Mar Biol (2012) 159:1173–1176
DOI 10.1007/s00227-011-1873-6

SHORT COMMUNICATION

Observations on a school of ocean sunfish and evidence for a symbiotic cleaning association with albatrosses

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Received: 7 November 2011 / Accepted: 26 December 2011 / Published online: 7 January 2012

Abstract We observed a school of ocean sunfish *Mola mola* at the surface in the western North Pacific Ocean (40°46.8′N, 165°01.7′E) for about 90 min in July 2010. The school consisted of juvenile fish, approximately 40 cm in total length, which kept the same tight formation throughout the observation. Most fish were heavily infested around the base of their dorsal fins with an ecto-parasite *Pennella* sp. The fish school appeared to actively follow Laysan albatrosses *Phoebastria immutabilis* that were sitting on the water nearby, and one of the birds was photographed as it picked a *Pennella* sp. from one of the fish and ate it. We hypothesize that this symbiotic cleaning behavior by the albatrosses may be a common feature of the biology of the ocean sunfish.

Communicated by S. Garthe.

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Introduction

The ocean sunfish (*Mola mola*) is the largest oceanic bony fish, belonging to the Family of Molidae, and has a wide distribution in the world's subtropical and tropical oceans (Fraser-Bruner 1951; Pope et al. 2010). The most accurate record of the maximum size of ocean sunfish is 2.3 metric tons and 2.7 m in total length (TL) (Roach 2003; Nakatsubo et al. 2007). Fraser-Bruner (1951) reported that one female had 300 million eggs, and that this species may undergo several morphologic life history stages prior to reaching maturity. Nakatsubo et al. (2007) reported that sample specimens with over 185 cm TL were sexually mature. However, very few studies have been done on its reproduction, and the ecology in regard to its juvenile life history is still largely unknown.

Recent tagging techniques have revealed new information on the behavioral characteristics of ocean sunfish life history. Despite its unusual body shape, ocean sunfish can swim rapidly (Cartamil and Lowe 2004; Watanabe and Sato 2008) and move over extremely broad ranges both horizontally and vertically (Cartamil and Lowe 2004; Watanabe and Sato 2008; Hays et al. 2009; Sims et al. 2009; Dewar et al. 2010).

Ocean sunfish typically inhabit the water column, but are often found on the sea surface (Pope et al. 2010). It has been hypothesized that ocean sunfish might spend their time at the sea surface to "re-warm" their body after diving into the cold deep waters of the ocean (Cartamil and Lowe 2004; Dewar et al. 2010). Another hypothesis on this "sunbathing" behavior is that ocean sunfish may take advantage of other vertebrates inclined to engage in parasite cleaning behavior at or near the sea surface (Hixon 1979; Thys 1994; Konow et al. 2006). Hixon (1979) and Konow et al. (2006) observed "cleaner" fishes picking parasites from an ocean

Fig. 1 A view from above of a school of 57 oceanic sunfish, showing the orientation and tightness of the school (photographed by KM)

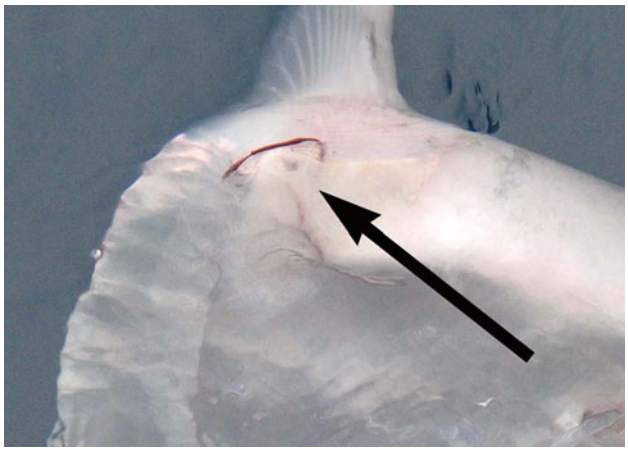

Fig. 2 *Pennella* sp. on the ocean sunfish body (indicated by the *black arrow*; photographed by KS)

sunfish, and Thys (1994) stated that seabirds also engage in the same behavior. To date, these observations have been confined to the nearshore environment. Prior to our report, no field observations of ocean sunfish ecology in offshore waters have been reported. This paper is the first report of a school of juvenile ocean sunfish and the possible symbiotic relationship between basking sunfish and albatrosses in the open ocean.

Field observation

A school of small ocean sunfish, *Mola mola*, or possibly *Mola* sp. B (Yoshita et al. 2009; Yamanoue et al. 2010), was sighted at the surface in the western North Pacific Ocean (40°46.8′N, 165°01.7′E, near the northern boundary of the North Pacific subtropical region) on July 2, 2010. The observations were made during the North Pacific cruise by the T/S *Oshoro Maru* (72.85 m length and 1,792 gross tonnage), which belongs to Hokkaido University, Hakodate, Japan. The vessel was on station for a hydrographic survey at the sighting time. The sea surface temperature was 17.3°C, and the water depth was approximately 5,400 m. The first sighting was made at about 9 a.m. local ship time (TZ: +11 h) as the vessel drifted next to the ocean sunfish school. The observations and successive photo documentation from the deck continued until the vessel drifted away at about 10:30 a.m.

Based on the photographs, at least 57 ocean sunfish were in the school. The ocean sunfish were all about the same size. When compared to the albatross nearby, they were estimated to be about 0.4 m TL. The distance between animals was about one fish body length, and all school members were headed in the same direction (Fig. 1). All ocean sunfish were floating at or near the surface, mostly showing their undulating dorsal or anal fins above the surface. Some swam sideways, and their exposed ventral bodies were clearly seen. After the initial sighting, the school was separated into two subgroups. They subsequently merged into a single, larger group when they started moving away from the port side of the vessel.

Most ocean sunfish in the observed school had several ecto-parasites attached at the base of their dorsal fins (Fig. 2). Ocean sunfish are documented to carry a heavy ecto- and endo-parasite load (Threlfall 1967; Logan and Odense 1974; Schwartz and Lindquist 1987), and more than 50 parasite species are reported from ocean sunfish (Love and Moser 1983). From photographs, this organism was identified as an ecto-parasitic copepod, *Pennella* sp., which is a well-known ecto-parasite of ocean sunfish (Yamaguti 1963; Love and Moser 1983; Hogans 1987) as well as numerous other species of large pelagic fishes and marine mammals (Yamaguti 1963). *Pennella* sp. buries its head deeply into the body tissue of a host fish (Yamaguti 1963; Hogans 1987). Photographs clearly showed that some *Pennella* sp. spread their elongated line-like egg strings, suggesting those parasites were in the mature stage. Parasites were obviously well developed and, based on evidence of the reddish inflamed tissue at the infection sites, seemed to cause moderate skin damage on their hosts' bodies.

Initially, there was one Laysan albatross (*Phoebastria immutabilis*) associated with the ocean sunfish school, and ocean sunfish did not evidence any avoidance or defensive reaction to the presence of the bird. As time elapsed, the school actively followed this particular bird. Figure 3 is one of the photographs taken when the school swam away about 5–6 m from the vessel. This photograph clearly shows this bird picking a *Pennella* sp. from one ocean sunfish in the school, and another Laysan albatross attempting to steal it. This event attracted the attention of more albatrosses, one Laysan albatross and three black-footed albatrosses (*Phoebastria nigripes*), which initiated a feeding activity. Some ocean sunfish appeared to present themselves by swimming sideways next to birds (Fig. 4).

Fig. 3 An albatross picked up a *Pennella* sp. from a sunfish (photographed by KS)

Fig. 4 Next to the albatrosses, the ocean sunfish school members were laying and showing their bodies (six individuals are pointed by *white arrows*; photographed by KM)

Sequential pictures showed a number of birds removing and ingesting at least four ecto-parasites, *Pennella* sp.

Discussion

"Basking behavior" during the day is a well-known characteristic of ocean sunfish. Pope et al. (2010) surmised that this behavior might be caused by deeper diving or parasite infestations. Because of their unusual body shape, ocean sunfish are regarded as being relatively inactive, slow swimmers. However, they are actually active swimmers (Cartamil and Lowe 2004; Watanabe and Sato 2008). Despite their strong swimming capability, this observed school of ocean sunfish did not show any escaping/avoiding behavior with respect to albatrosses and appeared to actively follow them. Moreover, some ocean sunfish appeared to present themselves to the birds, and albatrosses picked off their ecto-parasites, *Pennella* sp., in response. We hypothesize that the observed ocean sunfish might have stayed at the surface to look for an opportunity to get the albatross to remove parasites.

Parasite removal from the host, so-called "cleaning behavior," is a well-known symbiotic relationship between fishes (Grutter 1999), birds and mammals (Ruggiero 1996; Bradshaw and White 2006). This type of symbiosis may be applied to our observed association between the albatrosses and the basking ocean sunfish. Thys (1994) stated that seabirds feed on copepod parasites from the body surface of basking ocean sunfish, although her direct evidence for this is unclear. Our observations represent the first direct, photo-documented evidence of symbiotic cleaning behavior by albatross species on ocean sunfish in pelagic waters. The association of ocean sunfish with small cleaner fishes has been reported in coastal, nearshore waters (Hixon 1979; Thys 1994; Konow et al. 2006). These field observations strongly suggest that, at least, one of the reasons ocean sunfish bask at the sea surface may be to engage in ecto-parasite removal through symbiotic cleaning behavior with a variety of other vertebrates.

Because of the difficulties of direct observations in the open sea, these symbiotic relationships might have been missed in the past. Burger (1988) reported that over 85% of shearwaters (*Puffinus griseus*) resting flocks were associated with ocean sunfish in Monterey Bay, California. One of us (K. Sekiguchi) also photographed six black-footed albatrosses surrounding and pecking at a large basking ocean sunfish (approximately 1.5 m TL) on July 30, 2005, at 40°45.0′N, 165°00.0′E. Although no parasite removal was confirmed at that time, the behavior was similar enough to the event described here to suggest that albatrosses may regularly feed this way. In the Hawaiian Archipelago, indeed, *Pennella* sp. was found in its stomach contents of black-footed albatrosses with a 1.7% occurrence (Harrison et al. 1983). This finding supports our hypothesis. Our sightings and observations on this ocean sunfish school were quite opportunistic; however, these facts are very important to the understanding of the mysterious life of this giant fish in open ocean.

Acknowledgments We would like to acknowledge the Captain, crew and all students on board the T/S *Oshoro Maru* in the summer 2010 cruise, for their endless support and hard work. Prof. Naito, Azabu University, Prof. Nagasawa, Hiroshima University, and emeritus Prof. Ogi, Hokkaido University, provided us with important literature and advice. Drs. Gregor M. Cailliet, Robert L. Pitman, William Walker and Patricia Whitelock made useful comments on the manuscript.

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