
		<i>vg.</i> .....	Epidermal glands of the ventral surface.
		<i>vv.</i> .....	Ventral hood.





Aida, T. 1907. "Appendicularia of Japanese waters." *The journal of the College of Science, Imperial University of Tokyo, Japan = Tokyo Teikoku Daigaku kiyo*. Rika 23, 1-25.

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