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# Behaviors of female and male cyclopoid copepod Oithona davisae in relation to foraging and feeding



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［課程博士・論文博士共通］

# 博士学位論文内容要旨
# Abstract

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|---|---|---|---|
| 論文題目<br>Title | Behaviors of female and male cyclopoid copepod *Oithona davisae* in relation to foraging and feeding<br>（キクロプス目カイアシ類 *Oithona davisae* の雌雄別餌探索· 摂餌行動） | | |


**Motivation and Objectives**

For survival and reproduction, adult copepods need to ingest enough prey. Their encounter rate and ingestion rate are strongly affected by their swimming, foraging, and feeding behavior. Thus, quantifying the behavior of copepods allows us to reveal the relation of behavior on foraging and feeding. Cyclopoid copepod *Oithona davisae* is one of the dominant species in eutrophic waters, and contributes to secondary production. It is known that *O. davisae* detects prey-generated hydrodynamic signals, thus it prefers motile prey (such as flagellates, dinoflagellates and ciliates). Male and female adult copepods differ in their swimming, foraging, and feeding behaviors, which may affect their ingestion rates. Female *O. davisae* ingest more frequently than males; however, the relation of sexually dimorphic behaviors on sexual-specific prey encounter and ingestion are poorly documented. In my study, I observed how female and male *O. davisae* differ in swimming, detecting, and ingesting prey. I investigated the relation of behavior on encounter rate and ingestion rate. Then, I explored the sexual dimorphic behaviors as to contributing to different ingestion rates of both sexes.

**Materials and methods**

The behaviors of male and female *Oithona davisae* were observed three dimensionally under the same prey density in two different-sized vessels. The swimming behaviors under less restricted conditions were observed in a relatively large vessel. The foraging and feeding behaviors of *O. davisae* were observed microscopically in a small flow-cell for several minutes, to know the relative position between *O. davisae* and prey. The flagellate *Tetraselmis Tetrathele* were fed to copepods at a prey density of 2000 cells $mL^{-1}$. I also closely observed the prey attack process and whether the copepods' attacks succeeded or not.

**Results and Discussion**

*Oithona davisae* detected prey by their antennules while sinking and attacked prey close to their antennules, mandibles, and mouthparts. Perception volume was estimated from the length of antennules and detection distance. Encounter rate was evaluated from the perception volume, sinking speed, the time spent for sinking, prey swimming speed, and prey density. *O. davisae* can continually attack prey during a short time and then

rest for a long time. Under natural conditions, where prey organisms may not be encountered regularly, the voracious *O. davisae* will ingest prey frequently when available. The success rate of prey capture is inversely correlated with the ingestion distance (the distance between prey and copepod's mouthpart), indicating that it is easier for *O. davisae* to capture a nearer prey than a father prey. That is, as prey density becomes higher, the distance to prey decreases; therefore, prey ingestion rate should be nonlinearly correlated with prey density. Under a prey density of 2000 cells $mL^{-1}$, *O. davisae* attacked about 20% of encountered prey and captured 40% of attacked prey. This indicates that ingestion rate not only limited by encounter rate and handling time, but also by attack rate and capture success rate.

The behaviors of both sexes were observed and compared under certain prey densities. *O. davisae* attacked prey while sinking (38% for males and 33% for females), jumping (54% for males and 67% for females) or cruising (8% only for males). Females have a stronger ability to encounter and response to prey than males. Females spent >90% of their time in sinking, which is 3 times as high as males do; however, the perception volumes of both sexes were similar (~$10^{-4}$ mL). Thus, the time spent for sinking is the main determinant component of sexual dimorphism in prey encounter rate. Females attacked prey at a longer distance, which was 1.5 times of that of male. Both attack rate and ingestion rate for females were 3 times of that for males. Therefore, the sexually dimorphic ingestion rates are derived from mainly the attack rate and the ingestion distance. On the other hand, males spent most of their time in finding mates by swimming faster and ingesting less. The high foraging and feeding ability of females can partially explain the female-biased sex ratio in this species. The sexual differences in behavior may be due to males and females having different main missions in reproduction, i.e. females require more energy for egg production while males need to search for mates.