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FIRST RECORD OF A CYMOTHOID ISOPOD FROM A TIDEWATER GOBY AND THREE NEW TIDEWATER GOBY LOCALITIES IN HUMBOLDT COUNTY, CALIFORNIA

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The tidewater goby, *Eucyclogobius newberryi* (Teleostei: Gobiidae), is a small fish species restricted to brackish estuaries and lagoons along the California coastline from Tillas Slough, Del Norte County, to Agua Hedionda, San Diego County (Swift et al. 1989). In 1994, the tidewater goby was listed as federally endangered under the Endangered Species Act, due primarily to its disappearance from nearly 50% of its historic locations and the unstable status of remaining populations (USFWS 1994, 2005). Tidewater goby populations are negatively influenced by competition from non-native fish species, such as mosquitofish, centrarchids, striped bass, as well as both the yellowfin and chameleon goby (Swift et al. 1989, USFWS 2005); predation by the introduced African clawed frog, *Xenopus laevis* (Lafferty and Page 1997), and parasitism by both the trematode, *Cryptocotyle lingua* (Swift et al. 1989, Swenson 1999), and microsporidian, *Kabatana newberryi* (McGourty et al. 2007). To date, no reports exist of a cymothoid isopod and tidewater goby association.

The family Cymothoidae (Crustacea, Isopoda, Cymothoidae) consists of 380 spp. in 42 genera worldwide (Trilles 1991; N. Bruce, New Zealand's National Institute of Water and Atmospheric Research, personal communication). Most cymothoids occur in coastal, shallow-water environments (Bunkley-Williams and Williams 1998). Cymothoids are ectoparasitic, protandrous hermaphrodites considered to be permanent symbionts (Brusca 1981, Bunkley-Williams and Williams 1998). Many cymothoids are capable of causing deleterious effects to their host by inflicting large wounds, impairing growth rates, and occasionally killing the fish (Brusca 1981, Bunkley-Williams and Williams 1998, Bakenhaster et al. 2006). Cymothoids have been reported as ectosymbionts on a wide variety of host spp., mostly fishes (as summarized by Bunkley-Williams 1984). However, relatively few records exist that document cymothoid isopods infecting gobiid spp. (Popov 1933, Hatch 1947, Legrand 1952, Brusca 1981, Nieto and Alberto 1994, Charfi-Cheikhrouha et al. 2000, Ravi and Rajkumar 2007). Hatch (1947) and Brusca (1981) both reported cymothoids infecting the arrow goby, *Clevelandia ios*, in the eastern Pacific Ocean, but no records have documented an association between cymothoids and the tidewater goby.

One tidewater goby, 26 mm Total Length (TL), and associated cymothoid, 4 mm TL, were collected on 28 August 2006 in an unnamed slough tributary to the mainstem

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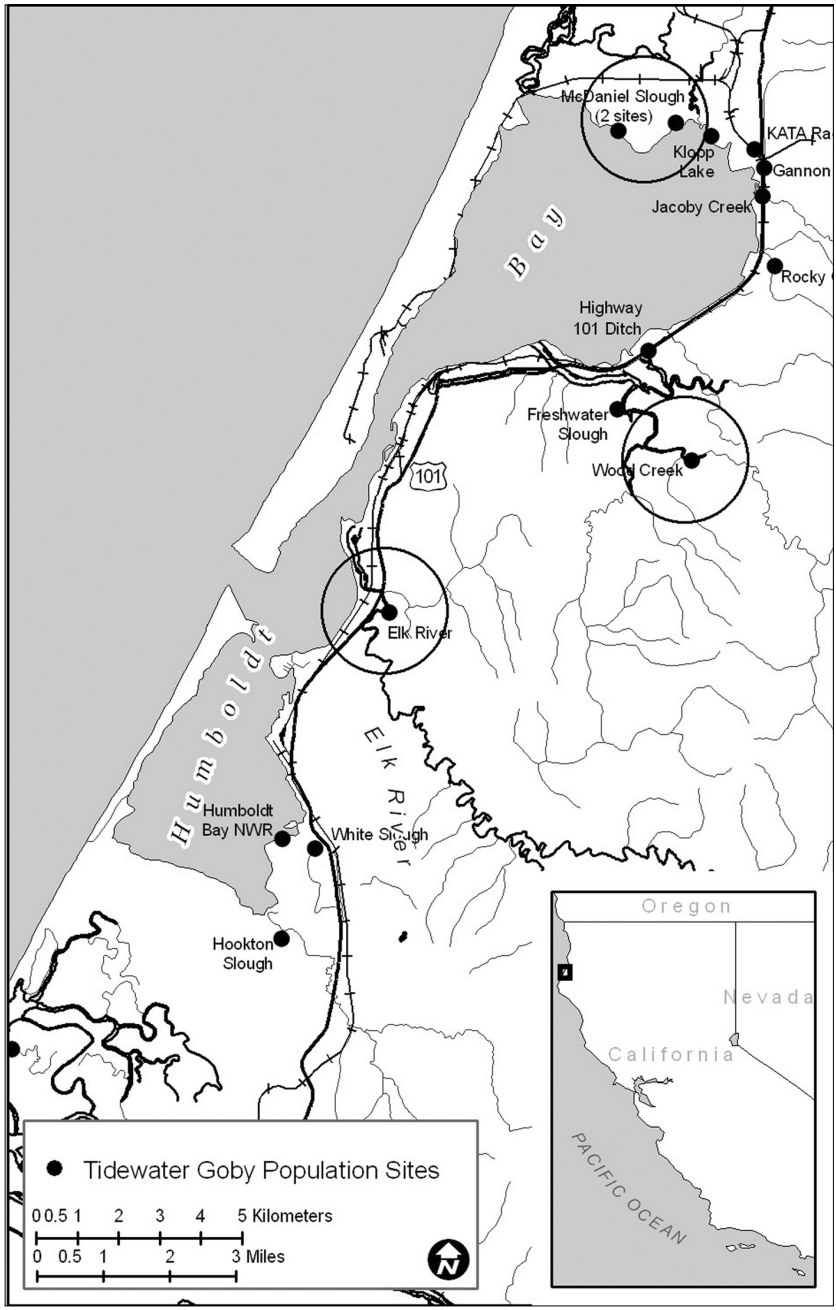

Figure 1. Known tidewater goby population sites in the Humboldt Bay area, including three new localities (shown in circles) discovered in 2006: (1) an unnamed slough tributary to the mainstem Elk River; (2) Wood Creek; and (3) McDaniel Slough.

Elk River in Humboldt County, California (40º45'3"N, 124º11'16"W) (Fig. 1). Elk River is the largest freshwater tributary to Humboldt Bay draining a watershed of 137 km^2 in area (Manka[2] 2005). An extensive northern range-wide study for tidewater gobies during the summers of 2003 - 2006 in northern California did not reveal an associated cymothoid at any other site. A total of 1,818 tidewater gobies were collected from 19 of the 76 total sites sampled from Tillas Slough, Del Norte County to Garcia River, Mendocino County during the four year study. The tidewater goby and associated cymothoid were placed in a holding container in order to observe swimming behavior of the goby, subsequently anesthetized in tricaine methanesulfonate (MS-222), transferred to 95% EtOH, and placed in the Humboldt State University Fish Collection (catalog number HSU 4275). The isopod was identified to the Family Cymothoidae using a dissecting microscope. The isopod was a male and/or juvenile, which are often impossible to identify to genus or species level. The cymothoid is reported as branchial parasite based on its position covering the gills, which leads us to believe this specimen may belong to the genus *Elthusa* (N. Bruce; J-P. Trilles, University of Montpellier, personal communication). Hatch (1947) and Brusca (1981) reported, mainly in California waters, *Elthusa californica* as a parasite to the arrow goby, which is a close relative of the tidewater goby. A total of 66 arrow gobies were collected during the four year study from nine different sites, but none were associated with a cymothoid.

Cymothoids have piercing-sucking mouthparts that are used for parasitic feeding and are capable of causing detrimental effects to their host (Stoskopf 1992, Bunkley-Williams and Williams 1998, Bakenhaster et al. 2006). Both the tidewater goby and cymothoid were living at the time of collection, and the goby did not display any clear visible signs of deterioration such as lesions, fin rot, or lethargic swimming behavior. The cymothoid was lodged underneath the goby's operculum and its length (over 15% of the goby's length) caused the operculum to be considerably stretched (Fig. 2). The cymothoid, nearly encased by the stretched operculum, was situated directly above the goby's gill arches. We believe its presence may harm the goby via three possible mechanisms: (1) the isopod may deform or erode the gill filaments based on its position (Sadzikowski and Wallace 1974, Brusca 1981, Williams and Bunkley-Williams 1985, Sievers et al. 1996, Thatcher et al. 2003); (2) the isopod may restrict respiration from the physical blockage of the gill opening (Segal 1987, Adlard and Lester 1995); and (3) the presence of the cymothoid may hinder the goby's weight balance and/or swimming endurance (Sievers et al. 1996, Östlund-Nilsson et al. 2005).

This is the first reported association of a cymothoid with a tidewater goby. Other authors suggest that cymothoids often have high host and site specificity (Brusca 1981, Bunkley-Williams and Williams 1998); and small fish may be more vulnerable to cymothoid infestation (Adlard and Lester 1995). At least five cymothoid spp. have been reported from gobiids: *E. californica* from the arrow goby mainly in California waters (Hatch 1947, Brusca 1981), *Anilocra frontalis* from the two-spotted goby,

[2]Manka, P. 2005. Suspended sediment yields in tributaries of Elk River, Humboldt County, California. M.S. Thesis, Humboldt State University, Arcata, California.

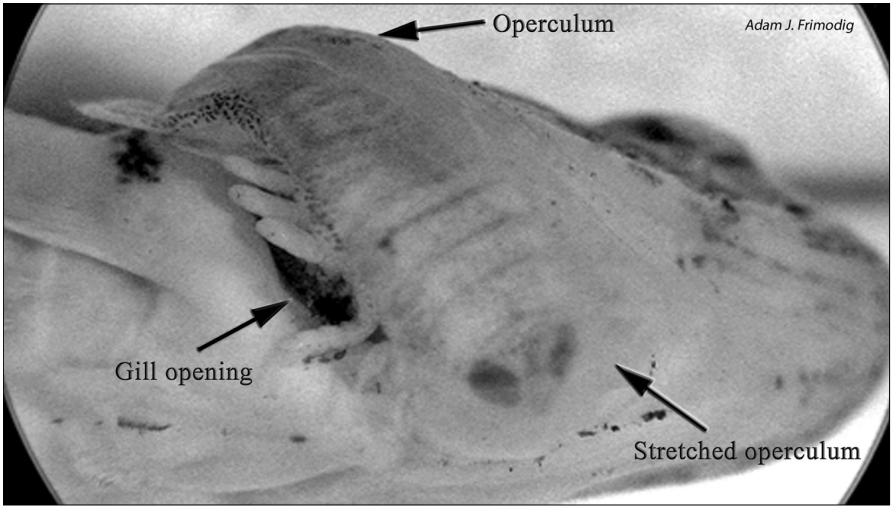

Figure 2. Picture of a cymothoid isopod (Isopoda, Cymothoidae) associated with a tidewater goby. The cymothoid is situated underneath the stretched right operculum of the goby indicated by the top and bottom arrows, and directly above the gill opening indicated by the middle arrow.

Gobius flavescens, the rock goby, *Gobius paganellus*, and the sand goby, *Gobius minutus*, in the Atlantic Ocean (Legrand 1952, Nieto and Alberto 1994), *Cymothoa indica* from the maned goby, *Oxyurichthys microlepis*, in the Indian Ocean (Ravi and Rajkumar 2007), *Nerocila bivittata* from the slender goby, *Gobius geniporus*, in the Mediterranean Sea (Charfi-Cheikhrouha et al. 2000), and *Nerocila tartakowski* from the knout goby, *Mesogobius batrachocephalus*, in the Black Sea (Popov 1933) (J-P. Trilles, personal communication). Presently, there is a lack of sufficient range-wide tidewater goby studies to assess whether or not the cymothoid found in this study is accidental or actually targets this endangered fish species. Most isopod gill parasites do not greatly distort the operculum and this male cymothoid was disproportionately large for the size of the tidewater goby host, suggesting that the isopod infestation may be accidental (N. Bruce, personal communication). Additionally, this is the first record of tidewater gobies inhabiting Elk River. Two other new locations, Wood Creek (40º47’1"N, 124º5’57"W) and McDaniel Slough (40º51’27"N, 124º6’20"W), were also discovered during the summer of 2006. Therefore, increased sampling and research clearly needs to be conducted on the tidewater goby, as well as careful inspection of individuals to determine if cymothoids are associated, in order to better understand and manage the population.

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