

Exogonadal Oogenesis in a Temperate Holothurian

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Abstract. Unusual structures were detected on the visceral peritoneum of the ovarian tubules in about 5%–10% of female sea cucumbers (*Cucumaria frondosa*) collected off Newfoundland, eastern Canada. The condition varied from mild to severe, with localized castration observed in the most heavily affected tubule sections. Investigation of the structures using histology, transmission electron microscopy (TEM), and gene analysis revealed that they were oocytes at different stages of development, growing singly or in groups of up to six. Their size and composition were consistent with those of oocytes found in the lumen of the ovaries, although “exogonadal” oocytes were devoid of a vitelline coat and presented few cortical granules. TEM sections suggest that the atypical oocytes emerged from the peritoneum and grew toward the coelomic cavity, and that they were not in direct contact with the basal lamina or the inner germinal layers. Similar masses have been observed in *C. frondosa* from the Gulf of St. Lawrence (Québec, Canada) and the Barents Sea (Russia), and in *C. japonica* from Russia and *Psolus fabricii* from Canada. The possibility that exogonadal oogenesis is attributable to anthropogenic disturbances should be investigated even though some of the affected specimens originate from presumably pristine locations.

Introduction

Oocytes in holothurians, as in other echinoderms, are produced in the ovary of the female; they are formed from

reproductive cells called germ cells, in a process referred to as oogenesis. The very close link that exists between the germinal epithelium, the germ cells, and the growing oocytes is obvious from histological preparations in many echinoderms (see review in Giese *et al.*, 1991). The production of new gametes is increasingly well understood in echinoderms, despite noticeable variations between different groups and species (Frick *et al.*, 1996; Walker *et al.*, 2005, 2006, and references therein). Briefly, the oocytes in holothurians are initially present as epithelial cells in the germinal epithelium and then bulge into the hemal sinus as they enlarge. A basal lamina lies between the oocyte base and the hemal sinus. As oogenesis progresses, the oocytes enlarge and the basal lamina is extended. The oocytes are growing from the basal lamina and hemal sinus toward the lumen of the gonadal tubules during this process (Frick *et al.*, 1996).

The sea cucumber *Cucumaria frondosa* is a well known broadcast-spawner, and its oogenesis has been described in populations from various regions (Jordan, 1972; Coady, 1973; Hamel and Mercier, 1995, 1996b, 1999; Singh *et al.*, 2001). The individuals examined during the present study followed the previously described pattern. However, whitish growths were found on the external epithelium of ovarian tubules in 5%–10% of samples collected off Newfoundland, Canada. A similar condition has previously been observed in *C. frondosa* and other species from various locations but was never fully characterized, except by an early Russian investigator who described it as a parasitic infestation (Djakonov, 1923). We hereby present histological, genetic, and ultrastructural evidence that these growths are in fact abnormal “exogonadal” oocytes. To our knowledge, this is the first description of its kind in the literature and should warrant further investigation into the process of oogenesis in holothurians.

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Abbreviations: EO, exogonadal oocyte; PCF, perivisceral coelomic fluid.