

Short Communication

DIRECT OBSERVATIONS OF THE ASSOCIATION BETWEEN A DEEP-SEA FISH AND A GIANT SCYPHOMEDUSA

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(Received 27 January 2004; In final form 16 April 2004)

This is a report of evidence of a close symbiotic relationship between the scyphomedusa, *Stygiomedusa gigantea* and the fish, *Thalassobathia pelagica*. Images from remotely operated vehicles (ROV) were obtained of the fish swimming on and around the large scyphomedusa. This is the first ever documented symbiosis between an Ophidiiform fish and a medusa.

Keywords: Symbiosis; Bythitidae; *Thalassobathia*; Cnidaria; *Stygiomedusa*; Gulf of California, Mexico; Range extension

Symbiotic behaviors between fishes and medusae or siphonophores have been documented in many studies (reviewed in Mansueti, 1963; Purcell and Arai, 2001). The nature of the interaction between the cnidarian and the fish varies from their commensal relationships to parasitism. The fish typically gain shelter and food from the cnidarian, which in turn benefits from parasite removal and by consuming careless fishes (Purcell and Arai, 2001). Associations between fishes and cnidarians in deep water are rare.

Less than twenty specimens of the fish *Thalassobathia pelagica* have been documented in collections. All earlier collections came from the meso- and the bathypelagic depths in the North Atlantic, except for a single specimen captured in the Bering Sea (Balanov and Fedorov, 1996). Harbison *et al.* (1973) hypothesized that the fish associates with giant scyphomedusa based on a few concurrent trawl captures with *Stygiomedusa*. In this article, we describe the capture of *T. pelagica* in the Pacific Ocean and from the *in situ* observations, we show that its association with scyphomedusae does occur, the first ever documented symbiosis for an Ophidiiform fish.

During an ROV Tiburon dive in the Farallon Basin (25° 27.22' N., 109° 50.17' W.) of the Gulf of California, Mexico, we observed a large scyphomedusa, *S. gigantea*, with

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the fish, *T. pelagica*, swimming on and around it (Fig. 1). The medusa had a bell diameter of ~ 0.8 m and an oral arm length of 3–4 m. At 1300 m depth the animals were just below the pronounced oxygen minimum zone of the Gulf. The local oxygen concentration was ~ 0.5 ml/l and the temperature was 4°C . When encountered, the medusa was swimming slowly and the fish was near the base of the voluminous oral

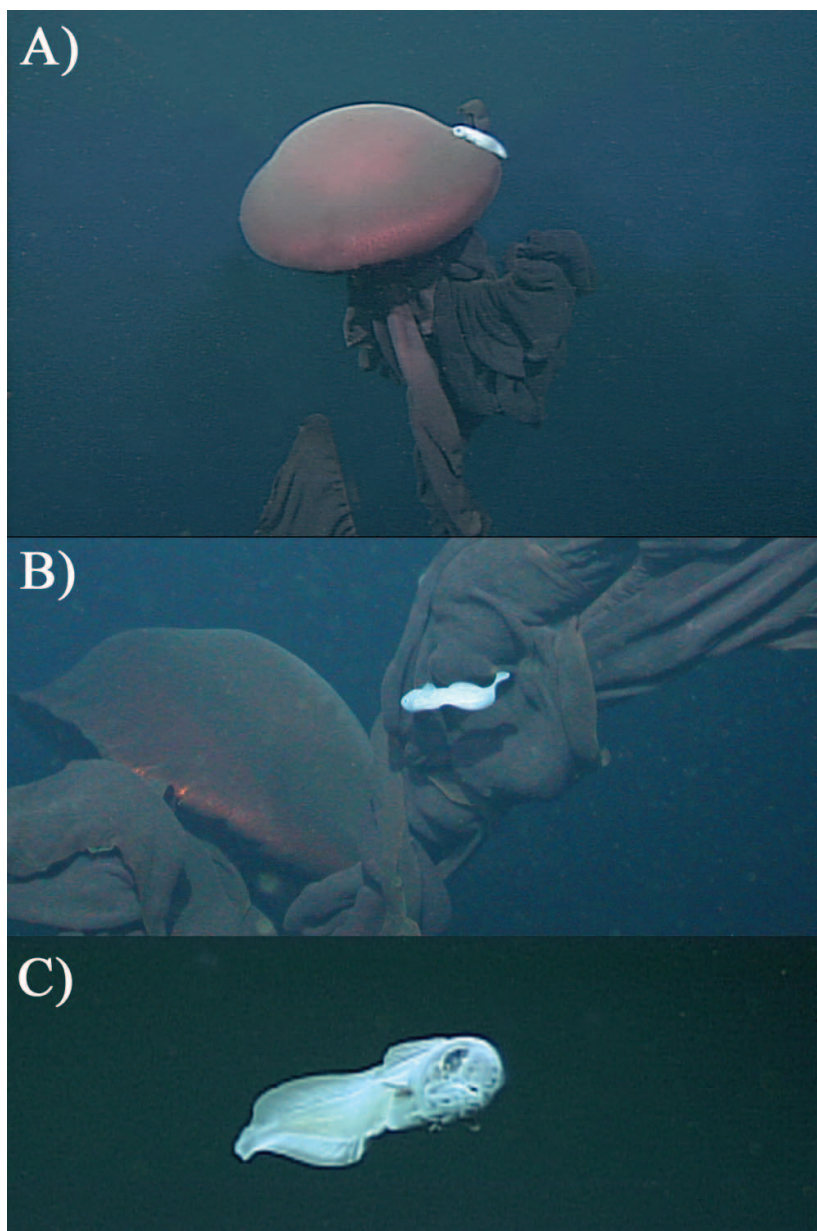


FIGURE 1 (A) *Thalassobathia pelagica* and host medusa, *Stygiomedusa gigantea* at 1300 m in the Farallon Basin, Gulf of California, Mexico, (B) *T. pelagica* swimming on its side with its belly toward the host's oral arms, and (C) close up of *T. pelagica* in situ.

arms. Through most of our 26 minutes of observation, the fish swam or hovered within several centimetres of the medusa. It often brushed or bumped into the medusa and oriented its belly to it, regardless of the region of the medusa it occupied (Fig. 1b). In one instance, the fish was upside down as it maneuvered from the underside of the belly to the top. The fish occasionally became separated from the medusa when the latter changed its direction. The fish quickly turned around and swam back toward the arms after being separated by a short distance. The fish and some tissue samples of the medusa were captured during one of these excursions using a high flow suction sampler (Robison, 1993).

The specimen was maintained in the laboratory aquaria, in the dark, with flowing chilled seawater at 6°C for 42 days. Its respiratory rate was determined to be $0.29 \mu\text{mol O}_2 \text{hr}^{-1} \text{g}^{-1}$; a rate concordant with its *in situ* swimming behavior and comparable to other sedentary and slow moving meso- and bathypelagic fishes (Torres *et al.*, 1979; Donnelly and Torres, 1988).

Throughout its captivity the fish swam slowly and continuously. It swam both backward and forward with equal efficiency. It oriented to the available surfaces, swimming with its belly facing the sides or the bottom of the tank or along the surface of the water. This specimen of *T. pelagica* did not eat, despite many attempts to feed it with a variety of dead (shrimp, fish, squid, euphausiids) and live prey (euphausiids, shrimp, small medusae, small *Pleurobrachia* sp., brine shrimp). Several attempts were made to encourage the fish to reassociate with a scyphomedusa host. Immediately after capture a large piece of the oral arm of *S. gigantea* ($15 \times 20 \text{ cm}^2$) was placed in the aquarium, where it floated on the surface. The fish bumped into it several times but did not resume its prior association. Subsequently, a large *Aurelia labiata* (20 cm diameter) was introduced but the fish moved away when contact was made with the bell. When it came into contact with the tentacles, it was stung by the medusa's nematocysts and it swam rapidly backward and forward until it broke free from the clinging tentacles.

After death, the fish was weighed and dissected. The measurements and counts are presented in Table 1. These characters are consistent with those of previously described *T. pelagica*. The mouth and dentition showed a massive tongue and many fine teeth (Balanov and Fedorov, 1996; Cohen, 1963). Suprabranchial tooth patches were prominent but no basibranchial teeth were evident. The gas bladder was creamy colored and solid, about 8 mm in length. X-ray images of the specimen showed its very poor degree of ossification. The specimen has been archived in the vertebrate collection at MBARI (specimen #2003078-HFSS11).

Our direct *in situ* observations confirm that a symbiotic relationship exists between the fish, *T. pelagica* and the scyphomedusa, *S. gigantea*. *Thalassobathia pelagica* is not a typical bythitid fish. First, it is a deep-living pelagic species in a family that is primarily benthic (Cohen, 1963; Nielsen *et al.*, 1999). Second, it associates with scyphomedusae as an adult; a behavior unique within the order Ophidiiformes.

Thalassobathia pelagica has several adaptations to a pelagic existence and some that would appear to be of benefit for living with the large scyphomedusae. Its poor ossification and reduced squamation, reduce its specific gravity, an advantage to a pelagic existence. Our observations indicate that the fish orients to any surface, even swimming upside down. This is obviously an advantage to a fish that must maneuver around and maintain position with a large gelatinous zooplankton whose own orientation is almost limitless in the open water column (Horn, 1977).

TABLE 1 Measurements and counts of the examined specimen of *Thalassobathia pelagica* compared to values from the literature (Cohen, 1963; Lee, 1974; Balanov and Fedorov, 1996) for *T. pelagica* and *T. nelsoni*. Measurements are given as a percentage of standard length.

	Gulf of California	Bering Sea	N. Atlantic	<i>T. nelsoni</i>
Number of specimens	1	1	8	2
Standard length (mm)	126	157	173–260	155–194
Head length	21.4	21	16–21.6	21.1–21.3
Snout length	3.2	3.8	3.7–4.5	3.9–4.1
Eye diameter	7.1	6.4	4.8–5.8	7–7.3
Interorbital distance	6.7	7.6	5.2–7.2	6.8–7.2
Upper jaw length	11.9	12.7	11–13.6	13.3–16.6
Pre-anal length	42.1	47.1	39.8–45.8	37.9–42.1
Pectoral fin length	11.9	13.7	11.7–14.7	11–11.8
Vertebrae	47	46	48–51	51–52
Dorsal rays	71	77	72–79	78–81
Anal rays	60	60	58–65	62–65
Pectoral rays	25	24	22–29	19–20
Pelvic rays	2	2	2	2
Caudal rays	10	10	10	10
Gill rakers	9	10	7–8	–
Branchiostegals	7	7	7	7

In shallow water, the fish–medusa associations are typically maintained via visual cues (Mansueti, 1963; Purcell and Arai, 2001). *T. pelagica* has very large eyes but it is likely that the fish was temporarily blinded in the bright lights of the ROV. Nevertheless, it was still able to reassociate with its host when separated, suggesting that other sensory mechanisms are also important. *T. pelagica* has a well-developed system of cranial pores (see Fig. 1c) and a lateral line composed of naked neuromasts (Balanov and Fedorov, 1996). The exposed neuromasts increase sensitivity to low frequency water movements (Montgomery and Pankhurst, 1997), such as those generated by the pulsing of the medusa's bell and they may aid *T. pelagica* in maintaining position with its host medusa.

The nematocysts of *A. aurita* stung the fish, but it was unharmed *in situ* by the nematocysts of *S. gigantea*, a status which was evident from its repeated contact without any adverse reaction. *Stygiomedusa gigantea* has no tentacles, but nematocysts are present along the large oral arms and on the subumbrellar surface (Russell and Rees, 1960). It is possible that *T. pelagica* associates with *S. gigantea* because it has a mucus coat which it uses to avoid being stung, or it is resistant to the nematocyst toxins (Lubbock, 1980; Arai, 1997). In anemonefish, protection against the nematocyst discharge can be species-specific (Lubbock, 1980). Our observations suggest that not all scyphomedusae are potential hosts for *T. pelagica*. However, we cannot say that the symbiosis is species-specific.

Many fishes that associate with the medusae are also gelativores at some stage and they exhibit modifications of the mouth and the alimentary canal for this type of feeding (Mansueti, 1963; Haedrich, 1967; Purcell and Arai, 2001). However, our specimen possessed no esophageal or pharyngeal modifications such as those found in the Alepocephalidae (Stein and Bond, 1985) or the stromateoid fishes (Haedrich, 1967). The fishes that consume gelatinous prey often have a very large stomach and an elongated intestine (Purcell and Arai, 2001). The ratio of the standard length to the intestine length can reflect the prey types in the diet of a fish (Robison, 1984). In the case of *T. pelagica*, this value was 1.9. In contrast, the gelativore *Ichthyococcus irregularis*

has a very long intestine and a low ratio of 0.7 (Robison, 1984) and the epipelagic medusa fish, *Ichthyos lockingtoni*, which eats its host has a ratio of 0.6 (Robison, unpublished data). *Thalassobathia pelagica* has an intestinal morphology similar to those of the myctophid and bathylagid fishes with mixed zooplankton diets. While it may consume some gelatinous prey, it does not appear to be adapted to rely on the tissues of its host for food.

The specimen of *T. pelagica* reported here is the first for the Pacific Ocean. One specimen reported from the Bering Sea was tentatively identified to be *T. pelagica* (Balanov and Fedorov, 1996). The congeneric *Thalassobathia nelsoni*, was described based on two specimens caught in deep water off Chile (Lee, 1974). Our specimen does have a similar eye diameter to *T. nelsoni*, but the other characteristics are more consistent with *T. pelagica* (Table 1). Our capture of *T. pelagica* in the Gulf of California dramatically extends the known range of habitat for this species. Previous studies have shown that *S. gigantea* is widely distributed in the Atlantic and Southern Oceans (Larson, 1986). Our observation in the Gulf of California and another, off the coast of Washington (47° 57' N., 129° 06' W., 1028 m, *T. pelagica* was not present) show that the species occurs in the Pacific and Larson (1990) suggested that the medusa is cosmopolitan. This broader range for *S. gigantea* raises the possibility that *T. pelagica* is also distributed broadly.

Acknowledgements

We thank B. Seibel who kindly assisted us with the respirometry work. M. Murray generously X-rayed our fish specimen. C. Widmer (MBA) supplied gelatinous animals for the laboratory experiments. D. Cohen provided constructive comments on an earlier draft of this manuscript. We also thank the crew of the R/V Western Flyer and the pilots of the ROV Tiburon. We gratefully acknowledge the support rendered by the David and Lucile Packard Foundation.

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