

## Why does the ocean sunfish bask?

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**B**asking at the sea surface is a well known, but peculiar behavior of ocean sunfish (*Mola mola*). One of hypotheses for this behavior is parasite elimination. However, in oceanic regions, very little direct evidence exists for this form of interspecific communication. In pelagic waters of the North Pacific Ocean, we observed a school of 57 ocean sunfish, that were heavily infested around the base of their dorsal fins with the ecto-parasite *Pennella* sp. We photographed a Laysan albatross (*Phoebastria immutabilis*) nearby that picked a *Pennella* sp. from one of ocean sunfish and ate it. We hypothesize that ocean sunfish did “bask” to look for skin cleaning and that this symbiotic cleaning behavior by the albatrosses may be a common feature of the biology of the ocean sunfish. Here we provide more photographs to show heavy parasite infections and scars after parasite removal by “cleaners,” and discuss how important a symbiotic cleaning relationship could be in the open ocean ecosystem.

The ocean sunfish (*Mola mola*) is a largest, and most widely distributed oceanic bony fish<sup>1,2</sup> with its maximum reported size is 2.3 t and 2.7 m in total length (TL).<sup>3,4</sup> Its bizarre appearance and strange basking behavior has been receiving much curiosity. Ocean sunfish are also known for their heavy parasite loads, both inside and outside of its body.<sup>5–7</sup> Love and Moser<sup>8</sup> listed 54 species of parasites in this species. Early studies hypothesized that basking ocean sunfish might be sick and/or dying because of heavy parasite infection.<sup>1,7</sup>

Recent studies suggested two main hypotheses to explain this basking behavior: “thermal recharging” and “parasite

elimination.”<sup>2</sup> Recent tagging studies have revealed the ocean sunfish dives several hundred meters deep, possibly for forage.<sup>9–13</sup> Thus, it has been hypothesized that ocean sunfish might bask at the sea surface to re-warm the body after deep dives into cold water.<sup>2,10</sup> However, there was no significant relationship between the amount of time per day fish spent in cold water and the amount of time fish spent at the surface; therefore this hypothesis does not appear to have enough supportive evidence.<sup>13</sup>

The “parasite elimination” by fishes or birds near the sea surface may be beneficial to ocean sunfish with many parasites.<sup>14–16</sup> In the near-shore region, it has been observed that small fishes act as cleaners of ocean sunfish.<sup>14,16</sup> There is some documentation that sea birds picked parasites off ocean sunfish,<sup>15,17</sup> although direct evidence has not yet been found. The reason for “basking,” the typical behavior of ocean sunfish, has been under discussion.

In our recent paper,<sup>18</sup> we presented evidence for the symbiotic cleaning association between ocean sunfish and albatrosses with clear field photographs in the open ocean. On 2 July 2010, we observed from the *T/S Oshoro Maru*, (1,792 gross tonnage; belonging to Hokkaido University, Hakodate, Japan) in the western North Pacific (40°46.8'N, 165°01.7'E) that this school of 57 basking ocean sunfish actively followed a resting Laysan albatross *Phoebastria immutabilis* and presented themselves to the birds. The ocean sunfish in school were heavily infected by ecto-parasite *Pennella* sp. A total of four Laysan and black-footed albatrosses *Phoebastria nigripes* initiated cleaning behavior, picking these ecto-parasites

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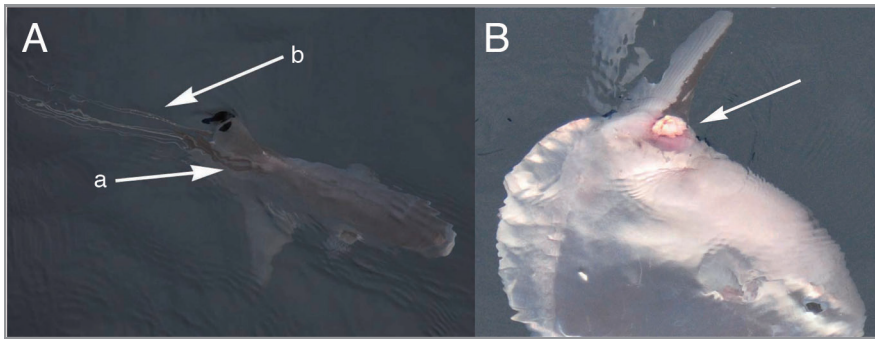
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**Figure 1.** (A) A view from above for an oceanic sunfish, attached by several mature female *Pennella* sp. (white arrow A) showing long egg strings (white arrow B) (photographed by K.S.). (B) A side view of an ocean sunfish with heavily damaged skin near the bottom of its dorsal fin probably caused by *Pennella* sp. (photographed by K.S.).

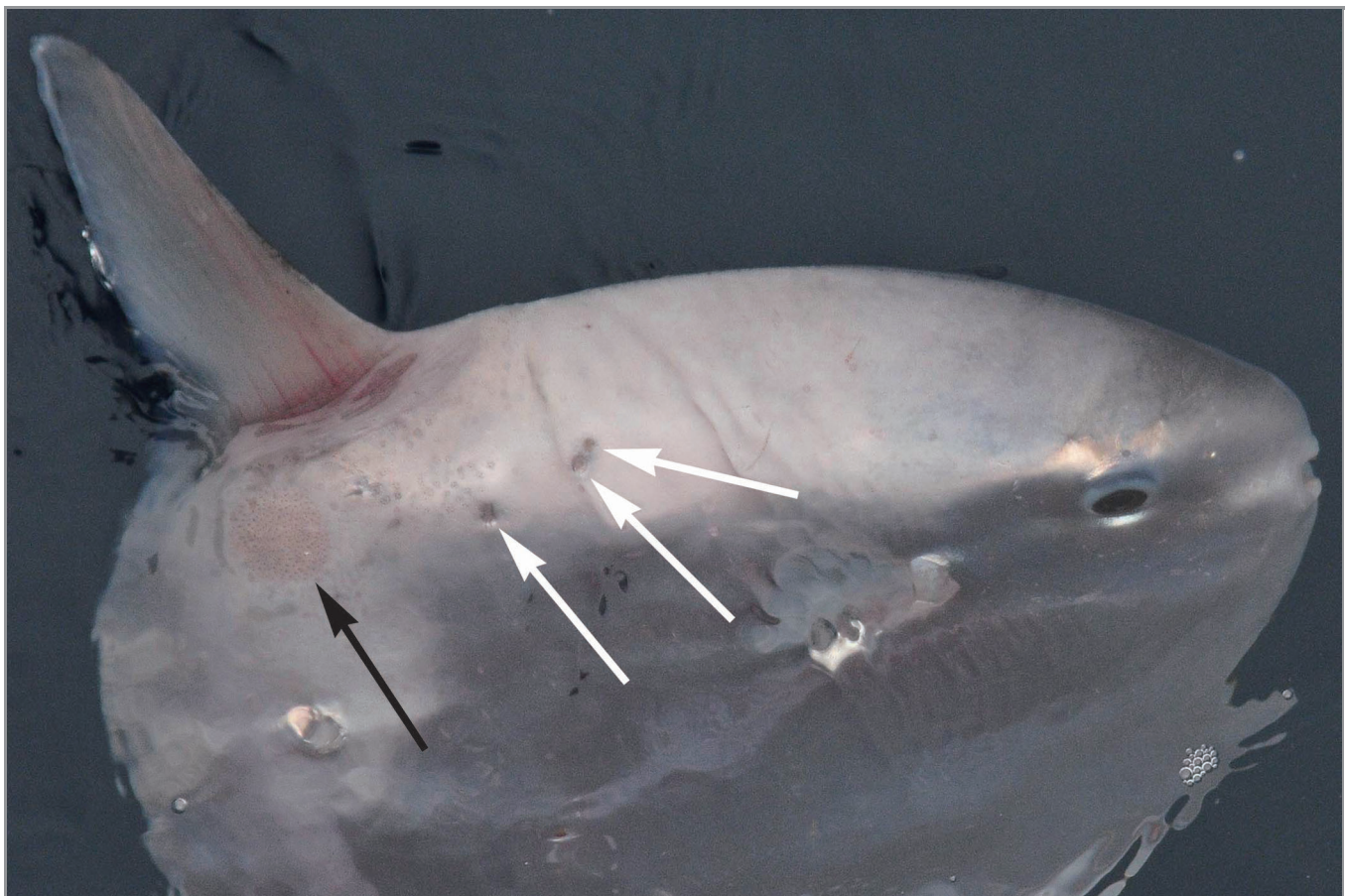
*Pennella* sp. off the skin of the ocean sunfish.

*Pennella* sp. is a large ecto-parasitic Copepoda.<sup>19</sup> It goes through some juvenile stages on different hosts, and then finally only the adult females become embedded

on marine mammals and large fishes, such as the ocean sunfish. The *Pennella* sp. we observed on ocean sunfish bodies were certainly mature with long line-like egg strings (Fig. 1A). Hogans<sup>20</sup> found a specimen of *Pennella filosa* near the base of

the sampled ocean sunfish dorsal fin. It seemed that this location is a favorite position at which to embed for *Pennella* sp. As Figure 1B shows, skin around the infected site was reddish-inflamed, suggesting damages to the host's body.

Although *Pennella* sp. becomes deeply anchored into host skin, Çiçek et al.<sup>21</sup> reported that individual *Pennella balaenopterae* were easily taken out from the skin of a dead fin whale by hand. Removal was easy perhaps because of the death of both host and parasite. Also it may be easy enough for the thick, strong tubenose bill of the albatross to remove these parasites. Among the school of ocean sunfish we observed, some fish had several small grayish spots near the base of their dorsal fin (denoted by white arrows in Fig. 2). Those spots are probably healed scars after removal of *Pennella* sp. by “cleaners.” These appeared similar to holes after removal of *P. balaenopterae* (Fig. 2B in



**Figure 2.** Small spots (pointed by white arrows) and a spot with inflamed skin (pointed by black arrow) near the dorsal fin base of the ocean sunfish possibly after removal of *Pennella* sp. by “cleaners” (photographed by K.S.).





**Figure 3.** An ocean sunfish with half-removed *Pennella* sp. (pointed by white and black arrows) and heavily damaged skin (pointed by black arrow) (photographed by T.A.).

Çiçek et al.<sup>21</sup>). Another scar in **Figure 2** (denoted by a black arrow) seemed like a bad inflammation, maybe from *Pennella* parasites. Doi et al.<sup>22</sup> reported that this kind of damaged tissue, caused by Pennellid species, would recover quickly.

One basking ocean sunfish, *Mola mola* or possibly *Mola* sp. B,<sup>23,24</sup> was caught in the western North Pacific Ocean (43°15'N, 155°00'E) during the T/S *Oshoro Maru* on another cruise on 30 July 2011 (sea surface temperature = 14.5°C). This animal was a juvenile and 0.4 m in TL. On the base of its dorsal fin, thin tube-like, semitransparent forms stuck out from the skin (**Fig. 3**). Those tubes were identified as neck portions of ecto-parasite *Pennella* sp., which might be cut out by “cleaners” such as albatrosses. This suggests that deeply entrenched

*Pennella* sp. are sometimes not easy to pull out completely from their host,<sup>25</sup> and the tissue of the parasite body may be destroyed if “cleaners” are too fast to take *Pennella* sp.<sup>26</sup> On the ocean sunfish we caught, one parasite-intruded area was very badly inflamed (**Fig. 3**, denoted by a black arrow). The reddish scars in **Figure 1B** (denoted by a white arrow) and **Figure 2** (denoted by a black arrow) showed the similar size and position of a fish body (i.e., the base of a dorsal fin). Those scars might be a healed inflammation after the **Figure 3** stage.

It is clear that infection by *Pennella* sp. can cause tissue damage to the host ocean sunfish, just as other parasites infections.<sup>6,7</sup> Thus, it is presumed that parasite removal is very beneficial for ocean sunfish. Without the help of cleaners, parasite like

*Pennella* could give serious damage on the skin and tissue of ocean sunfish. Basking ocean sunfish surrounded by six black-footed albatrosses (on July 30, 2005, at 40°45'N, 165°00'E; **Fig. 4**) and other large marine birds have been observed.<sup>17,18</sup> In the Hawaiian Archipelago, stomachs of black-footed albatrosses contained *Pennella* sp.<sup>27</sup> It is possible that parasite elimination is not only a significant event for ocean sunfish, but also a good food source for larger sea birds in open ocean. The symbiotic cleaning associations we have reported may be occurring on a more regular base in wide world ocean surfaces than previously thought.

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**Figure 4.** Next to black-footed albatrosses *Phoebastria immutabilis*, the large ocean sunfish was laying and showing its body (photographed by K.S.).

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