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On the Distribution of the Pelagic Amphipod, *Cyphocaris challengeri* (Gammaridea: Lysianassidae) in the Western North Pacific

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서부 북태평양에 있어서의 부유성 단각류 *Cyphocaris challengeri*의 분포에 관하여

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적 요

*C. challengeri*는 아한대수의 전형적인 부유성 단각류로써 서부 북태평양의 40°N 이북인 오야시오 수역에 널리 분포하고 있으며, 이 해역의 중심층 동물플랑크톤 생물량의 큰 비중을 차지하고 있다.

본종은 구로시오 본류 이남이나 북태평양 중앙 수역에 가끔 출현하여 그 분포의 남한이 재검토 되었다.

한편 본종의 수직분포와 생물량의 일주수직이동도 아울러 검토되어 35—1,750m 사이에 서식하고, 주간에는 180—280m, 야간에는 35—100m에서 성군을 함을 알았다. 또 250m의 범위를 수직이동하여 상부의 유기물질을 심부로 수송하는 역할을 맡고 있다.

본종의 남하는 아한대중층수의 이동에 따르며 분포의 환경요인은 수온(10°C 이하)과 염분도(34‰ 이하) 임을 밝혔다.

INTRODUCTION

The most common mesopelagic gammaridean amphipod in Subarctic Water of the North Pacific is *Cyphocaris challengeri* (Stebbing, 1888). Its variation and distribution in the Northeast Pacific has been recently discussed by Bowman (1967). In the western North Pacific its occurrence had been reported by Birstein and Vinogradov (1955, 1958), who provided a map showing its worldwide distribution. Nagata (1963) first reported its presence at Japanese Trench.

Since 1966, the author and his colleagues have been carrying an extensive macroplankton survey in the western North Pacific. While examining samples, it was found that a considerable numbers of *C. challengeri* was present and it consists a main part of mesopelagic zooplankton biomass in Oyashio waters.

The present paper deals with the horizontal distribution, vertical distributional and migrational patterns of *C. challengeri* in the western

North Pacific. The submergence of *C. challengeri* related with the Subarctic Intermediate Water is also discussed here.

MATERIALS AND METHODS

Material was collected with ORI-100 net in sixteen cruise (Table 1) made by R/V Tansei-Maru and Hakuho-Maru of the Ocean Research Institute, University of Tokyo, Japan.

ORI-100 net is cylinder-conical net with an openinig 160cm in diameter and 750cm long; filtering section is made of Cremona netting with 0.1mm mesh-opening (Omori, 1965). The net was towed horizontally and obliquely with ship's speed of 2 knots. The course of the net in the water was directly recorded with TS depth-distance recorder (Omori, Marumo, and Aizawa, 1965), and the volume of water filtered by the net was measured by means of flow-meter. The samples were collected different times of day and night.

All zooplankton materials were preserved in 10% seawater-formalin solution on shipboard and brought back to the laboratory. In the laboratory, the samples were splited into smaller subsamples by means of a modified Folsom splitter. Generally, 1/2 or 1/4 of the original sample was sorted. Then, amphipods were identified and counted. Body length measurement of the animal was made from dorsal view; from the anterior margin of the head (excluding the antennae) to the anterior margin of the head (excluding the antennae) to the urosome (including uropods), with the animal in an extended position. The biomass, wet weight in g/1000m^3, of the animal was measured to the nearest 1/10mg. The preserved specimen was placed on filter paper just before it was weighed to remove excess water.

RESULTS AND DISCUSSION

(1) Horizontal distribution of *C. challengeri*

In horizontal distribution studies 70 positions were selected, mainly based on 2,000m oblique tows of ORI-net which the net reaches over 500m to 1,000m. Figure 1 shows the horizontal distribution of *C. challengeri* in the western North Pacific. *C. challengeri* has been found only in the area north of the Kuroshio main current as far as the surface collection was concerned.

In KT-66-20 cruise (October, 1966), one specimen of *C. challengeri* was sampled at St. 197-1 (35°16.5N, 142°21.8E) by a 750-0m vertical tow with ORI-200 net. This was the first collection of *C. challengeri* in the southern area of the Kuroshio main current. Thereafter

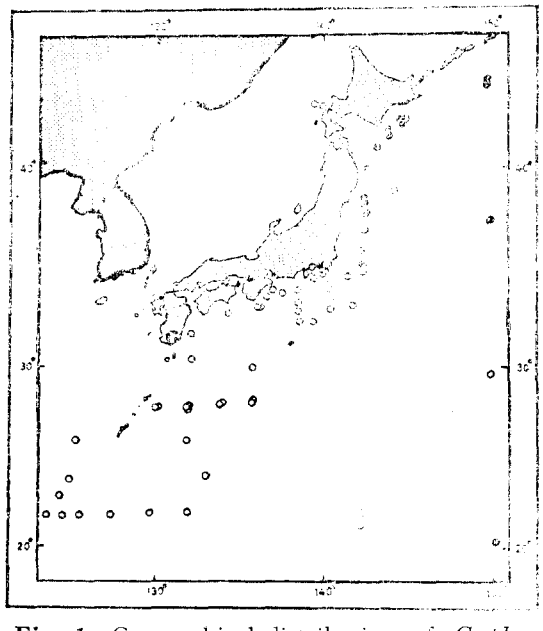

Fig. 1. Geographical distribution of *Cyphocaris challengeri* in the western North Pacific Ocean.

in KH-67-3 (December, 1967), three specimens of *C. challengeri* were cau ght at St. H12-16 (20°N, 150°E) by a 500-350 m horizontal tow with ORI-100 net. The later collection made by R/V Hakuho-Maru was the first record of southernmost boundary in the western North Pacific for *C. challengeri*.

The southern boundary of *C. challengeri* in the northwestern North Pacific is comparable to that of other subarctic planktons: the copepod *Calanus cristatus* (Omori and Tanaka, 19 67, Omori, 1967), the euphausiids *Thysanoessa longipes* (Nemoto, 1962), and the chaetognath *Sagitta elegangs* (Marumo, 1966). East of 150° E the southern boundary is not known, but presumably, as in other subarctic planktons, it runs parallel to and somewhat north of the North Pacific Drift.

(2) Vertical distribution of *C. challengeri*

Little information is available on the vertical distribution of *C. challengeri* in Subarctic Water. Birstein and Vinogradov (1955) show it ranging from near the surface down to 500-2,000m and possibly deeper. Bogorov (1958) refers to it as a surface zone (0-200m) species. Bowman (1967) reported that *C. challengeri* was caught mainly at night station from the depth of upper 70m.

In the western North Pacific *C. challengeri* shows apparent vertical movement and has characteristic pattern of vertical diurnal migration.

In the present studies revealed individuals of *C. challengeri* at depths of from 35 to 1,750m and possibly deeper. Their main population distributed at depths from 35 to 100m at night, and 180 to 280m at day. Diurnal migrational range of this species is 250m (Fig. 2). Figure 3 shows their occurrence and diurnal vertical migration of biomass, but this species

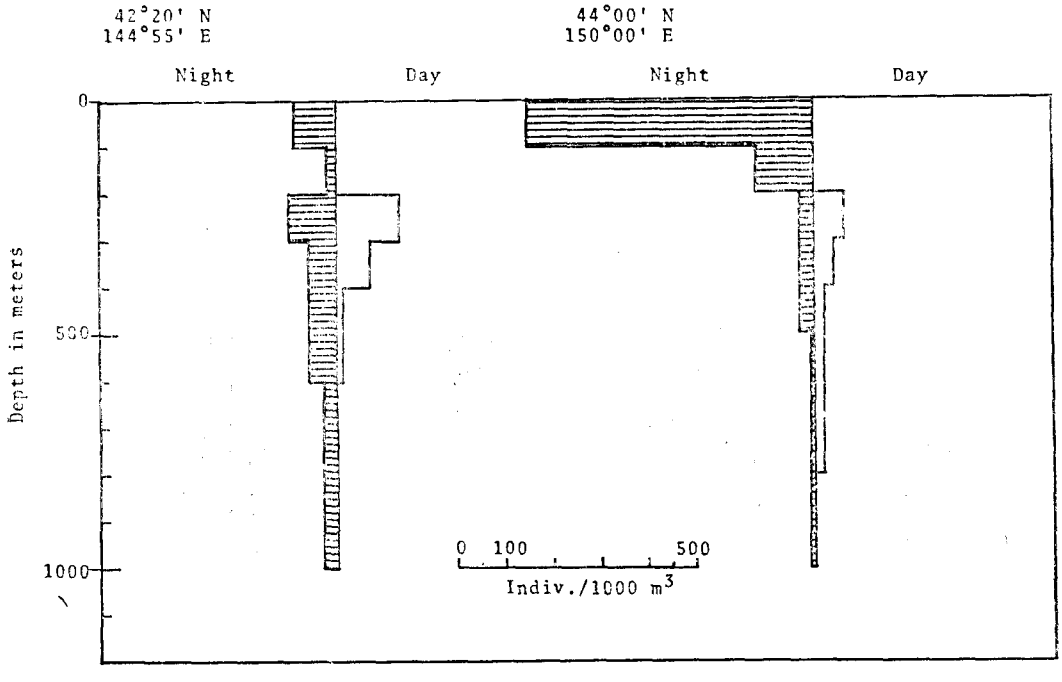

Fig. 2. Vertical distribution of *Cyphocaris challengeri*.

was seldom collected from surface net tow. Comparing with the population at deeper layers exceeded 1,000m which has not migrated at day and night their size frequency of this species differed from migrating population. There is clearly an upward movement of the population at night and the seasonal fluctuation and regional variations are not recognized in their vertical and diurnal migrational patterns.

(3) Distribution of *C. challenger* in Oyashio undercurrent

C. challengeri in Subarctic Waters distributes mainly in Oyashio area and their southern boundary is the northern boundary of Mixing area, not farther than 38°N. In our collection the southernmost locality where *C. challengeri* occurred was St. H12-16 (20°N, 150°E). Three individuals were collected in a tow down to 320-500m. In the coastal waters off Nojima-saki, only one specimen of *C. challengeri* was found at St. 197-1 (35°16.5N, 142°21.8E) in which the net reached down to the 750m level. Although the temperatures in the Oyashio area did not differ significantly from these two stations (10°C). It is known that *C. challengeri* seldom appears in water where the temperature is above 10°C.

The presence of three individuals of *C. challengeri* at St. H12-16 is apparently a new distribution record for this species in these southern waters. As none were obtained when the net was towed in the upper 500m in approximately the same position, it is supposed that they occurred only in waters deeper than 500 m. However, the fact that the species appeared at all other stations seems to indicate that the southern limit for the distribution of *C. challengeri* is in the vicinity of 20° N, 150°E.

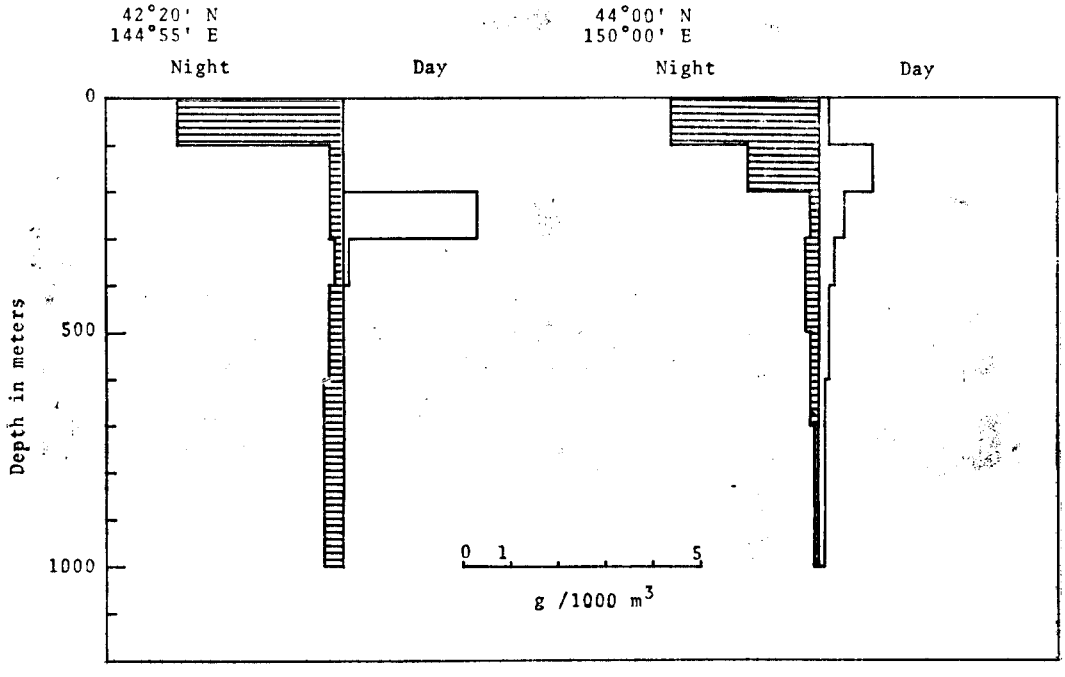

Fig. 3. Vertical migrational pattern of biomass, *Cyphocaris challengeri*.

The submergene of the Oyashio water was

well delimited by the change in the vertical distribution of *C. challengeri* The Oyashio waters, at the surface in the vicinity of H8 (44°N, 150°E), occur at depths greater than

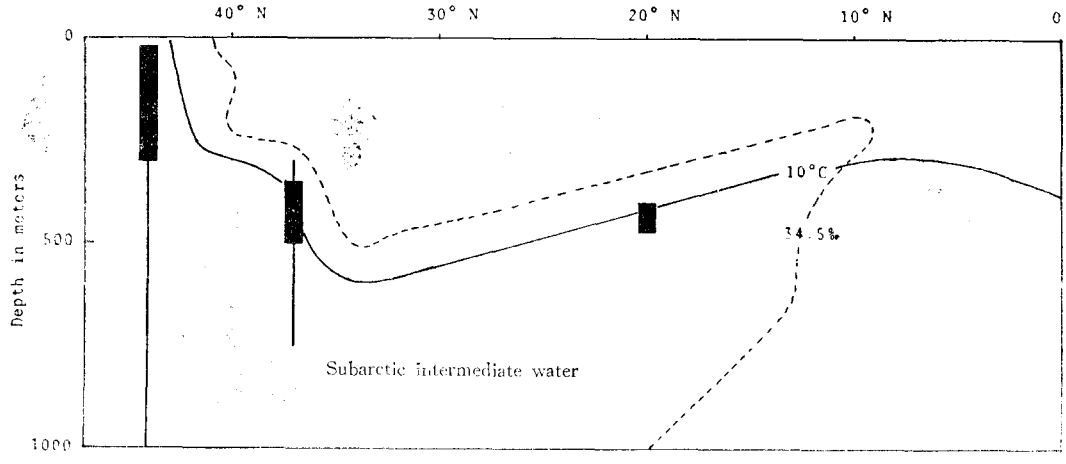

Fig. 4. Vertical distribution of *Cyphocaris challengeri* along 150°E line, with special reference to vertical section of water temperature (the black rectangle represents the center of distribuion).

Table 1. Cruise data from which amphipod samples were obtained

No.	Cruise no.	Date	Area surveyed
1	KT-64-8	May 20-27	Sagami and Suruga Bay
2	KT-64-13	Aug. 12-22	Sagami and Suruga Bay
3	KT-65-5	Feb. 27-Mar. 5	Sagami and Suruga Bay
4	KT-65-9	Apr. 23-28	Sagami Bay and Kuroshio area
5	KT-66-4	Apr. 18-21	Sagami Bay
6	KT-66-10	June 9-17	Kuroshio area
7	KT-66-14	July 14-25	Sagami and Suruga Bay
8	KT-66-19, 20	Sept. 20-Oct. 4	Oyashio-Kuroshio area
9	KT-66-27	Oct. 10-19	Sagami Bay and Kuroshio area
10	KT-67-1	Jan. 17-23	Sagami Bay
11	KT-67-4	Apr. 23-27	Sagami Bay and off Nojimazaki
12	KT-67-7	June 1-5	Sea of Japan
13	KT-67-15	July 29-Aug. 9	Oyashio-Kuroshio area
14	KH-67-3	Sept. 6-20	Kuroshio area
15	KH-67-5	Dec. 1-Feb. 18	North Pacific Ocean, western and central areas
16	KH-68-2	May 15-June 8	East China Sea and the adjacent sea areas

280m in the mixing area. In the coastal waters off Nojima-saki, it becomes gradually deeper toward the southwest. The core of the submerged Oyashio, Oyashio Undercurrent, is characterized by a salinity minimum (Uda, 1937).

From the distribution of temperature and salinity in a vertical section along a north-south tracks in 150°E Subartic Water, characterized by its low temperature and low salinity exceeding 34‰, lies in the surface layer between 40° N and 30°N. In mixing area it submerged into the deeper layer under 400m. Salinity minimum layer which indicates the core of the Subarctic Water located 35°N in 750m and shallow to southern part. In 20° N it located in 400m layer and abruptly shallow it embade as thin layer in 200m layer to 10° N.

The vertical distribution of *C. challengeri* along 150° E line, with special reference to vertical section of temperature and salinity is illustrated in Figure 4. It is believed that *C. challengeri* distributes only in the subarctic water mass, and in this case it seems that the temperature and salinity are the essential factors to limit the distribution of *C. challengeri*.

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