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Scientific note

Turtle riders: remoras on marine turtles in Southwest Atlantic

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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.

Uma visão geral é apresentada sobre uma relação pouco documentada entre vertebrados recifais no Atlântico Sul Ocidental: rêmoras (Echeneidae) associadas a tartarugas marinhas. Duas espécies de rêmora ou pegador (*Echeneis naucrates* e *Remora remora*) e quatro de tartarugas (*Caretta caretta*, *Chelonia mydas*, *Eretmochelys imbricata* e *Dermochelys coriacea*) são aqui registradas em associações simbiônticas para o Atlântico Sul Ocidental. *Echeneis naucrates* foi registrada tanto na costa como em ilhas oceânicas, ao passo que *R. remora* foi registrada somente em ilhas oceânicas e região pelágica. A associação entre rêmoras e tartarugas é habitualmente considerada como forese, embora forrageamento, por parte das rêmoras, também esteja envolvido neste tipo de simbiose. Esta associação parece ser rara no Atlântico Sul Ocidental.

Key words: 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 on the host 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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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)

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),

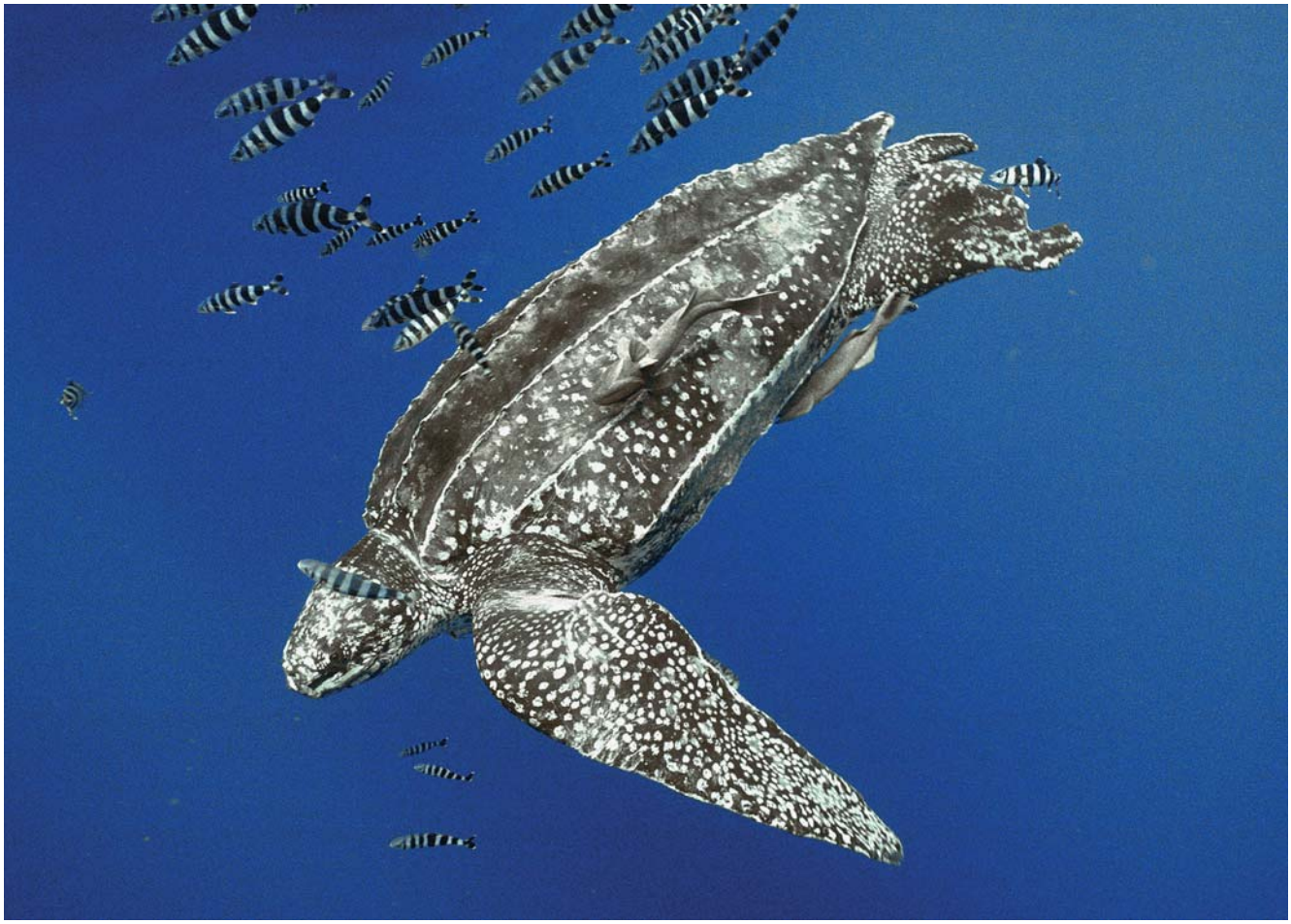

Fig. 1. A leatherback turtle (*Dermochelys coriacea*) with an adult couple of the common remora (*Remora remora*), one of the fish moving over the carapace (left side) and the other attached to the plastron. A group of pilotfish (*Naucrates ductor*) travels with the turtle. Photo by G. Marcovaldi.

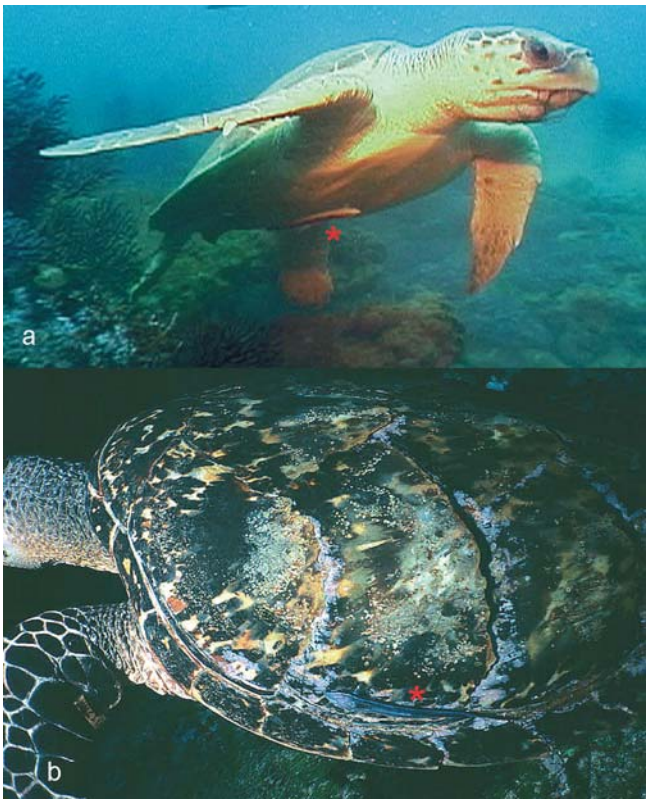

Fig. 2. A loggerhead turtle (*Caretta caretta*) with a juvenile sharksucker (*Echeneis naucrates*) attached to the plastron (red asterisk) (a). From a video-frame by G. Marcovaldi. A hawksbill (*Eretmochelys imbricata*) with a juvenile sharksucker (*Echeneis naucrates*) attached to the carapace (red asterisk) (b). Photo by L. B. Francini.

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

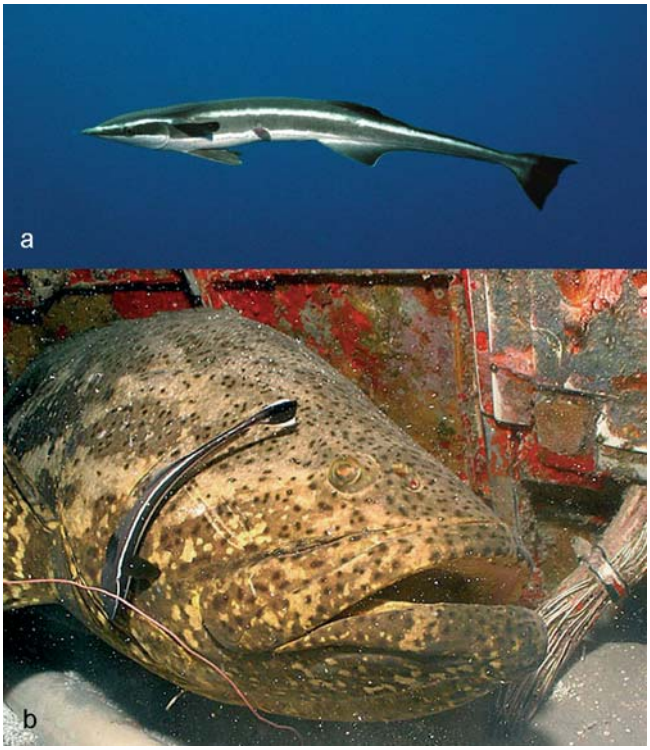

Fig. 3. A sharksucker (*Echeneis naucrates*) free-swimming in the water column (a). Photo by G. Marcovaldi. A station-based juvenile sharksucker cleaning a jewfish (*Epinephelus itajara*) in a shipwreck (b). Photo by L. B. Francini.

(*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 Guyana, whereas others were still alive when the turtles returned to the sea (Fretey, 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 related to a presumably lessened 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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Literature Cited

Alling, A. 1985. Remoras and blue whales: a commensal or mutual interaction? Whalewatcher (Journal of the American Cetacean Society), 19: 6-19.

Altmann, J. 1974. Observational study of behavior: sampling methods. Behavior 49: 227-265.

Booth, J. & J. A. Peters. 1972. Behavioural studies on the green turtle (*Chelonia mydas*) in the sea. Animal Behavior, 20: 808-812.

Carvalho-Filho, A. 1999. Peixes: costa brasileira. Melro, São Paulo, 304 p.

Clarke, E. & D. R. Nelson. 1997. Young whale sharks, *Rhincodon typus*, feeding on a copepod bloom near La Paz, Mexico. Environmental Biology of Fishes, 50: 63-73.

Fertl, D. & A. M. Landry Jr. 2002. Remoras. Pp. 1013-1015. In: W. F. Perrin, B. Würsig & J. G. M. Thewissen (eds.), Encyclopedia of Marine Mammals. New York, Academic Press, 1414 p.

Figueiredo, J. L. & N. A. Menezes. 1980. Manual de peixes marinhos do sudeste do Brasil. III. Teleostei (2). São Paulo, Museu de Zoologia Universidade de São Paulo, 90 p.

Fretey, J. 1979a. Commensalisme entre *Remora remora* (Linné) et des tortues marines pendant la nidification. Cybium, 3: 40.

Fretey, J. 1979b. Acompagnement à terre des tortues luths, *Dermochelys coriacea* (Linné) par des rémoras. Revue Française d'Aquariologie, 2: 49-54.

Froese, R. & D. Pauly (Eds.). 2006. FishBase. World Wide Web electronic publication. www.fishbase.org.

Grossman, A., C. Sazima, C. Bellini & I. Sazima. In press. Cleaning symbiosis between hawksbill turtles and reef fishes off northeast Brazil. Chelonian Conservation and Biology.

Lehner, P.N. 1979. Handbook of ethological methods. New York, Garland STPM Press, 403 p.

Márquez-M, R. 1990. Sea turtles of the world. FAO Species Catalogue, 11:1-81.

O'Toole, B. 2002. Phylogeny of the species of the superfamily Echeneoidea (Perciformes: Carangoidei: Echeneidae, Rachycentridae, and Coryphaenidae), with an interpretation of echeneid hitchhiking behaviour. Canadian Journal of Zoology, 80: 596-623.

Perrine, D. 2003. Sea turtles of the world. Stillwater, Voyageur Press, 144 p.

Robins, C. R. & G. C. Ray. 1986. A field guide to Atlantic coast fishes. Boston, Houghton Mifflin, 354 p.

Santos, M. C. de O. & I. Sazima. 2005. The sharksucker (*Echeneis naucrates*) attached to a tucuxi dolphin (*Sotalia guianensis*) in estuarine waters in south-eastern Brazil. JMBA2 – Biodiversity Records, 2pp. http://www.mba.ac.uk/jmba/jmba2biodiversityrecords.php

Sazima, C., A. Grossman, C. Bellini & I. Sazima. 2004. The moving gardens: reef fishes grazing, cleaning, and following green turtles in SW Atlantic. Cybium, 28: 47-53.

Sazima, I., R. L. Moura & M. C. M. Rodrigues. 1999. Juvenile sharksucker, *Echeneis naucrates* (Echeneidae), acting as a station-based cleaner fish. Cybium, 23: 377-380.

Sazima, I., C. Sazima & J. M. Silva-Jr. 2003. The cetacean offal connection: feces and vomits of spinner dolphins as a food source for reef fishes. Bulletin of Marine Science, 72: 151-160.

Sazima I. & M. Sazima. 1984(1983). Aspectos de comportamento alimentar e dieta da tartaruga marinha, *Chelonia mydas*, no litoral norte paulista. Boletim do Instituto Oceanográfico, São Paulo, 32: 199-203.

Silva-Jr., J. M. & I. Sazima. 2003. Whalesuckers and a spinner dolphin bonded for weeks: does host fidelity pay off? Biota Neotropica, 3: 1-5.

Silva-Jr, J. M., Silva, F. J. L. & I. Sazima. 2005. Rest, nurture, sex, release, and play: diurnal underwater behaviour of the spinner dolphin at Fernando de Noronha Archipelago, SW Atlantic. Aqua Journal of Ichthyology and Aquatic Biology, 9: 161-176.

Williams, Jr, E. H., A. A. Mignucci-Giannoni, R. K. B. Bunkley-Williams, C. Self-Sullivan, A. Pree & V.G. Cockcroft. 2003. Echeneid-sirenian associations, with information on sharksucker diet. Journal of Fish Biology, 63: 1176-1181.

Witzell, W. N. 1983. Synopsis of the biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis, 137: 1-78.

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