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Some aspects of the biology of the hyperiid amphipod *Hyperoche medusarum*

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KURZFASSUNG: **Zur Biologie des hyperiiden Amphipoden *Hyperoche medusarum*.** *Hyperoche medusarum* (Krøyer), ein räuberischer hyperiider Amphipode, ist in beträchtlicher Zahl im Plankton der Departure Bay vertreten. Im Labor durchgeführte Aufzuchtversuche zeigten, daß Jungtiere, die bei 10° C gehalten wurden, nach etwa 69 Tagen geschlechtsreif wurden und eine neue Brut von je 50 bis 90 Nachkommen produzierten. Frisch geschlüpfte Tiere attackierten sofort Heringslarven, die als Futter dienten. Das Erscheinen der ersten Brut des Jahres im April fällt mit dem Schlüpfen der Heringslarven in der Departure Bay zusammen. Magenuntersuchungen gaben Anlaß zu der Vermutung, daß neben Copepoden Heringslarven einen beträchtlichen Prozentsatz der Nahrung für *Hyperoche medusarum* ausmachen.

INTRODUCTION

Hyperiid amphipods play an important role in the plankton communities of the sea. In general only the copepods and euphausiids exceed them in numbers (Bowman, 1953). Recent works conducted by Westernhagen & Rosenthal (1976) revealed that the predatory hyperiid amphipod *Hyperoche medusarum* Krøyer at times displayed considerable predation on newly hatched herring larvae. Effects on larvae populations and recruitment of herring in respective areas might be expected. Yet there is but scant information on biology and ecology of this crustacean, and further detailed data on these subjects are desireable. This paper presents data and observations on some aspects of the biology of *Hyperoche medusarum (Hyperia medusarum)* based on collections and experiments made in spring 1974 and 1975 in Departure Bay (Nanaimo, Canada).

MATERIAL AND METHODS

Juvenile specimens of *Hyperoche medusarum* were caught with a pail at night after they had been concentrated at the water surface using a 300 W light bulb suspended 10 cm over the water surface, at the pier of the Pacific Biological Station, Nanaimo, Canada, in April and May 1974 and 1975. For rearing experiments the hyperiids were separated from other plankton organisms with a large bore pipette and transferred into 500 ml beakers stocked with 50 individuals each. The animals were kept at 10° C and fed daily with newly hatched live herring larvae. Water was exchanged every other day. For the determination of the growth, eye diameter and head plus thorax (Fig. 1) of the living animals were measured at intervals throughout the experiments.

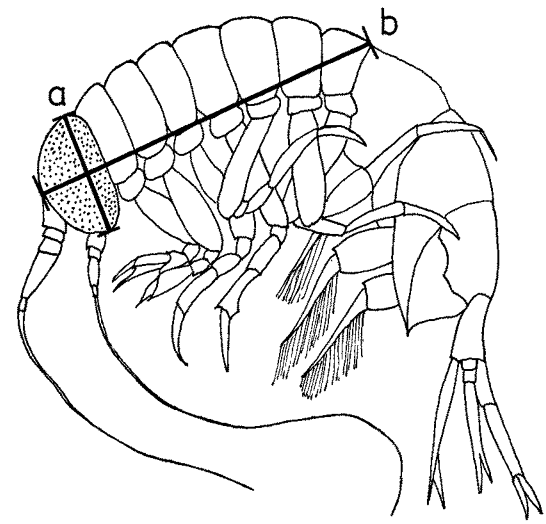

Fig. 1: Schematic drawing of *Hyperoche medusarum*. a = Eye diameter and b = Head plus thorax length used for growth determination

To determine ratio of fish larvae to hyperiids in the plankton, other hauls were preserved and fish larvae and hyperiids were counted individually. The hyperiids then were subjected to stomach analyses.

For the above mentioned investigations a distinction was not made between male and female specimens.

RESULTS

General ecology

During April and May *Hyperoche medusarum* is quite common in the plankton of Departure Bay, and it can occur in considerable numbers (WESTERNHAGEN & ROSENTHAL, unpublished). It is usually found free swimming, but juvenile specimens are frequently encountered close to the surface sitting on the exumbrellae of Hydromedusae of the genera *Tiaropsis, Sarsia, Phialidium* or *Polyorchis*. Specimens reared in the laboratory displayed raptorial behaviour; attacks on prey seemingly depended on chance encounters. Yet when given the choice between several fish larvae species such as *Clupea pallasii, Pholis laeta, Anoplarchus purpurescens, Artadius lateralis* and crustaceans such as zoeae and megalopeae of decapods and various copepod species, usually *Clupea* larvae were attacked and eaten. Since orientation towards a possible prey was not accomplished by means of optical stimuli (WESTERNHAGEN & ROSENTHAL, 1976), we assume that some means of chemical prey recognition after successful contacts is employed. When kept in confinement without sufficient food (herring larvae) *Hyperoche medusarum* displayed pronounced cannibalism.

Newly born and small specimens up to a mean head plus thorax length of 0.7 mm were in the natural habitat and in the experiments usually found close to the water surface. Larger individuals (> 0.7 mm) tended to avoid direct light and preferred dimly lit areas. In experiments with a 240 mm deep sea-water filled stand pipe with overhead fluorescent lights juvenile specimens permanently stayed in the upper 120 mm of the water column. Larger specimens congregated at the bottom of the pipe. Only in dim light or in darkness would large and sexually mature individuals appear in the upper layers of the water column. Illuminating the standpipe from the bottom end would partially reverse this behaviour, making larger specimens swim to the water surface, away from the light source.

Growth and reproduction

Under controlled conditions at 10° C, juveniles fed exclusively with herring larvae would reach sexual maturity after about 69 days. At this stage head and thorax of mature females measured 3.09 mm (total length about 6.5 mm) and the large eye diameter measured 1.15 mm. As shown in Figure 2 mean eye diameter and head plus thorax length proved to be good methods of growth monitoring. Using the mean total length for this purpose gave unsatisfactory results since its determination was very inaccurate. Live as well as preserved animals usually assumed a more or less curled position (see also DUNBAR, 1963), which foiled attempts to measure the total length accurately.

Sex discrimination using a binocular microscope (magnification 72x) was possible only at an age of about 30 days (at 10° C) when the long eye diameter of the specimens measured from 0.6 to 0.7 mm. Only at this stage did female specimens clearly show first small oostegites, and oocytes in ovaries could be found upon dissection. With an eye diameter of more than 1.0 mm male specimens can frequently be distinguished macroscopically from females by the presence of longer antennae as shown by DUNBAR (1963) for this species. In females the antennae remain much shorter, as mentioned also by BOWMAN (1953).

Egg carrying females are easily recognized by the yellow egg masses in the marsupium. Maturing females with a head plus thorax length of 2.3 mm and an eye diameter of 1.0 mm contained between 68 and 90 oocytes, and sexually mature females (10 examined specimens) kept between 48 and 94 eggs in their marsupium. The oostegites were then larger than the gills and, in contrast to conditions described in gammarid amphipods (e. g. BULNHEIM, 1965), did not bear any marginal bristles. The incubation at 15° C lasted 8 to 10 days.

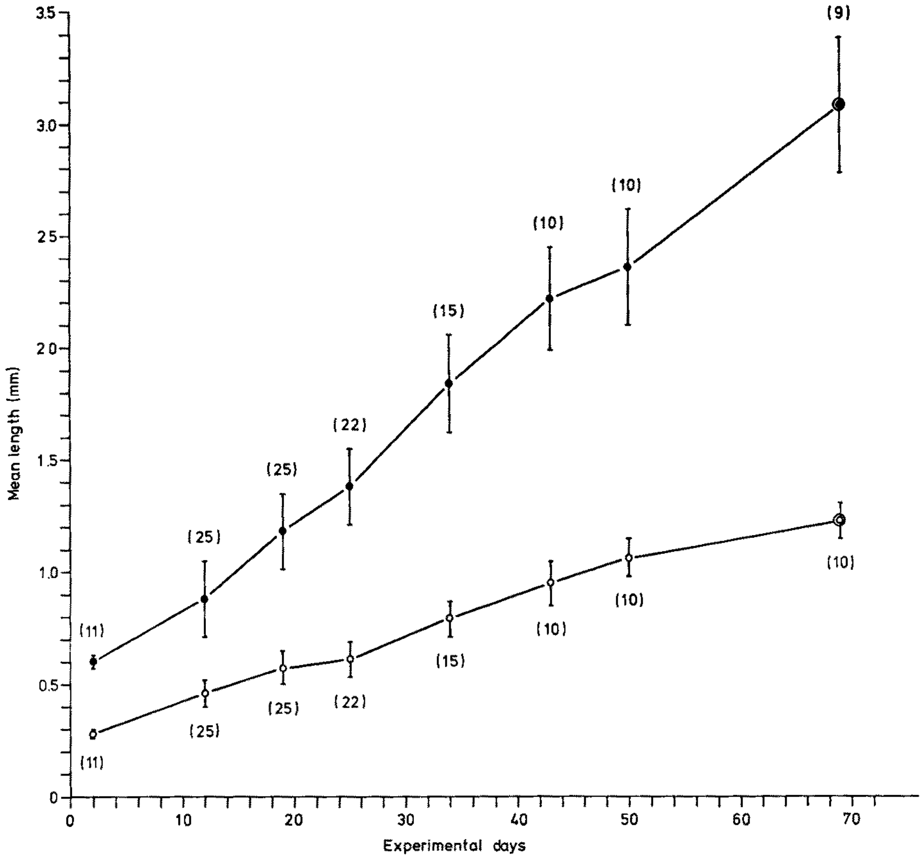

Fig. 2: Growth of *Hyperoche medusarum* reared in the laboratory at 10° C and fed with herring larvae. ● = Laboratory specimens, head plus thorax length, ○ = Laboratory specimens, eye diameter; ⊙ ⊙ = Data derived from approximately 50 day old wild catches then reared in the laboratory; (25) = number of specimens measured; vertical bars = standard deviation

Newly born *Hyperoche medusarum* given yolk sac herring larvae immediately started to attack and feed on these.

Size composition

Size composition of *Hyperoche medusarum* catches from April 1975 in Departure Bay indicate that the first brood of the year had been released at the beginning of this month (Fig. 3 B; 7/4/75 and 9/4/75). Only a few mature specimens were caught. On April 25th the size composition showed two distinct peaks at a larger eye diameter size than found in the former catches on April 7th and 9th. This sample too contained only few mature specimens. The sample taken in the middle of May (15/5/75) shows

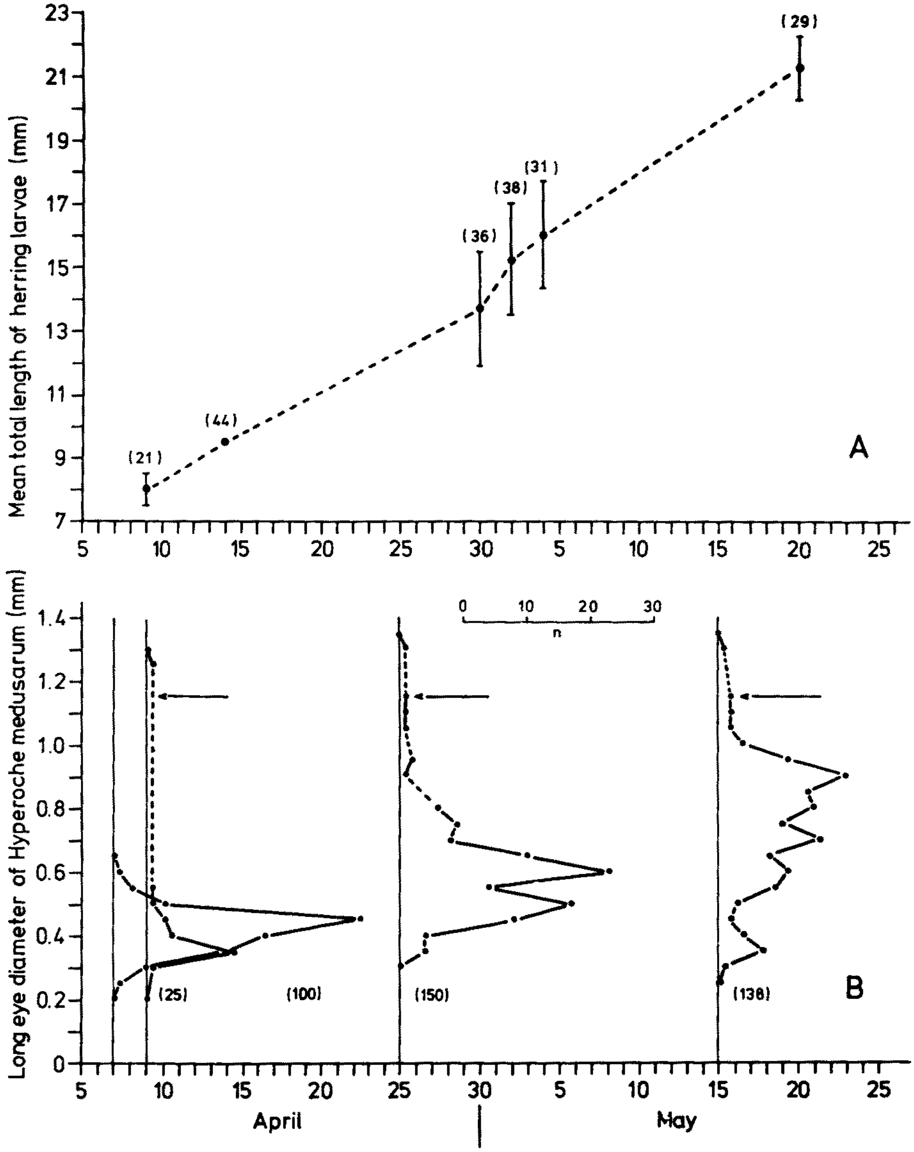

Fig. 3: A = Growth of herring larvae *(Clupea pallasii)* in Departure Bay, April and May 1975. (25) = Number of specimens measured. Value for (44) derived from preserved material. Vertical bars = standard deviation. B = Size composition of light catches of *Hyperoche medusarum* from Departure Bay, April and May 1975. Surface temperature: April 10th = 8.5° C; May 1st = 10° C; May 16th = 13° C; May 30th = 14.5° C. Arrow indicates onset of sexual maturity

the first peak of the population approaching sexual maturity. Several smaller peaks (broods?) follow the first, largest one. Again this sample contained only few sexually mature hyperiids.

Sex ratio analysis of the May population (15/5/75) revealed that both sexes were about equally represented (considering individuals with eye diameter > 0.6 mm only). Of 70 successfully sexed specimens 36 individuals were females and 34 were males.

Food

In the evaluation of the stomach contents a difficulty arose in recognizing the food items ingested. Although crustacean parts, such as copepod legs, head, eyes, and antennae, and zoeae abdomens and few other hard materials were recognizable, a considerable amount of the stomach contents frequently consisted of unidentifiable mush. Laboratory specimens dissected shortly after being fed live herring larvae revealed stomach contents of similar unidentifiable consistencey. Table 1 gives the results of the stomach analyses for 8 different hyperiid samples, and in addition an indication for the frequency of co-occurrence of other planktonic organisms. In cases where crustaceans constituted the major part of the stomach contents (Table 1, No. 7, 8) crustaceans were the most abundant organisms in the plankton, or herring larvae at

Table 1

Stomach contents of *Hyperoche medusarum* as derived from dissection of preserved specimens caught at night after attraction with a light in Departure Bay, Nanaimo, Canada. n = number of specimens dissected; cr = crustaceans; fl = fish larvae (predominantly herring); e = empty; o = others; +++ = very abundant; ++ = abundant; + = few; — = wanting

			Stomach contents in % of occurrence				Organisms in plankton catch			Herring larvae length
Date	No	n	cr	fl	e	o	cr	fl	o	(mm)
1974	1	22	22.7	31.8	45.0	0	++	++	+	9.0
1974	2	21	14.3	57.1	19.0	10.4	+++	+++	+	8.0
1974	3	22	45.5	31.8	4.5	18.2	++	++	++	9.0
1974	4	19	42.1	31.6	15.8	10.5	+++	+++	++	9.0
7/4/1975	5	20	28.0	56.0	8.0	8.0	+	+++	+	7.7
9/4/1975	6	19	26.3	57.8	10.5	5.2	+	+++	+++	8.0
25/5/1975	7	25	76.0	24.0	0	0	+++	++	+	13.0
15/5/1975	8	88	61.8	34.3	4.9	0	+++	—	+	—

that time were already fairly large (Fig. 3). In cases where herring larvae were dominant in the plankton (Table 1, No. 5, 6) or the ratio number of crustaceans/ number of herring larvae was balanced (Table 1, No. 1, 2, 3, 4), the percentage of hyperiids whose stomach contents consisted of unidentifiable soft material increased drastically suggesting that the diet of the hyperiids may at times include a considerable amount of herring larvae. This is backed by the fact that herring larvae in their early developmental state are, for about 40 days, co-occuring with the first-of-the-year populations of *Hyperoche medusarum* (Fig. 3).

DISCUSSION

The investigations show that *Hyperoche medusarum* occurs frequently and in great numbers in shallow inshore waters of the Strait of Georgia; at times at the surface. Other reports on the occurrence of *Hyperoche medusarum* in shallow and brackish water were given by BOWMAN et al. (1963) who found it at around 16 to 17 ‰ S in the Chesapeake and Narragansett Bays and SHOEMAKER (1930) who reported it from the Golf of St. Lawrence but in deeper water (30 to 90 m). SARS (1895) who described this species from the west coast of Norway stated that it was found at times near the surface, at times in greater depths. In fact LORZ & PEARCY (1975) have encountered *Hyperoche medusarum* 65 miles off the Oregon coast in depths as great as 200 m, and HURLEY (1956) reported one specimen having been caught off San Diego at 1300 m. Apparently *Hyperoche medusarum* can withstand a wide range of salinity and is capable of considerable vertical migration.

Temperature appears to be the limiting factor for its distribution. Its southern boundary at the United States west coast very roughly corresponds to the 14° to 15° C isotherm at 30 m (BOWMAN, 1953). This is about the temperature at which the first brood of the year reaches sexual maturity in Departure Bay (Fig. 3). How many broods can be produced over the summer we do not know. Yet it appears from the size composition of our catches (Fig. 3 B) that as in many gammarid amphipods only a few large females are able to overwinter (STEELE & STEELE, 1969, 1970, 1973) and after releasing the new brood disappear in early summer.

Our observations indicate that *Hyperoche medusarum*, in contrast to findings of SARS (1895) who thought the hyperiid to lead a parasitic life on medusae, is usually free swimming. These findings are supported by investigations conducted by EVANS & SHEADER (1972) who stated that in the North Sea *Hyperoche medusarum* is generally taken free in plankton samples only feeding or on occasions resting on *Pleurobrachia pileus* its usual prey.

Feeding habits of the Pacific specimens appear to be somewhat different from those recorded by EVANS & SHEADER (1972) for North Sea individuals, which, since their gut contents were completely unidentifiable, were presumed to feed almost exclusively on *Pleurobrachia pileus*. Feeding habits of Pacific *Hyperoche medusarum* are very much like those of another hyperiid amphipod *Parathemisto gaudichaudi* (SHEADER & EVANS, 1975), wild catches of which were reported to feed on copepods, decapod zoeae, euphausids, *Sagitta* spp., hydromedusae and at times – up to 23.4 % of the gut contents – on fish larvae, especially *Ammodytes* and clupeid larvae. Especially the latter supports our assumption that the unidentifiable matter in the amphipods' stomachs (Table 1) might have been fish (herring) larvae remnants.

The numerous occurrence of *Hyperoche medusarum* in Departure Bay during the spawning season of the herring *Clupea pallasii* and its feeding on herring larvae (WESTERNHAGEN & ROSENTHAL, 1976) might have some bearing on the recruitment of herring stocks in British Columbia waters.

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SUMMARY

1. *Hyperoche medusarum* KRØYER, a predatory hyperiid amphipod, occurs in considerable numbers in Departure Bay, Nanaimo, Canada.
2. One full reproductive cycle at 10° C takes about 69 days. Females mature at a head plus thorax length of 3.09 mm (total length about 6.5 mm) laying 50 to 90 eggs. Newly born *Hyperoche medusarum* immediately attack and feed on herring larvae if available.
3. The first brood of the year of *Hyperoche medusarum* in Departure Bay co-occurs with newly hatched herring larvae.
4. From stomach analyses it appeared that, aside from copepods, herring larvae constitute a major part of the hyperiids' diet.

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