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APPENDICULARIANS OF THE JAPANESE ANTARCTIC RESEARCH EXPEDITION

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EKMAN described in 1935 the peculiarities of Antarctic fauna in his book "Tiergeographie des Meeres", comparing them with those of the Arctic fauna. Throughout both the littoral and pelagic faunas, the Antarctic fauna is generally much richer than the Arctic one; the poorness of the Arctic fauna is considered to be partly attributable to the closed topography of the Arctic basin, but essentially, probably, to some unknown factors which might prevent the faunal development in the Arctic region, while the Antarctic fauna contains much more endemic species in addition to the abundant warm-water species which are evidently carried there from the adjoining antiboreal~south temperate regions and the richness of the Antarctic endemic species very possibly originated in the south temperate fauna might be due to some historical causes.

As to the Antarctic appendicularians, he wrote that there were known seven endemic species and 10–12 warm-water species in the Antarctic waters to that date and introduced the results of LOHMANN's work (1930) that, in the Weddell Sea, the Antarctic endemic species were confined to the upper 100 m layer with the temperature lower than –1.7°C, while the warm-water species were found in the lower layer deeper than 100 m and with the temperature slightly higher than the surface layer, up to 0.75°C. It is impossible, however, that such distributions are wholly attributable to the difference of temperature, because some Antarctic endemic species may sometimes be distributed far north to the West Wind Drift and moreover the temperature difference between these two layers is too small to be regarded significant in usual cases.

So far as I am aware, there are only three appendicularians known from the Arctic and subarctic waters. They are:

1. *Oikopleura* (*Vexillaria*) *vanhöffeni* LOHMANN, 1896
2. *Oikopleura* (*Vexillaria*) *labradoriensis* LOHMANN, 1892
3. *Fritillaria* (*Eurycercus*) *borealis* f. *typica* (LOHMANN), 1900

The distributions of the last two species may extend south to the mixing area of the

boreal water with the warm water, while the frequent and dense occurrences of the first one are usually confined to the northern subarctic and the high Arctic waters.

Against such a poor appendicularian fauna of the Arctic waters, the Antarctic waters seem to hold a much richer appendicularian fauna. Nine species were recorded or described during the years from 1905 to 1928.

1. *Oikopleura* (*Vexillaria*) *gaussica* LOHMANN 1905
2. *Oikopleura* (*Vexillaria*) *valdiviae* LOHMANN 1905
3. *Oikopleura* (*Vexillaria*) *drygalski* LOHMANN 1926
4. *Oikopleura* (*Vexillaria*) *weddelli* LOHMANN 1928
5. *Pelagopleura australis* (BÜCKMANN) 1924
6. *Pelagopleura magna* LOHMANN 1926
7. *Fritillaria* (*Acrocercus*) *antarctica* LOHMANN 1905
8. *Fritillaria* (*Acrocercus*) *drygalski* LOHMANN 1924
9. *Fritillaria* (*Eurycercus*) *borealis* f. *typica* (LOHMANN)

The last one shows bipolar distribution, but the distributions of the other eight are confined to the south polar seas. Some investigators consider the eighth species, *F. drygalski*, to be synonymous with *F. aequatorialis*. If this is true, then *F. drygalski* is nothing but only a warm-water form that penetrated into the Antarctic waters, and thus the Antarctic endemic species must drop to eight. All the four oikopleurids belong to the *labradoriensis*-group and moreover they resemble one another very closely, presenting themsveles as material to support CHUN's bipolar theory. On the other hand, two Pelagopleuras and *F. antarctica* LOHMANN are quite unique to the south polar seas. LOHMANN and HENTSCHEL (1939) recorded the names of seven more new Antarctic endemic oikopleurids without giving descriptions or figures. These are *Oikopleura falklandica*, *O. frigida*, *O. magellanica*, *O. meteori*, *O. oblonga*, *O. rigata* and *O. simplex*. These are invalid and nothing is known about their systematic affinities. The only thing certain is, however, that the Antarctic oikopleurids seem to show much more extensive variability than the Arctic oikopleurids, although there remains a serious question whether LOHMANN's four described Antarctic oikopleurids are nothing but merely variants of one or two distinct species. For instance, UDVARDY (1958) found only O. *valdiviae* (49°9′–65°49′ S) and *O. fusiformis* (to 61°29′S) in the samples collected in the Antarctic waters south of 60°S during the Swedish Antarctic Expedition. This shows that only a single form of LOHMANN's four species was found in the material. I had a chance to examine several plankton samples collected in the pack ice area of the Antarctic waters and found the following nine appendicularians in them.

1. *Oikopleura* (*Vexillaria*) *gaussica*
2. *Pelagopleura magna*

3. *Sinisteroffia scrippsi* TOKIOKA, 1957
4. *Fritillaria* (*Acrocercus*) sp.
5. *Fritillaria* (*Acrocercus*) *formica* FOL, 1872
6. *Fritillaria* (*Acrocercus*) *antarctica*
7. *Fritillaria* (*Eurycercus*) *borealis* f. *typica*
8. *Fritillaria* (*Eurycercus*) *tenella* LOHMANN, 1896
9. *Kowalevskaia tenuis* FOL, 1872

Of these, 5, 8 and 9 are evidently warm-water species. The occurrence of *Sinisteroffia* is the second record of the species which was previously collected in the HUMBOLDT Current off Peru, and thus it is uncertain whether this species is an Antarctic form. The fourth form, *Fritillaria* (*Acrocercus*) sp. resembles *F. haplostoma* very closely, but it is very unique in having two very remarkable gland cells only on the right side of the tail fin. Thus it is very possible that this is a distinct form characteristic to the Antarctic waters. Thus, four to five Antarctic endemic appendicularians were found in the samples I examined. However, the material includes only a single Antarctic oikopleurid. This resembles the result of UDVARDY's study. But, after all it is still evident that the Antarctic seas include more species of appendicularians than the Arctic waters and that the Antarctic oikopleurids might show an extensive variability. Then, what is the reason why more species of appendicularians or an extensive variability are found in the Antarctic waters?

In 1922, ESSENBERG described 30 new species of appendicularians from the coastal waters near San Diego, southern California; most of them were of the genus *Fritillaria*. However, none of these newly established fritillarians has ever been accepted as a distinct species with certainty, rather 24 of them may be considered merely as variants of two already known species, *F. haplostoma* and *F. borealis*. The extensive range of variations found in *F. borealis* was studied in detail chiefly by LOHMANN, and the remarkable variability of *F. haplostoma* is also guessed through the frequent occurrences of *Fritillaria abjörnseni* and *Fritillaria arafoera* in the neritic waters. The area where ESSENBERG collected her samples is effected by the southward flowing California Current and the northward flowing narrow DAVIDSON Current bordering the coast, and the two currents change their strength from time to time, besides the offshore oceanic water and some upwelled water may join there at times and make the environment of the area very complicated. And it is very possible that this circumstance may be responsible for the so variable morphological modifications found on those two fritillarians.

The Antarctic seas are opened widely to the southern parts of the three oceans; this is the most remarkable and at the same time the important-most difference

between the Arctic and the Antarctic waters. Of course, theoretically the Antarctic water mass might be separated from the northern antiboreal water masses by the polar front or the Antarctic convergence and also more or less by the West Wind Drift, when the discussion is confined to the surface layer of the waters. The polar front is, however, much less remarkable in the southern hemisphere and the West Wind Drift is not so effective in keeping the Antarctic water mass separated from the northern warmer water masses as the remarkable Gulf Stream and the Kurosio in playing the rôle of the barrier between the subarctic waters and the boreal waters in the two oceans. Moreover, there is a circumpolar cyclone zone of the Antarctic front ranging from 50° to 60° S and cyclones may serve to mix not only the surface water of the Antarctic seas and that of the antiboreal waters of the three oceans, but also the surface and deep water near the central areas of cyclones, accelerating the Antarctic divergence. This may result in the remarkable enrichment of the Antarctic waters leading to the abundant occurrences of Krill and then to the heavy catches of whales (BEKLEMISHEV 1958 and 1960) and at the same time the very southerly penetration of warm-water species. For instance, LOHMANN (1928) listed 17 warm-water appendicularians found in the Antarctic waters.

1. *Oikopleura longicauda*
2. *O. parva*
3. *Stegosoma magna*
4. *Folia gracilis*
5. *Fritillaria haplostoma*
6. *F. abjörnseni*
7. *F. aberrans*
8. *F. formica*
9. *F. fraudax*
10. *F. pellucida*
11. *F. megachile*
12. *F. tenella*
13. *F. scillae*
14. *F. venusta*
15. *F. borealis* f. *allongata*
16. *Appendicularia sicula*
17. *Kowalevskaia tenuis*

Thus, the cricumstances of the Antarctic seas seem to be rather variable and resultantly an extensively variable morphological modification may be expected in some appendicularians inhabiting there. Further, this might lead to the differentiation of much more species of appendicularians in the Antarctic than in the Arctic waters in the span of a so long time in the history of this animal group. In conclusion, the rich Antarctic pelagic fauna seems to be attributable to the rather variable state of the waters maintained for a long historical age and caused by the charactersitic topography of the Antarctic continent, the hydrographic condition around it and also by the existence of the cyclone zone of the Antarctic front.

There is another strange phenomenon about the Antarctic appendicularians. This concerns the distributions of two warm-water oikopleurids, *Oikopleura* (*Coecaria*) *longicauda* VOGT and *O.* (*C.*) *fusiformis* FOL. In the southern Atlantic

south of ca. 10°S, the distribution of *O. fusiformis* is seen along the continents, although the edge of the dense distribution reaches 50°S; while the southern limit of dense occurrences of O. *longicauda* is confined to the north of the 18°C isotherm and the distribution is limited by the 15°C isotherm (LOHMANN and HENTSCHEL 1939). UDVARDY (1958) records that *O. longicauda* occurred during the Swedish Antarctic Expedition 1901–03 most commonly between 38°50'N and 43°52'S, while *O. fusiformis* was found between 35°5'N and 61°29'S. Nevertheless, LOHMANN's records of appendicularians in the Antarctic waters shown in his paper of 1928 include only *O. longicauda*, but no *O. fusiformis*. Very probably this contradiction is due to the relative situation of the area of the frequent occurrences of heavy cyclones against the distribution of the dense population of *O. longicauda*.