

**PROCEEDINGS  
OF THE  
NINTH SYMPOSIUM  
ON THE  
NATURAL HISTORY OF THE  
BAHAMAS**

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## RELEVANCE OF MANGROVE RIVULUS BIOLOGY TO ECOLOGICAL AND LABORATORY STUDIES: AN ENCAPSULATED SUMMARY

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### ABSTRACT

“Unique,” is a word used frequently in discussions of the cryptic self-fertilizing, euryhaline fish, mangrove rivulus (*Rivulus marmoratus*), a.k.a. “rivmar.” This poster summarizes our current knowledge and some of the special features of this species.

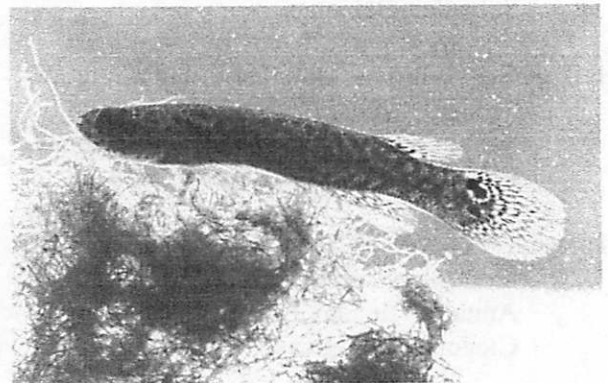
### INTRODUCTION

Rivmar represents the only known vertebrate adapted to “selfing.” Reproduction occurs by internal fertilization of ova within the oviduct of an integrated ovotestis. In nature, propagation through this “selfing” produces homozygous lines, which with current collection samples, seem to be more common in natural populations than are heterozygous individuals. Rivmar has a remarkable distribution from Brazil to mid-Florida.

Throughout their distribution rivmar are found in the mangals of western Atlantic coastal or island environments. Rivmars are especially associated with the red mangroves that provide habitats including crab burrows, temporary pools, tidal creeks, solution holes and a variety of wet microhabitats. In nature rivmar feed on invertebrates, crustacea, worms, insects or virtually anything they can ingest, including small fish and their own species. Rivmar behaviors include special adaptations related to their natural habitat including emersion from stagnant pools or burrows. When concentrations of H<sub>2</sub>S increase, rivmar respire in air through their skin by expansion of epidermal capillaries. Furthermore, they may move over the forest moist floor. They apparently can also aestivate within moist substrates, perhaps for months at a

time during drought. Additionally, there is evidence that diapause may occur in pre-hatch embryos within the chorion.

In the laboratory mature rivmar readily release fertile eggs. Hatchlings may be easily reared, and become reproductive at age 4-5 months. We have had individuals that continued producing fertile embryos for as long as 5-6 years. Rivmar represents an excellent organism for studies of reproduction. Specifically it represents an excellent vertebrate for investigating life history pattern, and how life cycle success might be impinged by environmental pollutant factors. Overall, *Rivulus marmoratus*, is an enigmatic specialist: one little fish that poses a wealth of biological questions!



**Figure 1.** *Rivulus marmoratus* (~30mm) captured in Crescent Pond, San Salvador, Bahamas with the pigmentation typical of the hermaphroditic form.

*Rivulus marmoratus* (mangrove rivulus; Figure 1), "A small brown creature (<100mm) which frequents standing pools in mangroves of the Western Atlantic...."

Range: Rivmar are distributed from south of Rio de Janeiro, Brazil apparently along the coast of South American nations throughout the Caribbean to mid-Florida (north to New Smyrna Beach and Tampa Bay). It has not been captured in west Gulf of Mexico north of Yucatan, implying Florida was colonized as an island like the Bahamas, Cuba and the rest of the Caribbean. This region also lacks development of mangals. This is a truly remarkable distribution range for a non-pelagic coastal fish species (Figure 2).



Figure 2. Remarkable distribution of *R. marmoratus*, which on a chart of the Western Atlantic is only missing from the west and north coasts of the Gulf of Mexico.

Emersion: Departs pools during H<sub>2</sub>S episodes taking refuge in hollows, burrows in the moist debris substrate of the mangal (Figure 3). Can cross the forest floor by flipping and squirming.

Diet: In the wild: crustacea, insects, worms or may be cultured with *Artemia* or most live foods.

Described by: Poey described from Cuba 1880. Redescribed by Rivas 1945 with "rediscovery" in the Florida Keys and Vero Beach, FL (Harrington and Rivas 1958).

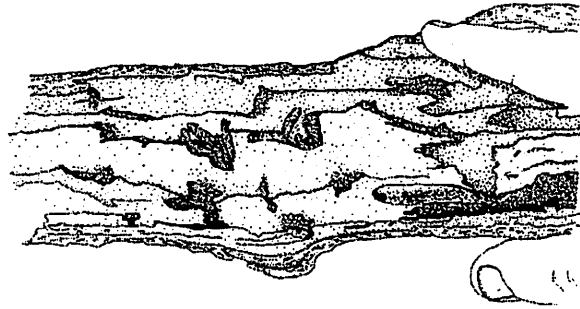


Fig. 3. A sketch from a photograph of a black mangrove branch which was a refugium for over 40 individual *R. marmoratus* escaping from stagnant pool that had become anoxic with high concentration of hydrogen sulfide.

Trap Capture: Rivmar is rarely captured with nets, i.e. seines. We use a variety of traps, including cups with funnel openings, tubes, and mesh-lined standard minnow traps and "Breder" traps depending upon the microhabitat (Figure 4). Also, the species voraciously bite and hold onto small worms when fished with small hooks.

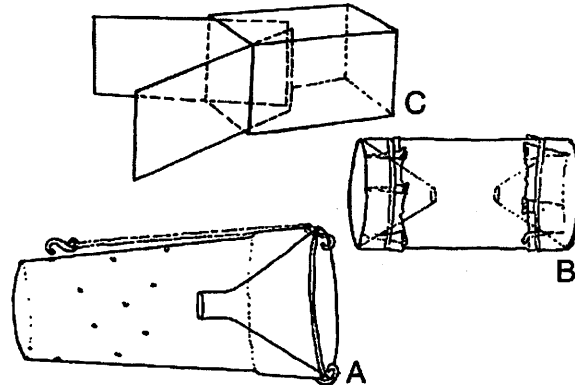


Figure 4. Examples of traps used in different microhabitats for capture of *Rivulus*: A. "DST" plastic cup and funnel design is particularly effective in land crab burrows; B. a plastic tube (~70-100mm dia.) with insect screen funnels may be fabricated in the field, and fishes many situations; C. "Breder" traps fish well in areas with changing water levels, but are cumbersome in thick mangrove habitats.

Reproduction: Internal fertilization of ova, within the oviduct, (selfing) producing homozygous clonal lines.

Laboratory Culture: Cultured for many generations in Carolina stackable culture bowls, but also have been reared in mayonnaise jars (by Harrington), or other small containers and aquaria (with covers !). For over 30 years successive generations of rivmar have been cultured in various laboratories.

Published studies:

- Hermaphroditism
- Homozygosity
- Field studies
- Diet
- Epidermal adaptations for aerial respiration
- H<sub>2</sub>S induces emersion
- Salinity influences chloride-cell development
- Induction of tumors by carcinogens
- Induction of skeletal anomalies by xenobiotics
- Population analyses by DNA fingerprinting
- Heterozygosity in specific populations
- Variation in percentages of phenotypic males in different populations
- Phylogenetic relationships by mitochondrial DNA
- Responses to toxic metals and EDC's.
- Behavior: Aggression models

Future Objectives:

- Inhibit/arrest male sexual function
- Produce functional females to enable crossing and creating different lines
- Gonadal tissue endocrinology in rivmar ovotestis function.

Web Site: <http://www.bsi.vt.edu/rivmar/>

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