PEEIR

Pacific Estuarine Ecosystem Indicator Research Consortium

Endocrine Disruption in a Salt Marsh Fish as an Indicator of Wetland Condition

Issue

Contamination of many wetlands by industrial chemicals, many of which are endocrine disrupting compounds (EDCs), has resulted in fish and invertebrates exhibiting alterations in reproductive function. Hormones such as natural and synthetic estrogens, and many other chemicals such as PAHs, PCBs, plasticizers (phthalates), dioxins, pesticides, personal care products and pharmaceuticals released from sewage treatment plants can disrupt endocrine function. Chemical analysis of sediments may not be an effective approach for identifying EDCs, since it is costly, and will not reflect bioavailability of the chemicals. However, managers must prioritize and control the release of hundreds of "emerging contaminants"? A characterization of the physiological condition of resident species that includes both indicators of endocrine disruption and of overall reproductive health, can provide a clear picture of the organismal impacts of EDCs and reproductive contaminants.

Approach and Rationale

Our approach was to focus on two types of reproductive impacts of EDCs in *Gillichthys mirabilis* (long-jawed mudsucker) collected from or outplanted at selected California marshes: 1) the presence of choriogenins (egg coat proteins) in male or immature fish and 2) the co-occurence of ovarian *and* testicular tissue (ovotestes). These abnormalities were analyzed in conjunction with a cell reporter assay for endocrine disruption potential, as well as with direct chemical characterization of sediments from these marshes (Link to Sediment Quality Objectives). The rationale for this approach was as follows:

- Choriogenins (egg coat proteins) are normally produced in the liver in response to estrogen and are transported in the blood to the ovary of reproductive female fish. They are not normally found in male or immature fish, thus the presence of choriogenins in plasma of male/immature fish reflects exposure to EDCs. Choriogenins are easily detected in plasma with Western blot analysis or ELISA and a choriogenin antibody. Fish can be marked and sampled repeatedly, allowing for numerous temporal assessments in order to monitor dynamic habitat condition, success of remediation, etc.

- Ovotestes are gonadal tissues with characteristics of both testicular and ovarian structures, and reflect exposure to EDCs that are estrogenic or anti-androgenic. Dissection of fish and gross examination of gonadal tissue for ovotestes is routine. Histological examination of tissue sections for confirmation of ovotestes, as well as for the presence of tumors and apoptosis (Link to Fish Apoptosis) is useful. Tissue samples for histology can be archived and analyzed at a later date.

Findings and Impact

Fish from contaminated marshes exhibited several types of impaired reproductive function:

- Choriogenins were detected in the plasma of a higher percentage of male/immature fish from marshes with higher contaminant levels (Figure 1a). Mudsuckers outplanted at selected stations reflected a similar trend (Figure 1b). The types of contaminants detected in sediments at sites where endocrine disruption occurs include PCBs, PAHs, DDT pesticides, metals, and phthalates (Link to Sediment Quality Objectives).

- The sediment estrogenic potential, as determined by a recombinant cell reporter assay, showed a similar response as choriogenins.

- Ovotestes were found only in fish from the most contaminated marshes, Stege and Carpinteria (Figure 2a). Typically one of the paired gonads exhibited both types of tissue (Figure 2b).

A research partnership between **University of California, Davis, Bodega Marine Laboratory** and **University of California, Santa Barbara**
Funded by **U.S. EPA Science To Achieve Results (STAR) EAGLE Program** Grant No. R82867601

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant # R-82867601

PEEIR

Pacific Estuarine Ecosystem Indicator Research Consortium

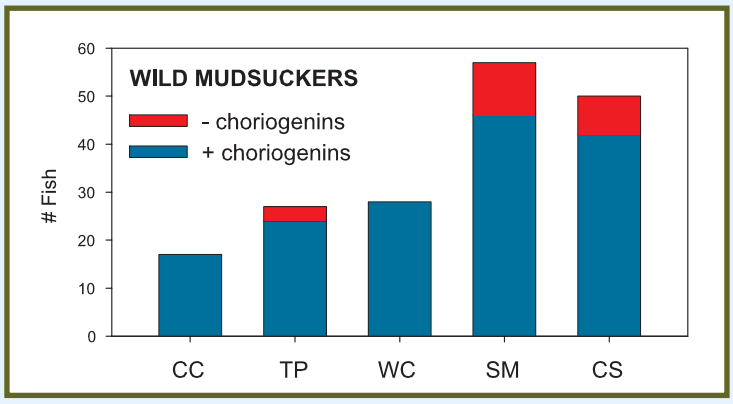

Figure 1a. Wild caught mudsuckers from Stege Marsh (SM) and Carpinteria Salt Marsh (CS) exhibited a higher incidence of chorio-genins in male or immature fish than mudsuckers collected from the less obviously contaminated marshes China Camp (CC), and Walker Creek (WC), although a few fish from Tom's Point (TP) also had choriogenins.

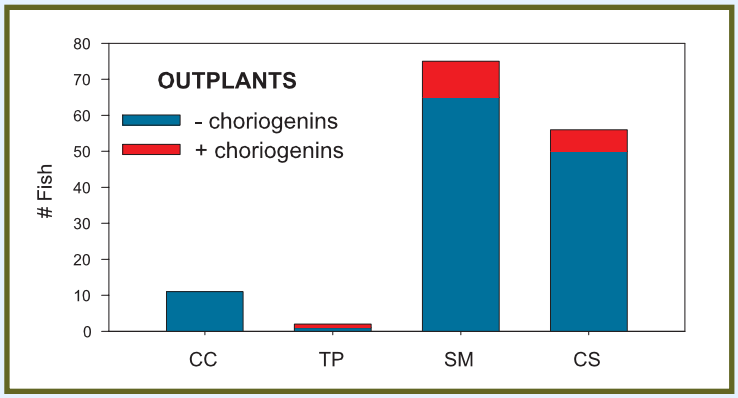

Figure 1b. Naive fish outplanted for 3 months at the sites indicated showed a similar trend.

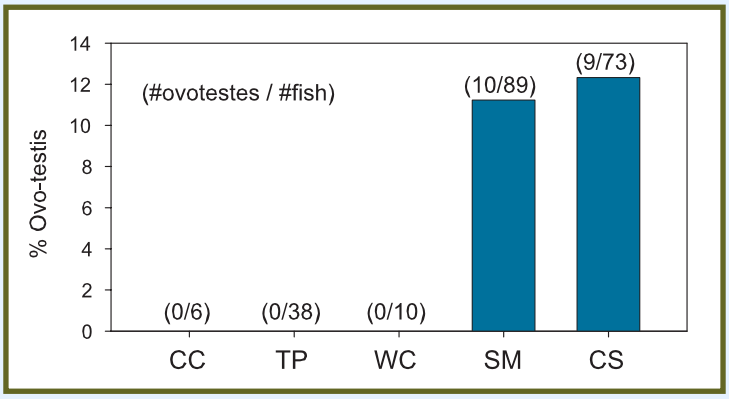

Figure 2a. Ovotestes were found only in mudsuckers from Stege Marsh and Carpinteria Salt Marsh.

Figure 2b. Mudsuckers from contaminated sites showed ovotes-tes where the gonads exhibited both testicular and ovarian tissue (top). Normal females show the typical paired ovaries of equal size (bottom).

Applications

- Presence of choriogenins in mudsuckers is a useful indicator for managers interested in diagnosing or monitoring for the presence of endocrine disrupting compounds in salt marshes. The techniques involved are relatively non-invasive (involving blood collection), and are routine and relatively inexpensive, involving analysis of plasma for choriogenins using commercially available antibodies and common detection methods. Analyses of fish from other marshes in the SF estuary is underway.

- The presence of ovotestes is a functional indicator of impaired reproduction due to EDC exposure in mudsuckers. Although sacrifice of fish is necessary, gross examination of gonads is inexpensive and simple to perform, and can be followed up by histological examination of tissue sections where appropriate.

- The EDC indicators developed here provide tools for managers to map the extent of endocrine disruption within or between marshes.

Contact Names

University of California, Davis, Bodega Marine Laboratory,
Carol A. Vines, cavines@ucdavis.edu
Gary N. Cherr, gncherr@ucdavis.edu

Contributing investigators, UC Davis: Swee Teh, Hyun Min Hwang, Steven Morgan, William A. Bennett, Susan Anderson; UC Santa Barbara: Andrew Brooks, Roger Nisbet

A research partnership between **University of California, Davis, Bodega Marine Laboratory** and **University of California, Santa Barbara**
Funded by **U.S. EPA Science To Achieve Results (STAR) EAGLE Program** Grant No. R82867601

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant # R-82867601