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NOTE

Facultative cleaning behavior in a western Atlantic sponge goby, *Elacatinus xanthiprora* (Teleostei: Gobiidae)

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Abstract

There are two large sets of brightly striped gobies of the genus *Elacatinus* in the warm waters of the western Atlantic Ocean: one that cleans larger fishes at cleaning stations on coral reefs and another set that live in and among sponges and are not known to clean. The two sets of gobies are phylogenetically separate as well, forming two independent monophyletic sets of mtDNA-sequence lineages. At almost all locations there are species of both groups present; however, at the northern temperate limits, along the northeastern coast of the Gulf of Mexico and along the east coast of the USA at North Carolina (beyond the range of coral-reef development), only one species is present and it belongs to the sponge goby group. We report here that the YellowproW Goby, *Elacatinus xanthiprora*, a member of the sponge goby group, regularly cleans fishes, both in the northern Gulf of Mexico and off North Carolina. Apparently, the absence of a local cleaner species permits the evolution of facultative cleaning behavior in a species from a group characterized by the absence of that behavior.

Key words: ichthyology, coral-reef fishes, cleaner goby, ecology, symbiosis, mutualism, behavior, YellowproW Goby, Florida, North Carolina.

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The large genus of cleaning and sponge gobies of *Elacatinus* occurs throughout the western Atlantic Ocean, from North Carolina, USA to Brazil (Colin 1975, 2010, Taylor & Hellberg 2006, Randall & Lobel 2009). The complex comprises at present 11 cleaner species, 9 sponge species, and two planktivorous species (the last with tiny geographic ranges). The total includes two recently described species from Cayman Islands (Victor 2014) and three allopatric endemic Brazilian cleaner species. At every location within the Caribbean Sea there are at least two species, one species of each main group (Colin 2010). At a few locations, there are at least 5 sympatric species, e.g. in the central Bahamas, Mesoamerican Barrier Reef, Puerto Rico, and Dominica. Outside the Caribbean Sea proper, there can be only a single resident species. Along the northeastern coast of the Gulf of Mexico and the southeast USA north of S. Florida, the single species is a sponge goby, the Yellowprow Goby, *Elacatinus xanthiprora* (Böhlke & Robins, 1968).

From the first review by Colin (1975), it has been noted that sponge gobies tend to be found within sponges and cleaner species are found on coral heads, rock, or the surface of sponges. He also noted that no sponge species has ever been observed cleaning, and that observation stands until now, despite countless hours of subsequent observations by reef-fish biologists and prodigious recent underwater photography. The northern sponge-associated species, *E. xanthiprora*, has been poorly documented, mainly because of its preference for the deep water of the Florida Middle Grounds where the main population resides (and is seldom visited by divers), and it only rarely occurs along mainland South Florida (the holotype was from the Florida Keys; only one other specimen has been photographed there since 1968, see Fig. 1) (Robertson & Van Tassell 2015, Starck *et al.* 2017).

Recently two underwater photographers have documented populations of *E. xanthiprora* in detail: Carol D. Cox along the panhandle coast of Florida from Pensacola to Carabelle, along the far northern reaches of the Gulf of Mexico, and the second author (FHK), who has undertaken at least 114 dives off North Carolina, 48 of those fish-survey dives associated with the Reef Environmental Education Foundation (REEF) Volunteer Fish Survey Project (www.reef.org). Both photographers have reported observing *E. xanthiprora* cleaning larger fishes and the second author has photographed the behavior on repeated occasions; neither has ever seen the Northern Neon Goby, *Elacatinus oceanops* Jordan, 1904, the cleaning goby of Florida and the Gulf of Mexico, in their areas. In the Gulf of Mexico, Cox has observed and photographed the species on dives at about 30 m deep, repeatedly over several years and at multiple sites. They were always associated with a local uncommon tube sponge, with up to 6 individuals in a single sponge. She observed cleaning behavior once in 2017, when a Gray Triggerfish, about 360 mm in length, hovered over a sponge and two resident sponge gobies proceeded to clean the triggerfish.



Figure 1. *Elacatinus xanthiprora*, adult in sponge, 24.881°, -80.562°, off Islamorada, Florida Keys (C.J. Estapé).

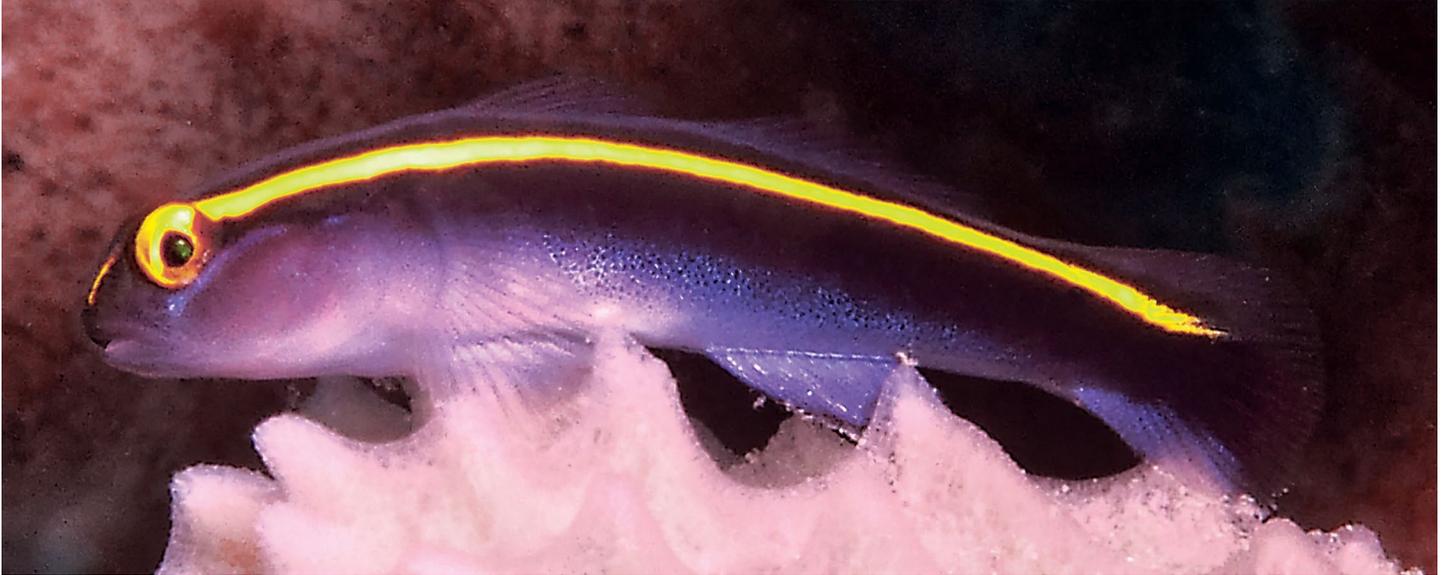


Figure 2. *Elacatinus xanthiprora*, off Mexico Beach, Florida, Gulf of Mexico (C.D. Cox).



Figure 3. *Elacatinus xanthiprora*, on hard substrate, off North Carolina (F.H. Krasovec).

The situation in North Carolina is different: there are *E. xanthiprora*, apparently unassociated with sponges, that regularly clean fishes and some found among sponges that so far have not been observed cleaning. The second author has documented two kinds of habitats: *E. xanthiprora* on wrecks that are not associated with sponges, i.e. the *Caribsea* (34.607°, -76.314°) and the *Hyde* (33.958°, -77.557°), and those closely associated with tube sponges on deep ledges along the coast. Cleaning behavior has been repeatedly observed and photographed on dives on the *Caribsea*. Cleaning behavior has not been observed at sponge sites. The client fishes include groupers, soapfish, and moray eels (Figs. 4 & 5).



Figure 4. *Elacatinus xanthiprora*, cleaning a scamp grouper *Mycteroperca phenax* (above) and a soapfish *Rypticus maculatus* (below), off North Carolina (F.H. Krasovec).



Figure 5. *Elacatinus xanthiprora*, cleaning a moray eel, *Muraena retifera*, off North Carolina (F.H. Krasovec).

Interestingly, both locations have no hard coral substrate, probably accounting for the absence of *E. oceanops*. In locations with hard coral reefs, the two species are both recorded, although not necessarily in overlapping habitats, since *E. xanthiprora* prefers sponges and is often found deeper, while *E. oceanops* prefers shallow, clear-water coral reefs. Both have been recorded in the Flower Gardens Banks in the northwestern Gulf, the Florida Middle Grounds in the eastern Gulf, and the Dry Tortugas (Robertson & Van Tassell 2015).

The fact that cleaning *E. xanthiprora* in North Carolina are observed resting on hard surfaces waiting for customers, while at other locations they are observed at the mouth of sponges, raises the question whether the cleaning individuals are truly *E. xanthiprora*. There is a similarly colored cleaning goby from the southeastern Caribbean, *Elacatinus randalli* (Böhlke & Robins, 1968), which ranges from the ABC Netherlands Antilles across Venezuela and up the Lesser Antilles to Dominica (Robertson & Van Tassell 2015). While a jump from there to the coast of the temperate USA is unlikely, the possibility needs to be evaluated.

A review of all available underwater photographs reveals differences in color pattern and body shape that confirms that the North Carolina *E. xanthiprora* at both wrecks and sponge sites look the same as the typical Gulf of Mexico *E. xanthiprora* (Figs. 2 & 3) and differ from *E. randalli* from the Caribbean Sea (Fig. 6). Both species share the basic color pattern of a yellow midlateral stripe from the eye to the caudal fin and a midline yellow line down the snout. The head and body above the yellow stripe is black (although lighter colored individuals can have a gray dorsal midline band) and a black band runs below the yellow stripe from the eye to the caudal fin, below which the ventral body is bluish white. There is often a thin blue stripe running between the black stripe and the white lower head and body.

The main difference between the two species is in the lower black band in adults; usually narrower at midbody in *E. randalli* and notably with a sharp margin with the white area vs. broader and shading into the white in *E. xanthiprora*. In *E. randalli*, the portion of the lateral black band behind the eye spans more of the height of the eye, usually from the level of the pupil to the bottom of the orbit, leaving the blue highlighting line below it as a relatively straight line vs. the black band narrower, spanning only the pupil height, causing the blue highlighting line below it to slant obliquely along the rear margin of the orbit in *E. xanthiprora*. The snout area is usually yellowish in *E. randalli* from the western portion of its range, the Netherlands Antilles across to northeast Venezuela, and dark in fish from St. Vincent, St. Lucia, and Dominica (however some individuals in the former range occasionally also show a dark snout, so the difference is not consistent); in comparison, *E. xanthiprora* always has a dark snout. *E. xanthiprora* also has a shorter snout, although that may only be obvious in large individuals.



Figure 6. *Elacatinus randalli*, Bonaire (top and upper middle, J. Holdorf; lower middle, C.J. Estapé) and St. Vincent (L. Wilk).

Both *E. xanthiprora* and *E. randalli* have terminal mouths, where the upper jaw is the farthest anterior point of the head, vs. inferior and shark-like in many of the cleaner gobies, such as *E. oceanops*. It may be that terminal or subterminal mouths reflect a wider range of diet preferences, while species that are mainly cleaning gobies develop inferior mouths, and specialized dentition to match (Colin 1975). This hypothesis fits with the flexibility documented here in the diet habits of *E. xanthiprora*.

Recent mtDNA studies (Victor 2014) show that all 8 of the cleaner gobies of the Greater Caribbean and two cleaners sampled from Brazil form a monophyletic clade of lineages. Similarly, the 7 sponge species that have been sequenced form a separate monophyletic clade of lineages. The cleaner and sponge groups are separated by 12.9% minimum distance between the two groupings in the COI mitochondrial marker sequence (by K2P). *Elacatinus xanthiprora* is not the closest lineage to the cleaning gobies, and is most closely related to *Elacatinus colini* Randall & Lobel, 2009, a sponge goby species from the Mesoamerican Barrier Reef that does not clean. Clearly, the cleaning behavior of *E. xanthiprora* does not reflect relatedness, but is apparently an independently derived adaptation. Most likely, the absence of a cleaner goby in parts of its range has allowed it to facultatively adopt that lifestyle in addition to its normal benthic sponge-living niche.

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Elacatinus xanthiprora, off North Carolina (F.H. Krasovec).