

A new and unexpected host for the sharksucker (*Echeneis naucrates*) with a brief review of the echeneid–host interactions

Juerg M. Brunnschweiler*‡ & Ivan Sazima†

*Institute of Zoology, University of Zurich, Winterthurerstrasse 190, CH–8057 Zurich, Switzerland. †Departamento de Zoologia e Museu de História Natural, Caixa Postal 6109, Universidade Estadual de Campinas, 13083-970 Campinas, São Paulo, Brazil.

‡Corresponding author; e-mail: juerg.brunnschweiler@zool.unizh.ch

The sharksucker, *Echeneis naucrates*, attaches to a variety of hosts including teleost fish, elasmobranchs, marine turtles, and mammals. We list 18 additional hosts not previously recorded for this species, including the first report of its attachment to a conspecific and review the possible role of the relationship between echeneid fish and their hosts. The attachment of *E. naucrates* to a conspecific represents an addition to known hosts for this species, but it remains unclear if remoras are a habitual host for conspecifics.

The Echeneidae contains eight recognized species in four genera that all rely on hitch-hiking behaviour to varying degrees (O'Toole, 2002). Among them, *Echeneis naucrates* (Linnaeus, 1758) displays the most eclectic behaviour and is known to attach to a wide variety of hosts including teleost fish (Cressey & Lachner, 1970), marine mammals (Fertl & Landry, 1999; Williams et al., 2003), turtles (Sazima & Grossman, 2006), and sharks (Brunnschweiler, 2006). Whereas several teleost fish species serve as hosts for *E. naucrates* (reviewed in O'Toole, 2002), it has never been documented that echeneid fish also attach to conspecifics. Here we introduce *E. naucrates* as a new host for conspecifics, list 17 additional hosts for this remora species and review briefly the echeneid–host interactions.

Our record was made at the Shark Reef Marine Reserve, Fiji (for map and description see Brunnschweiler & Earle, 2006) on 20 March 2006. A group of eight medium-sized to large (30–50 cm total length, TL) *E. naucrates* was observed, including one individual which had a smaller conspecific attached to its back (Figure 1). The attached *E. naucrates* was a juvenile visually estimated to be approximately 10 cm TL (adults reach about 80–90 cm, see Randall, 1996; Humann, 2002). The two *E. naucrates* remained attached for at least two hours, and were video-taped for a total of 4:52 min.

The *E. naucrates* host individual was easily identified by its injured upper jaw (Figure 1). During the observation period, the smaller *E. naucrates* that was attached to its conspecific did not leave its host and was mostly attached to the same body region (dorsum). The host *E. naucrates* displayed movement patterns similar to those described for reef sharks when they presumably try to dislodge attached sharksuckers including shaking as well as shivering which included rolling and pectoral fin flickering (Brunnschweiler, 2006). These body movements had no apparent visible effect on the hitch-hiking conspecific. The host sharksucker with injured upper jaw was not seen again at the study site the following days and thus it is unclear if the smaller conspecific stayed attached for longer than the observation period.

Juvenile *E. naucrates* (from hatching to approximately 60 mm standard length, SL, see Nakajima et al., 1987) are thought to live free-swimming and associate to floating objects (O'Toole, 2002). They start to attach to hosts at approximately 40–80 mm SL and are said to prefer boxfish (Ostraciidae) and parrotfish (Scaridae), these



Figure 1. An adult sharksucker (*Echeneis naucrates*) about 50 cm total length (TL) with a juvenile conspecific about 10 cm TL attached to its back. An injured upper jaw (circle) identified this particular sharksucker. Other fish are *Lutjanus bohar*, one *Caranx ignobilis*, and an additional adult sharksucker. From a video frame by Mike Neumann.



Figure 2. A juvenile sharksucker (*Echeneis naucrates*) 6 cm TL attached near the dorsal fin of a porcupine fish (*Diodon hystrix*) 38 cm TL. Photograph by Maurício Andrade.

relatively small and sluggish hosts being regarded as trial vehicles (Strasburg, 1964). A porcupine fish (*Diodon hystrix* Linnaeus, 1758) recorded off Brazil (Figure 2) may possibly be regarded as a trial vehicle as well, as it carried a small *E. naucrates*. As the remoras grow they presumably switch to larger and/or faster hosts (Table 1; see review in O'Toole, 2002). Medium-sized to large sharksuckers are often recorded free-swimming (Strasburg, 1964; Sazima & Grossman, 2006; this paper) and it is likely that an adult *E. naucrates* would acquire a smaller conspecific under these particular circumstances, thus playing the role of a host.

At least 30 different fish serve as host species (some hosts unidentified to species level) for *E. naucrates* and it seems that no host is predominant (O'Toole, 2002). However, most host fish are reef-dwellers, a situation similar to that we recorded in Fiji, South Pacific and north-east Brazil, south-west Atlantic (Table 1), which is consistent with the reef-dwelling habits of *E. naucrates* (see O'Toole, 2002; Sazima & Grossman, 2006). Thus, about 50 fish species are recorded as hosts for *E. naucrates* to date. Unfortunately, for most of these records there is neither data on the size of the sharksucker nor the place of attachment to the host. On a stationary host *E. naucrates* is reported to move over the host's body and clean it (Sazima et al., 1999; Sazima & Grossman, 2006; our personal observations). Data on attachment location would be useful to test the hypothesis that small juvenile sharksuckers attach to a greater diversity of body parts than larger juveniles and adults (Silva-Jr & Sazima, 2006). For instance, the attachment of a small sharksucker on the head of a permit *Trachinotus falcatus* (Linnaeus, 1758) and a trunkfish *Lactophrys trigonus* (Linnaeus, 1758), contrasts with the predominant mode of attachment which primarily occurs on the hosts' ventral, dorsal or lateral surface (Table 1). Attaching to the head of a bottom feeding fish, such as the permit and trunkfish, allows the sharksucker to pick the food stirred up by the foraging host (our personal observation; see also Sazima & Grossman, 2006).

The unique suction disk of the remoras – a modified first dorsal fin that migrated anteriorly onto the neurocranium and underwent a series of morphological modifications – and its performance (Fulcher & Motta, 2006) would largely define the interactions with their hosts. However, the relation between a remora and its host seems to differ for each echeneid species (Strasburg, 1959; Alling, 1985; O'Toole, 2002;). The suction disk allows hitch-hiking behaviour which benefits echeneids with reduced costs of transportation and expenditure of energy (Strasburg, 1957; Steffensen & Lomholt, 1983; Alling, 1985;), access to food resources (Strasburg, 1959; Sazima et al., 2003; Sazima & Grossman, 2006), protection from predators (Silva-Jr et al., 2005), and presumably increased mating opportunities (Silva-Jr & Sazima, 2003). But the suction disk performance has also effects on the hosts. These effects are by far less well studied and only recently has the question of costs and benefits for the hosts been considered (Brunnschweiler, 2006; Sazima & Grossman, 2006; Silva-Jr & Sazima, 2006). A possible benefit for the host is cleaning with removal of parasites and diseased or injured tissue (Cressey & Lachner, 1970; Sazima et al., 1999; Silva-Jr & Sazima, 2006). This benefit is likely outweighed by the potential costs for the host, however. While factual evidences and hypotheses about the nature of these costs exist (Brunnschweiler, 2006; Sazima & Grossman, 2006; Silva-Jr & Sazima, 2006), no quantitative data are available as yet. However, evidence is increasing that at least some host types such as sharks and dolphins are discomforted or even impaired with echeneid attachment or position on their body, and subsequently try to dislodge or relocate the remoras (Brunnschweiler, 2006; Fish et al., 2006; Silva-Jr & Sazima, 2006). This may explain the finding that remoras attach to many different body parts on larger hosts and seem to prefer the dorsal and ventral

Table 1. Records of additional fish hosts for the sharksucker (*Echeneis naucrates*) from Fiji, South Pacific and north-east Brazil, south-west Atlantic. Host sizes (cm total length, TL, except for wingspan for the ray*) estimated against objects of known size; *E. naucrates* TL calculated from photographs on hosts or visually estimated against the host size; placement of *E. naucrates* on moving hosts. On ten host species *E. naucrates* were recorded regularly (N not counted). Order of families follows Nelson (1994); species in alphabetical order. A, Atlantic; P, Pacific.

Host species	Host size	<i>E. naucrates</i> size	Placement on host body	Area
GINGLYMOSTOMATIDAE				
<i>Nebrius ferrugineus</i>	250–300	20–40	Ventral, dorsal, lateral	P
CARCHARHINIDAE				
<i>Carcharhinus amblyrhynchos</i>	120–180	</>20	Ventral, dorsal	P
<i>Carcharhinus melanopterus</i>	80–120	~15	Ventral, dorsal, lateral	P
<i>Carcharhinus perezii</i>	160–200	20–40	Ventral, dorsal, lateral	A
<i>Negaprion acutidens</i>	180–200	20–40	Ventral, dorsal, lateral	P
MYLIOBATIDAE				
<i>Aetobatus narinari</i> *	50–60	~15	Ventral	P
ECHENEIDAE				
<i>Echeneis naucrates</i> (N=1)	50	10	Dorsal	P
CARANGIDAE				
<i>Caranx ignobilis</i>	120–140	~15	Ventral, head	P
<i>Trachinotus falcatus</i> (N=1)	70	8	Head	A
SERRANIDAE				
<i>Epinephelus lanceolatus</i>	250	</>20	Ventral	P
<i>Mycteroperca bonaci</i> (N=2)	100–120	25–30	Lateral, Ventral	A
<i>Variola louti</i> (N=1)	60	~15	Dorsal	P
LABRIDAE				
<i>Cheilinus undulatus</i>	100	</> 20	Ventral	P
LUTJANIDAE				
<i>Lutjanus bohar</i>	40–70	~15	Ventral, lateral	P
<i>Lutjanus jocu</i> (N=1)	50	20	Ventral	A
SCARIDAE				
<i>Scarus trispinosus</i> (N=1)	60	15	Lateral	A
OSTRACIIDAE				
<i>Lactophrys trigonus</i> (N=2)	35–40	8, 30	Head, ventral	A
DIODONTIDAE				
<i>Diodon hystrix</i> (N=1)	38	6	Dorsal	A

surface of their hosts (Table 1; Brunnschweiler, 2006). Due in part to the dislodging behaviour of the host, echeneid fish often change location. Remoras need a relatively flat surface to generate seal (Fulcher & Motta, 2006), so they tend to attach to areas of the host that provide a broad flat surface. Further studies of the echeneid–host association may aim at identifying and quantifying costs that would result from echeneid attachment to different host species.

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REFERENCES

- Alling, A., 1985. Remoras and blue whales: a commensal or mutual interaction? *Whalewatcher (Journal of the American Cetacean Society)*, **19**, 16–19.
- Brunnschweiler, J.M., 2006. Sharksucker-shark interaction in two carcharhinid species. *Marine Ecology*, **27**, 89–94.
- Brunnschweiler, J.M. & Earle, J., 2006. A contribution to marine conservation efforts in the South Pacific: Shark Reef Marine Reserve, Fiji. *Cybium*, (in press).
- Cressey, R.F. & Lachner, E.A., 1970. The parasitic copepod diet and life history of diskfishes (Echeneidae). *Copeia*, **1970**, 310–318.
- Fertl, D. & Landry, A.M., 1999. Sharksucker (*Echeneis naucrates*) on a bottlenose dolphin (*Tursiops truncatus*) and a review of other cetacean–remora associations. *Marine Mammal Science*, **15**, 859–863.
- Fish, F.E., Nicastro, A.J. & Weihs, D., 2006. Dynamics of the aerial maneuvers of spinner dolphins. *Journal of Experimental Biology*, **209**, 590–598.
- Fulcher, B.A. & Motta, P.J., 2006. Suction disk performance of echeneid fishes. *Canadian Journal of Zoology*, **84**, 42–50.
- Humann, P., 2002. *Reef fish identification: Florida, Caribbean, Bahamas*, 3rd edn. Jacksonville: New World Publications.
- Nakajima, H., Kawahara, H. & Takamatsu, S., 1987. The breeding behavior and the behavior of larvae and juveniles of the sharksucker, *Echeneis naucrates*. *Japanese Journal of Ichthyology*, **34**, 66–70.
- Nelson, J.S., 1994. *Fishes of the world*, 3rd edn. New York: John Wiley & Sons.
- 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.
- Randall, R.E., 1996. *Caribbean reef fishes*, 3rd edn. Neptune City: T.F.H. Publications.
- Sazima, I. & Grossman, A., 2006. Turtle riders: remoras and marine turtles in Southwest Atlantic. *Neotropical Ichthyology*, **4**, 123–126.
- Sazima, I., Moura, R.L. & Rodrigues, M.C.M., 1999. A juvenile sharksucker, *Echeneis naucrates* (Echeneidae), acting as a station-based cleaner fish. *Cybium*, **23**, 377–380.
- Sazima, I., Sazima, C. & Silva-Jr, J.M., 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.
- Silva-Jr, J.M. & Sazima, I., 2003. Whalesuckers and spinner dolphin bonded for weeks: does host fidelity pay off? *Biota Neotropica*, **3**, 1–5.
- Silva-Jr, J.M. & Sazima, I., 2006. Whalesuckers on spinner dolphins: an underwater view. *JMBA2 – Biodiversity Records*, 6 pp. <http://www.mba.ac.uk/jmba/jmba2biodiversityrecords.php>
- Silva-Jr, J.M., Silva, F.J.L. & Sazima, I., 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.
- Steffensen, J.F. & Lomholt, J.P., 1983. Energetic cost of active branchial ventilation in the sharksucker, *Echeneis naucrates*. *Journal of Experimental Biology*, **103**, 185–192.
- Strasburg, D.W., 1957. Notes on the respiration of small *Remora remora*. *Copeia*, **1957**, 58–60.
- Strasburg, D.W., 1959. Notes on the diet and correlating structures of some central Pacific echeneid fishes. *Copeia*, **1959**, 244–248.
- Strasburg, D.W., 1964. Further notes on the identification and biology of echeneid fishes. *Pacific Science*, **18**, 51–57.
- Williams, E.H.Jr, Mignucci-Giannoni, A.A., Bunkley-Williams, L., Bonde, R.K., Self-Sullivan, C., Preen, A. & Cockcroft, V.G., 2003. Echeneid-sirenian associations, with information on sharksucker diet. *Journal of Fish Biology*, **63**, 1176–1183.

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