Comparative SEM Study of Mouthpart Diversity in Three Estuarine Copepod Species

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Introduction

Copepods are the most numerous multicellular organisms on Earth, being found in all aquatic environments. Three copepod species were used in this study. While *Acartia tonsa* and *Labidcocera aestiva* are planktonic calanoid copepods, *Oncaea venusta* is a benthic cyclopoid. *Acartia* has a naupliar photosensitive eye and is primarily a filter feeder. However, its "nutcracker-like" mandibles can be used for processing mineralized food sources. *Labidocera* has transformed eyes with two dorsal scanning eyes and one smaller ventral eye to facilitate hunting. Its mouthparts are specialized for holding large struggling prey during mastication. Exaggerated appendages facilitate enhanced propulsion to capture prey. *Oncaea*, a blind species, is both a benthic scavenger and a predator. This study seeks to correlate anatomical specializations with feeding strategies.

Methods and Material

Copepods were field collected using a 300µ plankton net in the Apalachicola Estuary of the northern Gulf of Mexico. Species were sorted by light microscopy and microsurgically manipulated to expose internal structures. Samples were fixed in 2.0% glutaldehyde, rinsed, ththen fixed in 1% osmium tetroxide. Samples were then dehydrated in added alcohol and dried using HMDS. Specimens were then placed on stubs using adhesive carbon mounts, sputter-coated with gold-palladium, then viewed on a Hitachi TM-3000 scanning electron microscope. Images were processed using Adobe Photoshop.

Discussion

Due to its larger size, *Labidocera aestiva* can consume a wider variety of prey than could be injested by *Acartia tonsa*, allowing both species to occupy similar habitats without direct competition. *A. tonsa*, the middle-sized species, is an omnivore with maxillae and mandibles that can be used for grasping prey in addition to the filter feeding of particulate matter. A. tonsa has 7 mandibular teeth on each side of its mouth that are rounder and not as jagged as those of L. aestiva's. Thus, its teeth are more suited for grinding than tearing, but have the ability to do both. Additionally, A. tonsa lacks the setae that L. aestiva uses to filter out certain foodstuffs, such as plant matter. This is consistent with A. tonsa's filter feeding habits. *L. aestiva's* mandible has a toothed gnathobase with carnivorous dentition (figure 4). The most ventral tooth is monocuspid, serrated, and separated from the other teeth by a diastema (figure 9).

Fig. 1: Light micrograph of *Labidocera aestiva.* Note anteriorly located two dorsal and one ventral eye. 80X

Fig. 2: Light micrograph of *Oncaea venusta.* Note the translucency of the cuticle and diminished appendages. 800X

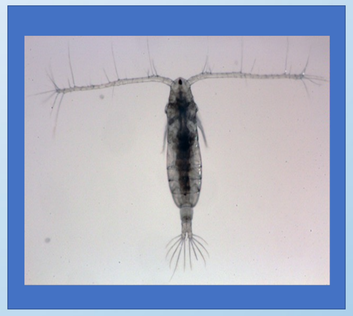

Fig. 3: Light micrograph of *Acartia tonsa.* Note cuticular transparency and prominent antennules. 250X

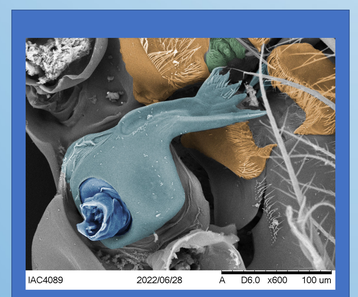

Fig. 4: SEM of *Labidocera* mandibles. Coxa (blue) comprises tooth gnathobase. 600X

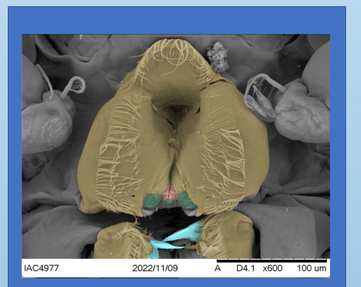

Fig. 5: *Labidocera* labium. Note hood and tripartite labium with central oral cavity. 600X

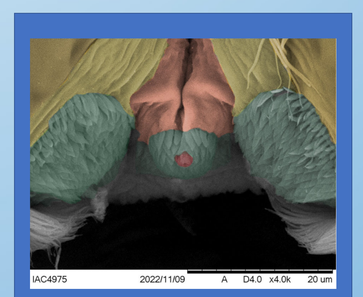

Fig. 6: *Labidocera* labial filtration basket, includes erectile spines, lubricating filaments,. Erectile spines (green) form a size selective filter. Central gland (red) of unknown function. X4.0K

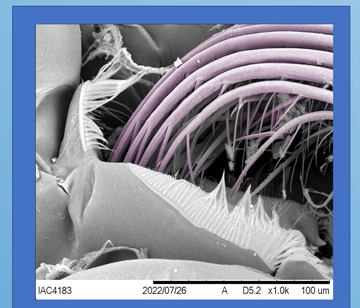

Fig. 7: *Labidocera* maxillae (green) placing trapped food particles into the oral cavity. SEM 1.0X

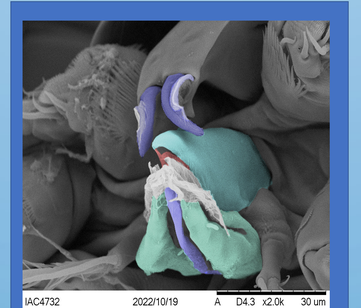

Fig. 8: *Oncaea* mouth parts. Ingestion of scavenged food (white) SEM 2.0KX.

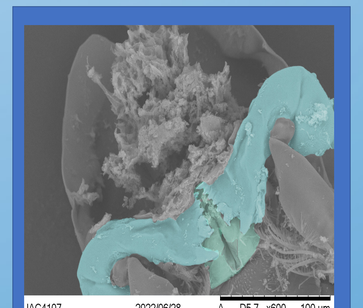

Fig. 9: *Acartia* mandibles (blue). Note coxa's gnathobase ending in teeth.

Discussion Continued

In contrast, *O. Venusta* is *a* scavenger that has a mandible suited to scraping/rasping food particles, while the sharp maxillipeds are used for prey penetration. *O. venusta* use nonvisual sensory cues to locate food (figure 8). It uses antennae to locate food, and maxillipeds to pierce, tear, and macerate the prey. The mandible functions much like a proboscis to ingest preys' body fluids (figure 8). Thus, each species studied uses mouthparts that are specialized for its unique feeding habits and niche.

Conclusion

While the main role of the juvenile is to feed and grow rapidly, the primary role of the adult of a species is to obtain the nutrients needed for survival and reproduction. Thus, organs are specialized for the acquisition and processing of foodstuffs. Efficient food assimilation generates greater adult fecundity. Towards this end, the correlation of vision, mouthparts, and diet allow different species to define a unique niche within the same environment. While both *L. aestiva* and *A. tonsa* are planktonic calanoids, *L. aestiva's* scanning eyes allow it to hunt larger prey and its mouthparts are specialized for processing struggling prey. Larger prey supports *L. aestiva's* greater body size, giving it a niche distinct from *A. tonsa*. As a planktonic filter feeder, *A. tonsa's* eyes are used in phototaxis to facilitate nocturnal feeding. Mandibles allow *A. tonsa* to exploit additional foodstuffs with mineralized frustules, such as diatoms. *O. venusta* is a blind benthic scavenger whose mouthparts are specialized for grasping and tearing . These comparisons demonstrate that all three species are uniquely specialized to co-exist without direct competition while meeting the prime directive of reaching adulthood rapidly to optimize fecundity. Copepods, as the most numerous multicellular organisms on Earth, must have the ability to fully exploit available food sources without direct competition with one another. As such, we see a direct correlation between vision, mouthparts, and diet among three observed copepod species.

Acknowledgments

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