

Preliminary Observations on the Biology of a Marine Cladoceran
Pleopis ("Podon") *schmackeri* (POPPE)

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(Figs. 1-8)

Pleopis schmackeri (POPPE) was originally described without any figures as a new species of the marine cladoceran of the genus *Podon* by POPPE¹⁾ in 1889 based on parthenogenetic female specimens collected near Hong Kong. GURNEY²⁾ subsequently recorded a single parthenogenetic female of this species from Port Taufiq near Suez, the southern entrance of Suez Canal, and figured it for the first time with a brief description. KOKUBO³⁾ recorded the occurrence of this species in waters around Japan with a figure of a parthenogenetic specimen. UENO⁴⁾ only briefly stated that this species is distributed in waters around Japan. CHENG and CHEN⁵⁾ described and figured it in further detail based on specimens collected in the waters along the coast of China. FRONTIER⁶⁾ recorded it from the Bay of Nosy-Bé, northern Madagascar. This is the first record of this species from the Indian Ocean. Recently, MORDUKHAI-BOLTOVSKOI⁷⁾ redescribed and figured this species in more detail than in any other previous publications. He then revised the taxonomy of the marine Podonidae, placing this species under the genus *Pleopis* in which another "Podon" species had already been included, *i.e.*, *Pleopis polyphemoides* by MORDUKHAI-BOLTOVSKOI⁸⁾ and GIESKES⁹⁾. Judging from these previous records, the distribution of *Pleopis schmackeri* seems to be restricted to the Indo-West Pacific region. Apparently, very little is known about the biology and ecology of this species. It may be presently rendered as the least known among the eight species of marine cladocerans in the world ocean as stated by ONBÉ.¹⁰⁾ This paper deals with some of the preliminary observations on *Pleopis schmackeri* - especially on its reproductive biology - as a first step towards elucidating the ecology and life history of this species in the waters around Japan.

Before going further, I would like to thank the staff members of Tokushima Prefectural Fisheries Experimental Station, Hiwasa, Shikoku, for placing their large collection of zooplankton samples at my disposal. Without their kind cooperation, this work could not have been made. Dr. Yasuhiko Jo of the same station kindly took all the trouble to send the monthly samples to me, to whom my sincere thanks are due. Dr. Sachiko NAGASAWA, Ocean Research Institute, the University of Tokyo, kindly translated the Russian text for me. I acknowledge with thanks her cooperation. This work was supported in part by a research grant from the Ministry of Education, Science, and Culture of Japan (Grant No. 066082).

MATERIALS AND METHODS

Individuals of *Pleopis schmackeri* were picked out from the plankton samples collected at monthly intervals by the Tokushima Prefectural Fisheries Experimental Station at 17 stations off the south-eastern coast of Shikoku during the period from June, 1973 through May, 1975. The location of sampling stations is given in Fig. 1. All the plankton samples were collected by the vertical hauls of a plankton net (Marutoku-type) from 50 m depth up to the surface. The net has a mouth diameter of 45 cm and a conical part of 80 cm in length, and is made of nettings of 0.33 mm in mesh (GG54). In this preliminary work, only those plankton samples collected in July, and in part, in August, 1973, were used for examination.

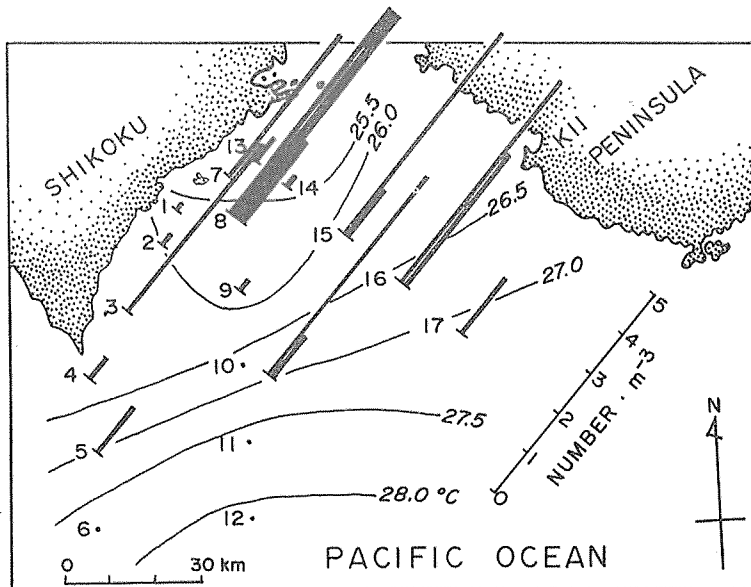


Fig. 1. Map showing the location of sampling stations off the south-eastern coast of Shikoku, the population density of *Pleopis schmackeri* in the upper 50m, and the surface temperature. Hydrographic data provided by courtesy of Tokushima Prefectural Fisheries Experimental Station.

All measurements and observations were made under a compound microscope on the specimens preserved in 5% formalin seawater. Each individual was dissected carefully and the eggs or embryos within the brood pouch were counted. Much attention was paid to find out gamogenetic forms, *i.e.*, males and females bearing resting eggs. Standard length taken was the distance between a shallow notch at the cervical part and the tip of caudal furca as shown in Fig. 2A. Most specimens were preserved in a fashion that the head is

bent ventrally, which made it impossible to adopt as standard the "morphological length" which is defined by BAKER¹¹⁾ as the "distance from the anterior point on the margin of the head to the base of caudal seta". Gross length (Fig. 2A) was also measured which is the maximum distance from the tip of the head to the dorso-posterior edge of the brood pouch.

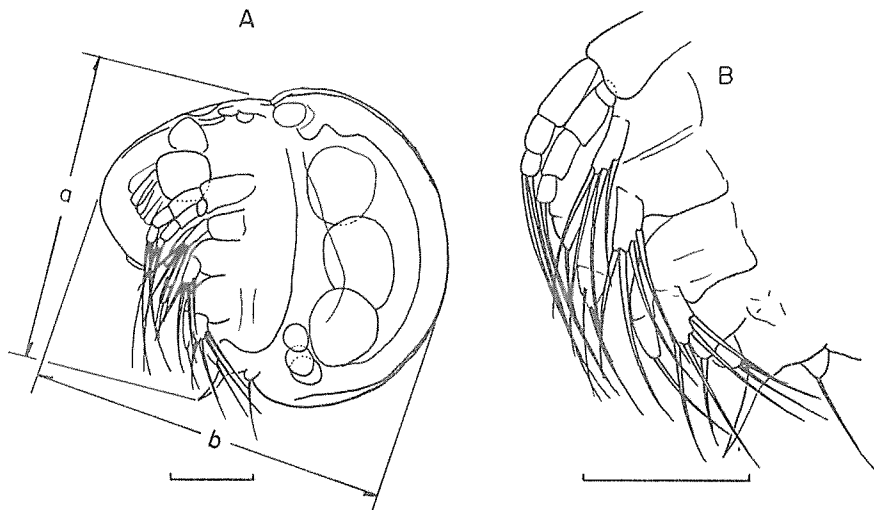


Fig. 2. *Pleopis schmackeri*. A: parthenogenetic female, a: standard length, b: gross length. B: showing the left second antenna and exopods of 1st-4th thoracic legs. Scale bar: 0.10mm.

RESULTS

I. Distribution and Abundance in the Waters off South-Eastern Coast of Shikoku

The marine cladocerans found in the present samples are represented by the following four species: *Penilia avirostris*, *Pseudevadne tergestina**, *Pleopis polyphemoides*, and *Pleopis schmackeri*. As shown in Fig. 2A, the body outline of *Pleopis schmackeri* is more rounded, the cervical groove shallower, and the caudal furca slenderer and more sharply pointed than those of *Pleopis polyphemoides* and the other species of *Podon*. It has a setation formula of the exopods of the 1st-4th thoracic legs as 4,4,4,2 (Fig. 2B). Population density at each station, expressed as the number per cubic meter of seawater, is given in Fig. 1. The density was in general very low and less than 10 individuals per cubic meter. The population was most abundant at Station 8 where 17.1 individuals m^{-3} were recorded, followed by Station 16 (8.3 ind. m^{-3}) and by Stations 10 and 15 (both slightly more than 6 ind. m^{-3}). At three southernmost stations (Stations 6, 11 and 12), no *Pleopis schmackeri* were collected.

* Formerly *Evadne tergestina*, revised by MORDUKHAI-BOLTOVSKOI.⁷⁾

The isopleths of population density are then given on a T-S diagram in Fig. 3. The stations having abundant specimens of this species fall within a certain range of temperature and salinity, indicating that the distribution of this species seems to be strongly influenced by these two environmental parameters. Because of the fact that

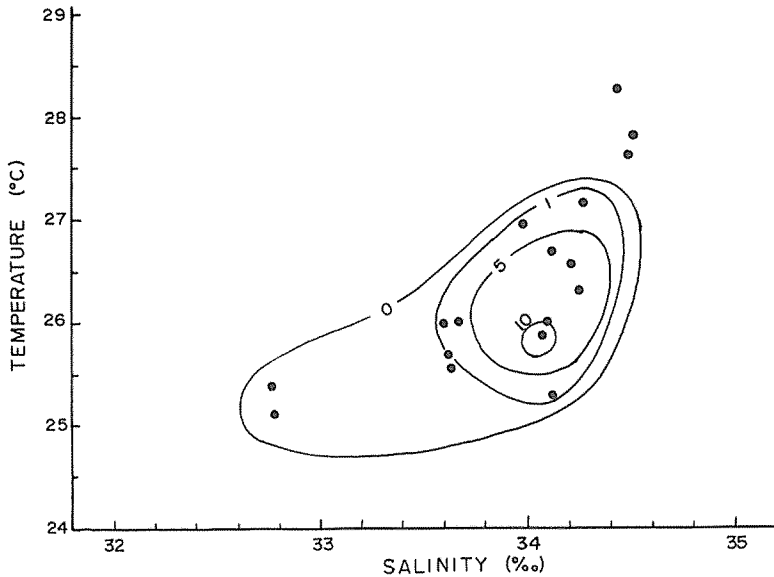


Fig. 3. *Pleopis schmackeri*. Isopleths of population density drawn on a T-S diagram based on surface temperature and salinity data. Each figure denotes the density in terms of number m^{-3} .

most marine cladocerans are surface dwellers, only the surface data of temperature and salinity are used in this figure. At least in July, *Pleopis schmackeri* occurred under the temperature of 25.1° – $27.1^{\circ}C$ and the salinity of 32.77 – 34.26 ‰ S in the study area.

2. Length Frequency Distribution

The standard and gross length frequency distributions are shown in Fig. 4. The standard length of the parthenogenetic females (Fig. 4A) ranges from 0.29 to 0.43mm, which falls roughly within the size range of *Pleopis polyphemoides* in the Inland Sea of Japan examined by ONBÉ.¹²⁾ The largest individual, 0.45mm in standard length, turned out to be a gamogenetic female carrying a resting egg, which will be described later. The gross length (Fig. 4B) covers a range from 0.25 to 0.52 mm, which varies according to the developmental stages of eggs or embryos in the brood pouch. In Fig. 5 is shown the relationship between the standard length and the gross length.

3. Brood Size

The number of parthenogenetic eggs or embryos in the brood pouch varies from 2 to 5 with a mean of 3.73. The number of eggs is plotted against the standard length in Fig.

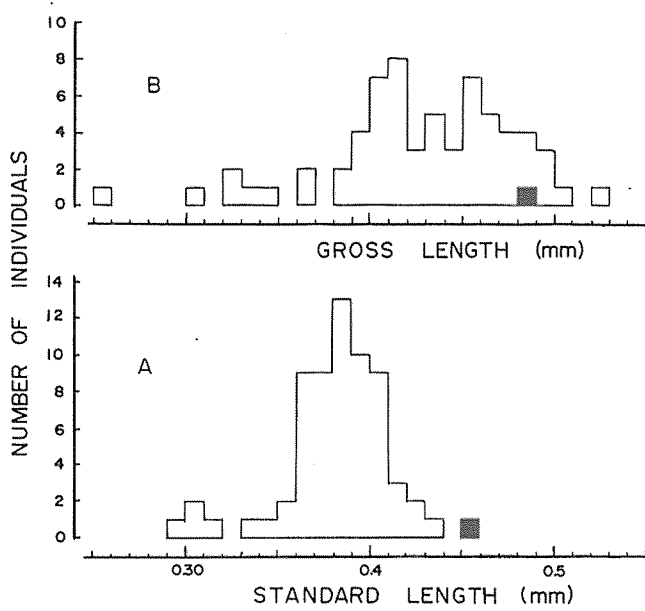


Fig. 4. *Pleopis schmackeri*. Length-frequency distributions. A: standard length; B: gross length; open part: parthenogenetic female; solid part: gamogenetic female.

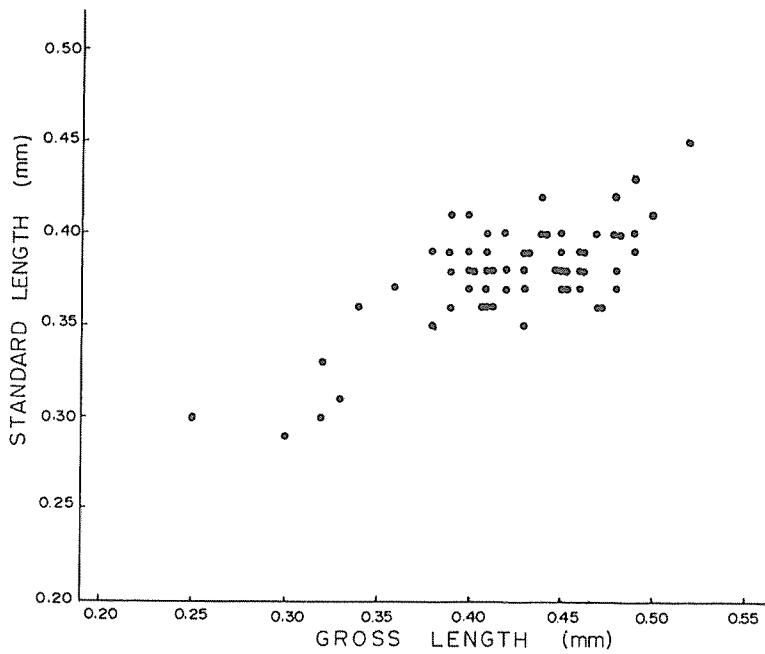


Fig. 5. *Pleopis schmackeri*. Relationship between standard length and gross length.

6. No positive correlation can be found between these two variables in contrast to the case of *Pleopis polyphemoides* in which there is a clear positive relationship between them (see Fig. 56B after ONBÉ¹²).

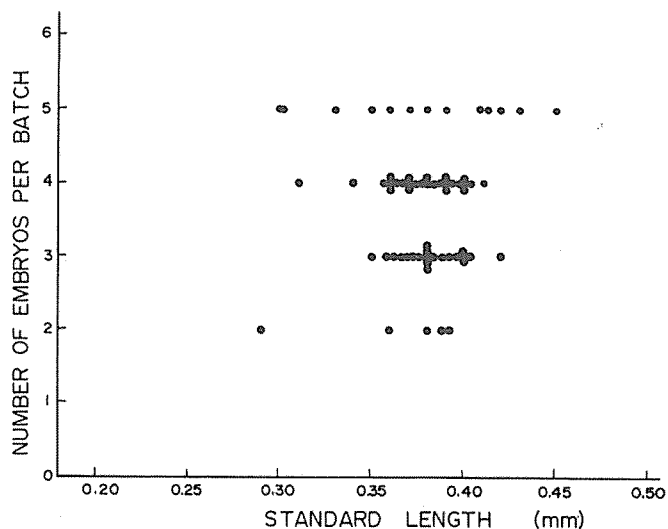


Fig. 6. *Pleopis schmackeri*. Relationship between standard length and brood size (number of eggs or embryos in brood pouch).

4. Developmental Stages of Embryos

The smallest individual (s. l. : 0.30mm) found in plankton samples was seen to have some early-stage embryos in its brood pouch. Fig. 7A represents a female bearing embryos of 0.17mm in gross length, which have developing second antennae and thoracic appendages (Fig. 7B). A female having embryos at more advanced stage of development is shown in Fig. 7C,D. This mother animal has a batch of eggs of next brood (Fig. 7E) in addition to the advanced embryos which are about 0.25mm in gross length. The paedogenesis has been observed in many species of podonids (see review by ONBÉ¹⁰). This is a phenomenon that eggs are formed in the embryonal brood space of advanced embryos, while the latter are still held by the mother animal. As yet, no such paedogenetic embryos have been noted in this species. However, the paedogenesis may be the case also in this species, judging from the fact that the smallest individual found in the plankton samples had already its own eggs within its brood pouch.

5. Gamogenetic Form

As far as I know, no record has been made on the presence of the gamogenetic forms of *Pleopis schmackeri*. In spite of thorough examination, no gamogenetic individuals could be found in the July samples. In the course of observations of the samples collected in the next month (August, 1973), an individual showing a sign of resting egg

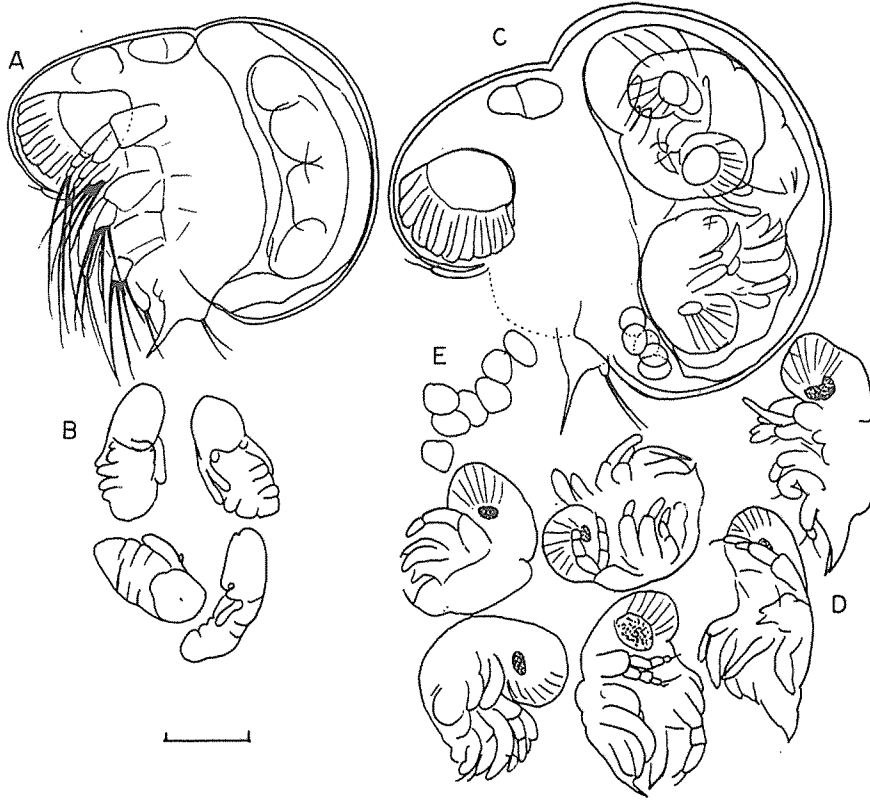


Fig. 7. *Pleopis schmackeri*. Parthenogenetic females and embryos dissected out of brood pouch. A: female having 4 embryos; B: embryos with developing second antennae and thoracic legs dissected out of A; C: female having 6 advanced embryos (D) and a batch of eggs of next brood (E). Scale bar: 0.10mm.

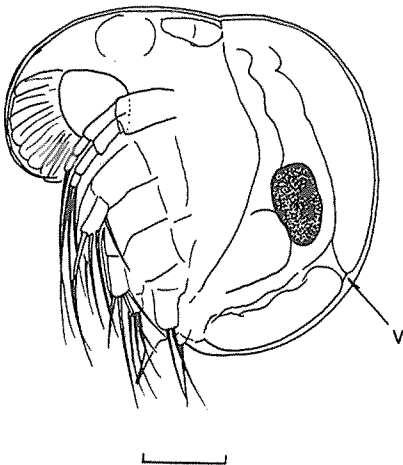


Fig. 8. *Pleopis schmackeri*. Gamogenetic female bearing a developing resting egg. v: vagina. Scale bar: 0.10mm.

formation was found, as illustrated in Fig. 8. A single egg seen in the figure is very large as compared with a parthenogenetic egg. It looks dark under the transmitted light due to its heavy accumulation of yolk substances. There is an orifice at the postero-dorsal part of the brood pouch which is presumably attributed to the vagina as described and figured by MORDUKHAI-BOLTOVSKOI and RIVIER¹³⁾ and ONBÉ¹⁴⁾ in the gamogenetic females of other podonid species. No males have been confirmed to exist at the present time.

DISCUSSION

In contrast to the other species of marine cladocerans, *Pleopsis schmackeri* has received surprisingly little attention since its discovery about a century ago. KOKUBO³⁾ briefly stated that this species is distributed in warmer waters in comparison with its congener and related species occurring in Japanese waters (*Pleopsis polyphemoides* and *Podon leuckarti*). He also noted that in Aomori Bay, northernmost Honshu, it appears in the plankton in mid-September when the influence of the warm Kuroshio Current becomes most conspicuous. According to CHENG and CHEN⁵⁾, this species has been collected along the coast of China, and its distribution is restricted to the area south of Shantung coast. Its occurrence is reported to be within the period from spring through summer, being most abundant in May.

ONBÉ and KUMAI (in preparation) investigated the seasonal distribution of marine cladocerans in a small inlet of central Japan facing to the Pacific Ocean, which is located about 150 km east of the present study area. *Pleopsis schmackeri* were found only in the plankton samples collected in August. This species has not been recorded from the Inland Sea of Japan where intensive investigations of marine cladocerans have been made since 1965 (MURAKAMI and ONBÉ,¹⁵⁾ ONBÉ,^{10, 12)}). HIROTA¹⁶⁾ once recorded it from near the south entrance of Hoyo-Kaikyo, a strait between Kyushu and Shikoku, in June, 1963. Apparently, this species is a warm water oceanic form, occurring only in warmer months in waters of high salinity. However, the discovery of a single gamogenetic female in this work suggests that this species may also have a character of neritic inhabitant whose planktonic existence is restricted to the warmer months of the year and whose population may tide over the unfavorable colder months as resting eggs in sea-bottom sediments in shallow coastal areas.

The plankton samples used in this work had been taken with a 0.33mm-mesh net. The number per cubic meter of seawater obtained here may be considerably underestimated for smaller individuals due to the escapement through the meshes. More quantitative data are necessary to acquire basic information on the life history and biomass of this species for evaluating its ecological significance in zooplankton communities of warm-temperate, subtropical and tropical seas.

SUMMARY

Pleopis ("Podon") *schmackeri*, the least known marine cladoceran occurring exclusively in the warm waters of the Indo-West Pacific region, was examined for specimens collected off the south-eastern coast of Shikoku, Japan, in July-August, 1973. The distribution density in the upper 50 m was generally low, being less than 10 individuals m^{-3} at most stations. Maximum density recorded was 17.1 individuals m^{-3} . Parthenogenetic females were 0.29–0.43 mm in standard length and 0.25–0.52 mm in gross length, with 2 to 5 eggs or embryos (mean 3.73). A single gamogenetic female bearing a developing resting egg found in the August sample was described and figured for the first time.

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ウミオオメミジンコの生態に関する観察

遠 部 卓

ウミオオメミジンコ, *Pleopis* ("Podon") *schmackeri* (POPPE) はインド - 西太平洋暖水域に分布が限られる特異な海産枝角類であり, その生物学的知見はほとんどない。本研究は, 1973年夏期, 四国南東部沖合の太平洋沿岸域で採集された動物プランクトン標本中の本種について計数ならびに生物学的測定を行ったものである。表面から 50m 深までの分布密度は低く, ほとんどの定点で 10 個体・ m^{-3} 以下であり, 最高は 17.1 個体・ m^{-3} であった。単為生殖雌の標準体長は 0.29 - 0.43 mm, 全長 0.25 - 0.52 mm, 抱卵数は 2 - 5 個 (平均 3.73 個) であった。8 月に採集された標本中に耐久卵をもつ雌が 1 個体確認されたが, これは本種の有性生殖個体についての最初の記録である。