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Hermaphroditism in Laboratory-Cultured Albino Western Mosquitofish

SWEE J. TEH*

Department of Anatomy, Physiology, and Cell Biology, University of California-Davis, Davis, California 95616, USA

CHRIS E. MILLER

Contra Costa Mosquito and Vector Control District, Concord, California 94520, USA

DAVID E. HINTON

Department of Anatomy, Physiology, and Cell Biology, University of California-Davis, Davis, California 95616, USA

Abstract.—During routine inspection of a colony of albino western mosquitofish *Gambusia affinis*, approximately 10 females were discovered to have distended abdominal cavities. Cause for the distention was investigated by examination of tissue sections from four sacrificed individuals, all of which suffered severe ascites. Hermaphroditic gonads were seen in two of the fish.

Since 1991 the Contra Costa Mosquito and Vector Control District has maintained a small inbred colony of albino western mosquitofish *Gambusia affinis* for use in ornamental fish ponds and water gardens for mosquito control. During a routine inspection of the fish colony, approximately 10 females had distended abdominal cavities. Behavior and swimming pattern did not seem to be affected in these fish.

Methods

To investigate the cause of the distention, four females were anesthetized by placement in tricaine methanesulfonate (50 mg/L; MS-222, Sigma, St. Louis, Missouri) and fixed in 10% neutral-buffered formalin. Tissues were dehydrated in a graded ethanol series and embedded in JB-4 glycolmethacrylate (GMA; Polysciences, Warrington, Pennsylvania); five sections (4 μm thick), at 100–200-μm intervals, were cut from each fish and stained routinely with Mayer's hematoxylin and eosin.

Results and Discussion

All four fish had severe ascites. Microscopically, all livers had severe vacuolar (fatty) change, inflammation, and hepatocellular glycogen depletion. All fish had ovaries with edema, follicular atresia, and multifocal granulomatous inflammation. Hermaphroditic gonads (Figure 1) were seen in two of four fish.

To date, there is no report of hermaphroditism in laboratory-cultured *Gambusia.* Although sexual dimorphism is pronounced and seems stable in *Gambusia,* the bipotentiality of the sex cells—that is, the ability for hermaphroditism to develop in *Gambusia* (sperm cells in the ovary or eggs in the testis)—under the influence of androgenic and estrogenic compounds has been described (Okada 1943). Okada (1943) showed that unlike other species of fish in which induction of hermaphroditism can only be seen in mature females, it is possible to induce hermaphroditism in mature female and male mosquitofish under the influence of appropriate gonadal hormones. Unlike the masculinization and development of gonopodium in females exposed to certain concentrations of pulp-mill effluents (Howell et al. 1980; Cody and Bortone 1997), it is postulated that the stimulation of hermaphroditism in the western mosquitofish of the present study might have resulted from either dietary stress, instability of the sex cells, or chronic exposure to much lower concentrations of chemicals in the water or diet such that no induction of secondary male sex characteristics was seen. The observation of hermaphroditic gonads in two females showing no signs of external male secondary sex characteristics is unique.

* Corresponding author: sjteh@ucdavis.edu

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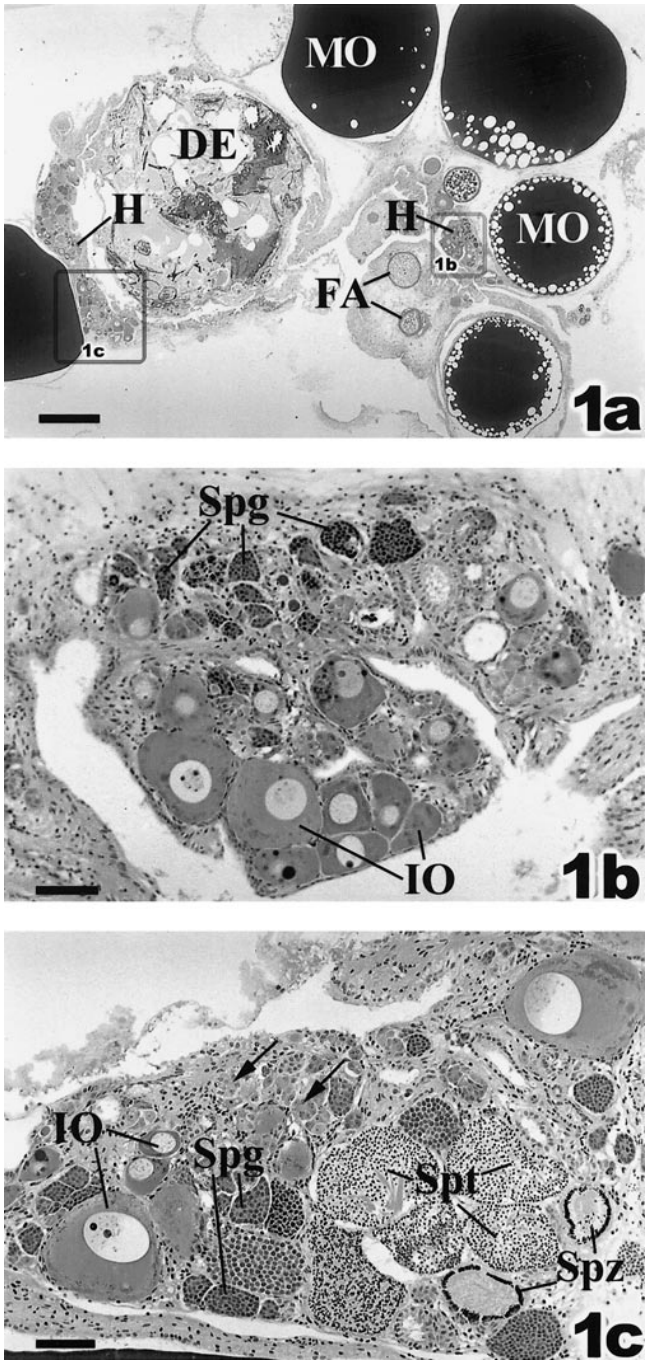

FIGURE 1.—Tissue sections of western mosquitofish stained with hematoxylin and eosin. **(a)** Section shows ovary with hermaphroditic gonads (H), dead embryonated egg (DE), mature ova (MO), and follicular atresia (FA). Bar = 500 μm. **(b)** Higher magnification of the hermaphroditic gonads (box 1b) in panel (a) showing the presence of immature ova (IO) and spermatogonia (Spg). Bar = 50 μm. **(c)** Higher magnification of hermaphroditic gonads (box 1c) in panel (a) showing the presence of immature ova (IO), spermatogonia (Spg), spermatids (Spt), and spermatozeugmata (Spz). Arrows point to the undifferentiated germ cells. Bar = 50 μm.

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