

Predatory Feeding of the Planktonic Copepod *Tortanus forcipatus* on Three Different Prey^{1), 2)}

Comparing to enormous amount of information on the feeding of marine herbivorous (or suspension-feeding) copepods, knowledge on the feeding of carnivorous copepods is few (CORNER et al. 1976, LANDRY 1978, LONSDALE et al. 1979, YEN 1983). Copepods of the genus *Tortanus* are true carnivores (ANRAKU & OMORI 1963, GOSWAMI 1977, OHTSUKA et al. 1987), and the functional response of *T. discaudatus* was investigated by AMBLER & FROST (1974). We investigated the functional response of *Tortanus forcipatus* (GIESBRECHT) adult female using three different prey.

Live zooplankton samples were obtained in Fukuyama Harbor from September to November 1980. Immediately after arrival to our laboratory (Hiroshima Univ.), adult females of *T. forcipatus* were isolate and individually transferred to 500 ml-volume glass bottles, to which known number of prey has already been transferred. We used *Pseudodiaptomus marinus* nauplii (NII-NIV), *Oithona davisae* adults (CVI M & F) and newly hatched (<1 day old) *Artemia* nauplii as prey. *P. marinus* nauplii were obtained from the stock culture

in the laboratory. *O. davisae* adults were isolated from the zooplankton samples collected in Fukuyama Harbor. *Artemia* nauplii were obtained by incubating the resting eggs in filtered seawater in the laboratory. At each prey density (40–400 indiv. l⁻¹), six bottles were prepared, two of which served as controls without predator. The bottles were filled to the brim with glassfiber (Whatman GF/C) filtered seawater and topped with a piece of polyethylene film which was held in position with a screwcap lid. They were enveloped in dark vinyl bags and were secured on a grazing wheel (1 rpm) in the temperature controlled room (21±1°C) for 24 hours. After the experiment, contents of the bottles were sieved and the remaining animals were observed and counted under a dissecting microscope. Carbon contents of prey and predator were determined with a CHN analyzer (Yanagimoto, MT-3).

Our observation has revealed that *T. forcipatus* adult females do not generate feeding currents as found for suspension-feeding copepods like *Calanus*. They swim in random darting motions and pounce on prey, when it

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2) 3種の異なる餌に対する肉食性カイアシ類 *Tortanus forcipatus* の捕食速度

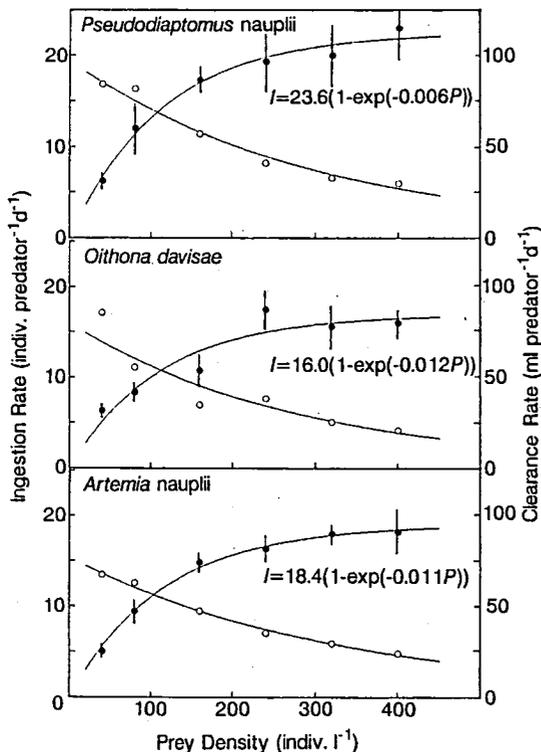


Fig. 1. Ingestion rates (filled circles) and clearance rates (open circles) of *Tortanus forcipatus* adult female on *Pseudodiaptomus marinus* nauplii (top), *Oithona davisae* adults (middle) and *Artemia* nauplii (bottom) at various prey densities. Vertical lines indicate SE.

enters within the detecting proximity (ca. 0.5 mm) to the predator, by extending their feeding appendages. Captured *P. marinus* nauplius was ingested within several seconds, while *Artemia* nauplius was held with the second maxillae and maxillipeds and tossed up to the mouth, and it took occasionally more than three minutes to ingest.

The mortality of prey was less than 1% in control bottles, and dead individuals looked still fresh. Hence, we assumed that the loss other than predation was negligible in the experimental bottles. Partial feeding, i.e. eating only part of prey body, was not observed. In each prey-predator combination, the ingestion rate of *T. forcipatus* increased with increasing prey density approaching an asymptotic value and this relationship was

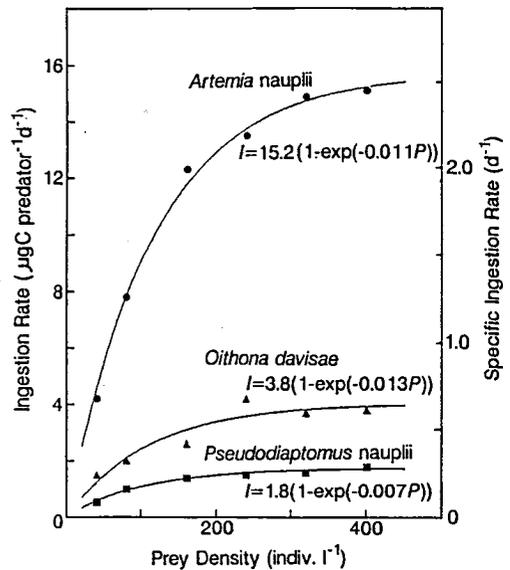


Fig. 2. Ingestion and specific ingestion rates of *Tortanus forcipatus* adult female in terms of carbon on *Pseudodiaptomus marinus* nauplii (filled squares), *Oithona davisae* adults (filled triangles) and *Artemia* nauplii (filled circles) at various prey densities.

described by Ivlev equation (Figure 1). Maximum ingestion rate varied with prey type; it was highest in *P. marinus* nauplii (23.6 indiv. d^{-1}) and was followed in order by *Artemia* nauplii (18.4 indiv. d^{-1}) and *O. davisae* adults (16.0 indiv. d^{-1}). The degree of increasing ingestion rate also varied; 90% of the maximum ingestion rate was attained at prey density of 160, 240 and 320 indiv. l^{-1} for *O. davisae*, *Artemia* and *P. marinus*, respectively. Such differences are attributed to the difference in detection rate and escape ability among prey (KERFOOT 1978, LANDRY 1978, LANDRY & FAGERNESS 1988), although we could not quantify these differences for the prey we used.

The clearance rate of *T. forcipatus* decreased with increasing prey density (Figure 1), indicating that predator search prey more actively at lower prey densities. Maximum clearance rate was approximately 100 ml predator $^{-1} d^{-1}$.

Body carbon weight (C , μg) of *T. forcipatus* used in each experiment was

determined by substituting its prosome length (PL , μm) to the equation: $\log C = 2.04 \log PL - 5.10$ ($N=8$, $r=0.92$). Mean carbon content of *P. marinus* nauplius, *O. davisae* adult and *Artemia* nauplius was 0.08, 0.24 and 0.83 μg , respectively. The ingestion and specific ingestion rates of *T. forcipatus* were then expressed in terms of carbon (Figure 2). These rates were directly related to prey carbon content. The maximum specific ingestion rate was 2.51 d^{-1} for *Artemia* nauplii, 0.63 d^{-1} for *O. davisae* adults and 0.29 d^{-1} for *P. marinus* nauplii. Although *Artemia* nauplii are not natural prey, it should be noted that *T. forcipatus* is capable of ingesting 2.5 times its body carbon weight per day. *O. davisae* is numerically most dominant copepod species in summer-fall zooplankton samples of Fukuyama Harbor, and hence this species is considered to be primary food for *T. forcipatus* in the field (UYE & KAYANO unpublished).

UYE & YASHIRO (1988) measured the respiration rate of *T. forcipatus* adult female at 24.5°C as $0.10 \mu\text{l O}_2 \text{ predator}^{-1} \text{ h}^{-1}$. The minimum carbon requirement, assuming that the respiratory quotient is 0.8 and the assimilation efficiency is 0.7, is $1.0 \mu\text{g predator}^{-1} \text{ d}^{-1}$. The mean density of small planktonic crustaceans was 68 indiv. l^{-1} in Fukuyama Harbor in summer and fall (UYE & KAYANO unpublished). At this prey density, the carbon ingestion rate of *T. forcipatus* is sufficient ($2.2 \mu\text{g predator}^{-1} \text{ d}^{-1}$) when it consumes *O. davisae* adults, but insufficient ($0.7 \mu\text{g predator}^{-1} \text{ d}^{-1}$) when it eats *P. marinus* nauplii. Size selective feeding behavior for larger prey is energetically advantageous (AMBLER & FROST 1974, LANDRY 1978, GREENE & LANDRY 1985, YEN 1985). Under natural conditions where various sizes of prey are available, *T. forcipatus* tends to select larger prey within the range of its prey size.

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