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Estuarine Copepod Internal Anatomy: An SEM Evaluation of Microsurgery

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Copepods are ubiquitous in aquatic environments, being the most numerous multicellular organisms on planet earth. As primary consumers, zooplankton play important ecological roles, passing energy from one trophic level to the next. Estuarine copepods contribute substantially to carbon cycling as they undergo diurnal migration to avoid daylight UV-B damage and surface water predation.

Estuarine copepods were field collected by plankton tows in the Apalachicola Estuary of the Gulf of Mexico, along the Florida Panhandle. While many microscopic techniques have been employed to look at the anatomy of copepods, few match the level of detail rendered by microsurgery followed by SEM. Estuarine copepods are rather small, measuring half mm to several mm in length, being approximated by the width of a human hair. Microsurgery was conducted under a dissecting scope fitted with foot controls, modified from ophthalmic surgery. Sagittal, transverse, and coronal incisions were performed to expose internal anatomy. Surgical success was evaluated by SEM.

Female reproductive anatomy revealed distinct progressive egg development in the ovary. Surgically bisected oviducal eggs, showed both yolk and albumin strata, along with attached nurse cells. Considerable variation was found in the genital aperture between species to accommodate both spermatophore attachment variants, as well as egg mass production. Spermatheca have highly variable morphology amongst invertebrates [1,2]. Copepod spermatheca were noted to have several morphologically distinct regions believed to correspond to sperm delivery from the spermatophore, sperm storage, nutrient maintenance of stored sperm, and sperm delivery to ovulated ova.

The male reproductive tract revealed classic components including testis, vas deferens, seminal vesicle, spermatophore sac, ejaculatory duct, and gonopore [3]. A completed spermatophore, bearing attachment plaques, was found within the spermatophore sac, *en route* to the gonopore.

Labidocera aestiva is a hunter with transformed eyes with a GRIN lens and scanning retina. Lens cross section reveal concentric rings, each made of lamina comprising lens fibers, all covered by polygonal surface epithelial cells that provide nutrient and waste exchange to deeper layers.

Being a hunter, *Labidocera* mouthparts show specialization far beyond the classic filter feeding copepod. The challenge of consuming large struggling prey is to be able to retain it following the first bite. In addition, no single bite should be large enough to block the mouth. A filter mechanism, with erectile scales, is employed. In addition, labral gland acini were identified with ducts leading to the oral orifice. These are presumed to provide lubrication, agglutination, and to initiate digestion. There appears to be a distinct correlation between copepod vision, mouthparts, and dietary preference.

While many modern techniques can show the location and shape of internal organs in intact copepods [4,5], few reveal the level of SEM detail following microsurgery, justifying the training effort.

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