Turtle riders: remoras on marine turtles in Southwest Atlantic

Ivan Sazima* and Alice Grossman**

An overview is presented for a poorly documented relationship between reef vertebrates in Southwest Atlantic: remoras (Echeneidae) associated with marine turtles. Two remora species (Echeneis naucrates and Remora remora) and four turtle species (Caretta caretta, Chelonia mydas, Eretmochelys imbricata, and Dermochelys coriacea) are here recorded in symbiotic associations in the SW Atlantic. Echeneis naucrates was recorded both on the coast and on oceanic islands, whereas R. remora was recorded only at oceanic islands and in the open sea. The remora-turtle association is usually regarded as an instance of phoresis (hitchhiking), albeit feeding by the fish is also involved in this symbiosis type. This association seems to be rare in SW Atlantic.

Keywords: Marine symbiosis, Remora, Echeneis, phoresis, feeding association, mating opportunity.

Remoras (Echeneidae) are known to attach to several types of marine vertebrates, including fishes, turtles, and mammals (review in O’Toole, 2002). Remoras may benefit from this association in several ways, including transport, feeding opportunities, and protection from predators (e.g., Alling, 1985; Fertl & Landry, 2002; O’Toole, 2002). Some remora species attach to a diverse array of hosts, whereas others use a particular host type. For instance, Echeneis naucrates attaches to varied hosts from fishes to mammals, whereas Remora australis attaches exclusively to cetacean hosts (e.g., Fertl & Landry, 2002; O’Toole, 2002; Sazima et al. 2003). Although the habits of several remora species are known to some detail (review in O’Toole, 2002), the association between echeneids and turtles was not examined in particular for any area (but see Fretey, 1979b).

We present here an overview of a poorly documented association between marine vertebrates in Southwest Atlantic: remoras attached to marine turtles. We focus our study on three main questions: (1) Which species of remoras attach to marine turtles and which are their turtle host species? (2) What are the smaller and the larger remora/turtle host ratios? (3) What is the relative occurrence of this association in a given area? We sought to obtain a general view of the remora-turtle association, and to gain some insight on what advantages the fishes may obtain from their association with turtles, as well as the possible disadvantages for the host.

Besides our own field observations, we analyzed all reliable photographic and videotaped records provided by biologists and divers, both professional and amateur. Field observations were conducted in two oceanic islands off northeast Brazil, and on the coast of São Paulo, southeast Brazil. Photographs and videotapes were obtained from additional places along the coast in northeast and southeast Brazil (see Table 1). For each association we identified the remora and the turtle, and recorded the position the fish was at the time of the observation. When the associated animals could be followed for some time, we recorded the behaviour of both the remora and its host. “All occurrences” and “focal animal” samplings (Altmann, 1974; Lehner, 1979) were used both in the field observations and the analyses of videotapes. Remoras were identified based on their external characters (body colour, shape, and proportions – see e.g., Figueiredo &
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Menezes, 1980; Robins et al., 1986; Froese & Pauly, 2006). We discarded one record for SE Brazil in which the fish identification was doubtful. Remoras’ size was estimated as total length (TL) or standard length (SL) against measured turtle carapace length or number tag width; turtles’ size was measured as curved carapace length (CCL) or estimated total length (TL). We calculated the remora/turtle ratios at two oceanic sites for which we had censuses of turtle numbers (Fernando de Noronha Archipelago and Rocas Atoll), to assess the relative occurrence of the association.

Two remora species (*Echeneis naucrates* and *Remora remora*) and four turtle species (*Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, and *Eretmochelys imbricata*) are here recorded in symbiotic associations in the Southwest Atlantic (Table 1, and Figs. 1-2). For the Rocas Atoll the remora/turtle ratio was 0.003 for both *R. remora* and *C. mydas* (N= 259 turtles),

Table 1. Remoras recorded on marine turtles in Southwest Atlantic (a single remora per turtle unless stated otherwise): fish and turtle sizes, positions on host, and record sites. AA= Abrolhos Archipelago, NE Brazil; AC= Arraial do Cabo, SE Brazil; FN= Fernando de Noronha Archipelago, NE Brazil; JP= João Pessoa, NE Brazil; RA= Rocas Atoll, NE Brazil; OS= open sea, SE Brazil; SE= Sergipe, NE Brazil; SP= São Pedro and São Paulo Rocks, NE Brazil; SV= São Vicente, SE Brazil.

| Remora           | Size (cm) | Turtle          | Size (cm) | Position on turtle | Record sites |
|------------------|-----------|-----------------|-----------|-------------------|--------------|
| *E. naucrates*   | 3 (TL)    | *C. mydas*      | 107 (CCL) | carapace (central)| RA (oceanic) |
| *E. naucrates*   | 5 (TL)    | *C. mydas*      | 30 (CCL)  | carapace (lateral)| FN (oceanic) |
| *E. naucrates*   | 20 (TL)   | *C. mydas*      | 45 (TL)   | carapace (lateral)| SV (coastal) |
| *E. naucrates*   | 35 (TL)   | *C. mydas*      | 50 (TL)   | plastron (lateral)| AC (coastal) |
| *E. naucrates*   | 25 (TL)   | *C. caretta*    | 90 (TL)   | plastron (lateral)| SE (coastal) |
| *E. naucrates*   | 7 (SL)    | *E. imbricata*  | 47.5 (CCL)| carapace (lateral)| FN (oceanic) |
| *E. naucrates*   | 10 (TL)   | *E. imbricata*  | 45 (TL)   | carapace (lateral)| AA (coastal) |
| *E. naucrates*   | 25 (TL)   | *E. imbricata*  | 60 (TL)   | carapace (anterior)| JP (coastal) |
| *E. naucrates*   | 35 (TL)   | *E. imbricata*  | 60 (TL)   | carapace (lateral)| SE (coastal) |
| *R. remora*      | 13 (TL)   | *C. mydas*      | 43 (CCL)  | plastron (lateral)| RA (oceanic) |
| *R. remora* (two individuals) | 45 (TL) | *E. imbricata X C. mydas hybrid* | 50 (TL) | carapace (lateral), plastron (lateral)| SP (oceanic) |
| *R. remora* (two individuals) | 50 (TL) | *D. coriacea* | 150 (TL) | carapace (lateral), plastron (middle) | OS (oceanic) |

Fig. 1. A leatherback turtle (*Dermochelys coriacea*) with an adult couple of the common remora (*Remora remora*), one of the fish moving over the carapace (left side) and the other attached to the plastron. A group of pilotfish (*Naucrates ductor*) travels with the turtle. Photo by G. Marcovaldi.
and *E. naucrates* and *E. imbricata* (N= 288 turtles). For Fernando de Noronha Archipelago this ratio was 0.002 for *E. naucrates* and *C. mydas* (N= 384 turtles), and 0.006 for *E. naucrates* and *E. imbricata* (N= 154 turtles). The size ratio remora/turtle varied 0.02-0.9 (mean= 0.37, SD= ±2.49, N= 12).

On two occasions we recorded sharksuckers (*E. naucrates*) feeding on particles stirred up during the foraging of their hosts. In one instance, the host was a hawksbill (*E. imbricata*) that fed on sponges and disturbed the substrate, the sharksucker leaving the host for a while to forage on the suspended particles. This sharksucker was attached on the margin of the carapace close to the turtle’s head. In another occasion the host was a green turtle (*Chelonia mydas*), which seems to disturb the substrate less than the hawksbill (Sazima & Sazima, 1984; C. Sazima et al., 2004; Grossman et al., in press). In this case, the fish was attached to the margin of the plastron, also close to the turtle’s head.

The sharksucker (*Echeneis naucrates*) is the most versatile species among the remoras (O’Toole, 2002), and is here recorded both in oceanic islands and on the coast. It may even enter estuarine waters (Santos & Sazima, 2005). The sharksucker free-swims in the water column feeding on small fishes and plankton (Fig. 3 and O’Toole, 2002) and attaches to a wide array of hosts (review in O’Toole, 2002). Its versatility includes the role of a station-based cleaner (Fig. 3 and Sazima et al., 1999), an unexpected behaviour for a mostly hitch-hiking fish group (O’Toole, 2002). The variety of turtle hosts here recorded for the sharksucker agrees well with its catholic habits, reef-dwelling habitat, and its basal position within the echeneid phylogeny (O’Toole, 2002). We predict that the sharksucker will likely be recorded attached to the olive Ridley turtle (*Lepidochelys olivacea*) as well, since this turtle is found near reefs in SW Atlantic even if infrequently (AG, pers. obs.).

On the other hand, the common remora (*Remora remora*) seems strictly an oceanic species which attaches mostly to large pelagic vertebrates such as leatherback turtles, manta and devil rays, and whale sharks (Fig. 1 and O’Toole, 2002). Its occurrence on reef-dwelling turtles at oceanic islands only (present paper) strengthens the view on the pelagic habits of this remora species. *Remora remora* is known to ram-filter plankton while attached to whale sharks (Clarke & Nelson, 1997).

The remora-turtle association is usually regarded as an instance of phoresis or hitch-hiking (e.g., Perrine, 2003), albeit feeding is also involved in this symbiosis type. For instance, species of remoras are recorded to forage feeding on the hosts’ faeces and/or vomits, food scraps of their hosts, cleaning the hosts on occasions, ram-feeding on plankton while attached to the moving host (Clarke & Nelson, 1997; Sazima et al., 1999; 2003; O’Toole, 2002; Williams et al., 2003; Silva et al., 2005), and foraging on stirred particles (present paper; see additional fish species following turtles to capitalize on stirred particles in Sazima et al., 2004).

Based on their sizes most of the remoras here recorded on turtles are juveniles (see Carvalho-Filho, 1999; Froese & Pauly, 2006 for adult sizes of both species). As the four adult *R. remora* individuals were attached in couples, they may be mating pairs. Couples of adult fish are recorded for the whalesucker (*Remora australis*) attached to spinner dolphins.
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(Stenella longirostris), these individuals being regarded as pre-mating ones (Silva-Jr & Sazima, 2003). Remoras attached to sea turtles may increase their chance to find a mate when the turtles congregate for their own mating (e.g., Márquez, 1990; Perrine, 2003). However, there are reports on a few R. remora individuals attached to D. coriacea females dying of desiccation when the latter left the sea to excavate their nests on beaches in French Guiana, whereas others were still alive when the turtles returned to the sea (Freytey, 1979a, b).

The greater the remora/turtle ratio, the greater the hydrodynamic drag the attached fish exerts on its host, and thus presumably hampers the host’s swimming performance, especially when the attached fish is relatively large or when the remoras occur in pairs or even more individuals (present paper, V. Barth – photographs from the Caribbean). Lessened swimming ability may be crucial under some circumstances, e.g., when male turtles are competing for a female (e.g., Booth & Peters, 1972; Perrine, 2003), or when they are attacked by sharks (e.g., Witzell, 1983; Perrine, 2003). Thus, the advantages for a remora attached on a sea turtle include taking a ride (an energy-saving behaviour), foraging, and mating opportunities. On the other hand, for the turtle, the disadvantages may be limited to the dynamic drag the attached fish exerts on its host and thus presumably hampers the host’s swimming performance.

The extremely low remora/turtle ratio we found indicates that this symbiosis is a rare association in Brazil’s oceanic islands. For the coast we have no such data. However, a glance at the Table 1 indicates that there is a possibility that the association may be a little commoner on the coast than on oceanic islands. In any case, however, both qualitative and quantitative studies focused on the subject may clarify further the turtle-remora association in Southwest Atlantic.

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