

First record and establishment of an exotic molly (*Poecilia butleri*) in the Baja California Peninsula, Mexico

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The family Poeciliidae (37 genera and about 304 species) includes live-bearing fishes of small size (<200 mm length) having diverse morphology and coloration, with distribution in the freshwater and brackish environments of the eastern United States, South America, and Africa, including Madagascar (Moyle 2002, Nelson 2006). Males of new world species possess the elongated anterior anal fin rays modified as a gonopodia to place packets of sperm in the vents of females, which subsequently bear live young (Moyle 2002). Twelve poeciliid species are native to the United States (Page and Burr 1991), and about 78 are native to Mexico (Miller et al. 2005). The genus *Poecilia*, with 27 species (Nelson 2006), is represented in Mexico by 12 nominal species (Miller et al. 2005).

A myriad of species of the genus *Poecilia* have been widely and deliberately introduced worldwide for mosquito control (Fuller et al. 1999) or the aquarium trade (Crossman and Cudmore 1999) due their short generation time, colorfulness, hardiness, and readiness to breed in captivity (Moyle 2002). The stocking of exotic fishes into natural water bodies has caused strong impacts to the native biota, especially in biotopes with low species richness that are typical of arid or semiarid regions of North America (Minckley and Douglas 1991, Contreras-Balderas et al. 2008). Two invasive exotic fishes of ample distribution among the oases of the Baja California peninsula are the guppy (*Poecilia reticulata*) and redbelly tilapia (*Tilapia* sp. cf. *zillii*) (Ruiz-Campos et al. 2003). Both species

have contributed to the population decline of the endangered endemic Baja California killifish (*Fundulus lima*) throughout its distributional range (Ruiz-Campos et al. 2003, Ruiz-Campos et al. 2006).

This work provides the first record of Pacific molly (*Poecilia butleri* Jordan 1889; Figure 1) in the Bahía de La Paz and in the Baja California peninsula, Mexico. This molly is native to freshwater and estuarine biotopes in the Pacific slope of Mexico and Middle America, from the lower Rio Fuerte basin, southeastern Alamos, Sonora, southward into the mouth of Rio Comasagua, west of La Libertad, El Salvador (Miller et al. 2005). Although the Pacific molly has an ample distributional range, it is considered as specially protected by the Mexican government (SEMARNAT 2010). Recently, it has been reported from the upper Rio Ameca and Rio Coahuanyana basins, in the State of Jalisco, Mexico (Miller et al. 2005), and is considered an exotic species in that geographic area.



FIGURE 1.—Pacific molly, *Poecilia butleri* (UABC-1882), female 45.9 mm SL (upper) and male 45.3 mm SL (lower), collected at Estero Enfermeria, Baja California Sur, Mexico, on 9 September 2010. Photograph by Gorgonio Ruiz-Campos.

Our collecting site was the Estero Enfermeria located into Bahía de La Paz (BLP), Baja California Sur (24°14'30" N, and 110°18'30" W). This salt marsh is connected to BLP through of a narrow channel of approximately 6-m wide and 0.8-m deep. The water temperature ranges from 32°C (July) to 19.4°C (December), salinity from 34 to 44 ppt, and percent of organic matter from 2.8% (soft bottom of the salt marsh) to 1.8% (channel of coarse bottom) (Espinosa et al. 1982). Vegetation is composed of macroalgae of the genera *Spyridia*, *Lyngbya*, *Gracilaria*, *Caulerpa*, *Polysiphonia* and *Ulva*, which are attached to roots of the red mangrove (*Rhizophora mangle*) (Llinas-Gutiérrez 1983). The phytoplankton is dominated by *Gyrosigma*, *Amphora*, *Rhizosolenia*, *Navicula*, *Nitzschia*, *Chaetoceros* and *Coscinodiscus* (Bustillos 1981). Copepods are the most important zooplankton group (Sanchez et al. 1982), while the benthic macrofauna is represented by

56 species dominated by crustaceans and polychaetes (Llinas-Gutierrez 1983). The fish community associated with the mangrove ecosystem at the study site was previously described by Maeda-Martinez (1981).

A series of fish samplings were carried out in the channel section (24°13'55" N, 110°18'25" W) that connects the Estero Enfermeria to Bahía de La Paz, from November 2006 to September 2009. Additionally, we monitored the presence and dispersal of this molly into the adjacent salt marsh biotopes (e.g. Estero Erendira) on 25 July and 9 September 2009. The fishes were collected using a cast net (5-m diameter and 1-cm mesh size) and hand dip nets. Specimens were fixed in 10% formalin. The taxonomic identification was based on Miller et al. (2005). Specimens were measured in length (total length [TL] and standard length [SL]) with a digital caliper (precision 1 mm), and weighed to the nearest 0.01 g. Finally, the specimens were catalogued and deposited in the Fish Collection of the Universidad Autónoma de Baja California (UABC), at Ensenada, Baja California, Mexico.

A total of 16 individuals of Pacific molly (52.9-69.1 mm SL, 1.82-5.24 g) were caught on 6 November (n= 7, five females and two males; UABC-1882) and 18 November 2006 (n= 9, all females; UABC-1883). On 25 July 2009, we sampled the same site to verify the permanence of the species, and 20 individuals were collected (6 males and 14 females, 51.2 to 65.2 mm SL). On 9 September 2009, 19 individuals (14 females and 5 juveniles; UABC-2330) were collected at Estero Enfermeria, and nine other individuals (all females, 16.6 to 36.8 mm SL; UABC-2331) collected at Estero Erendira. During the collections, temperature varied from 29.9 to 34.2°C, salinity from 39.0 to 39.9 ppt, and dissolved oxygen from 4.6 to 8.14 mg/l.

The specimens of Pacific molly (Figure 1) were identified by the following diagnostic characters (Jordan and Evermann 1896): eye equal to snout, three times in head; body deep and compressed; the straight anterior profile rising considerably to front of dorsal; teeth in two series, well separated, the inner series smaller and more close-set and unicuspid at tips; color of males green, with a pale-blue spot on each scale, surrounded by bronze shades; females similar but paler with a faint dark spot behind the pectoral fin; and, dorsal fin with numerous round, black spots in both sexes.

Measurements and counts for 14 males (41.2-54.4 mm SL) follow Hubbs and Lagler (1958). Counts are expressed as range and mode for each character as follows: dorsal fin rays (9-10, 10), anal rays (8-9, 8), pectoral fin rays (13-14, 14), pelvic fin rays (6-7, 6), and gill rakers (24-26, 26). The measurements, in thousandths of the standard length, expressed as mean and standard deviation for dorsal fin length (138±12), anal fin length (69±11), pectoral fin length (75±7), pelvic fin length (46±8), pre-dorsal length (614±17), pre-anal length (609±18), body depth (356±15), caudal peduncle depth (199±9), interorbital distance (146±8), ocular diameter (82±9), pre-orbital length (77±8), and post-orbital length (125±8).

During sampling, we collected 20 other fish species associated with salt marsh habitats: *Cetengraulis mysticetus*, *Chanos chanos*, *Mugil cephalus*, *M. curema*, *Fistularia commersonii*, *Centropomus nigrescens*, *Hoplopogrus guentherii*, *Lutjanus aratus*, *L. argentiventris*, *L. novemfasciatus*, *Diapterus brevirostris*, *Eucinostomus currani*, *E. dowii*, *E. gracilis*, *Eugerres axillaris*, *Gerres simillimus*, *Haemulopsis elongatus*, *Abudefduf troschelii*, *Gobionellus microdon*, and *Sphoeroides annulatus*.

The Pacific molly represents the second non-native fish species reported for Bahía de La Paz; the other was the seabream (*Sparus aurata*; Balart et al. 2008). The Pacific

molly occurs in a variety of habitats such as brackish waters, the lower parts of big rivers and coastal lagoons, and usually prefers sites with aquatic vegetation such as algae and grasses (Schultz and Miller 1971, Miller et al. 2005). Its affinity for estuarine and freshwater environments could be a factor that promotes its potential dispersal to other sites of the Baja California peninsula. Other introduced fish species reported for the freshwater environments of Baja California Sur are common carp (*Cyprinus carpio*), guppy (*Poecilia reticulata*), green swordtail (*Xiphophorus hellerii*), southern platyfish (*Xiphophorus maculatus*), mosquito fish (*Gambusia affinis*), and redbelly tilapia (*Tilapia* sp. cf. *zillii*) (Ruiz-Campos et al. 2003, Ruiz-Campos et al. 2006).

The Pacific molly shows marked sexual dimorphism as well as a high reproductive potential, reaching sexual maturation at five or six months, and producing from 20 to 60 young after a gestation of 28 days (Wischnath 1993). In addition, this molly is a reservoir of some parasites such as trematodes, cestodes, and nematodes (Salgado-Maldonado 2006) that could be transmitted to the fishes listed above.

The presence of juvenile and mature Pacific mollies in different sampling dates and sites indicates its virtual establishment in salt marshes of Bahía de La Paz. Its rapid dispersal in the study area likely is a result of its viviparous reproductive strategy and its feeding based on dipterous larvae that are abundant there. The source of *P. butleri* in the brackish environments in Bahía de La Paz is probably escapees from the Pacific white shrimp (*Litopenaeus vannamei*) farms adjacent to Estero Enfermería. It is very probable that some individuals of Pacific molly were transported accidentally from Sinaloa to Baja California Sur via containers for breeding Pacific white shrimp from the year of 1995, as early shrimp farmers in Baja California Sur originally imported shrimp broodstock from Sonora and Sinaloa (Mazon-Suastegui et al. 1996).

The establishment of Pacific molly in the study area could result in competitive interactions with the juvenile stages of native fishes (e.g., mullets, snappers, grunts and snooks) that use the salt marsh biotopes as a critical nursery and recruitment ground (Gonzalez-Acosta et al. 1999). A program of monitoring for this exotic molly in the study area and adjacent sites is needed to evaluate its dispersal and invasive capacity, as well as its ecological interactions with the native fish species.

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