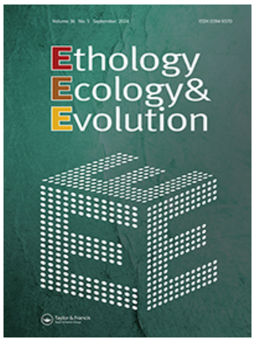

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Short communication

Chafing behaviour of great barracudas on sea turtles triggers escape response of external parasites

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If chafing behaviours on the bottom or rocks are common, interspecific events are rare and usually involve smaller ray-finned fishes rubbing on larger sharks or manta rays. Reports on interspecific chafing between fishes and reptiles are even less common, with just one report of great barracudas (*Sphyraena barracuda*) using swimming hawksbill (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*) as chafing surfaces in the Southwestern Atlantic. Here, we describe a chafing interaction between a great barracuda and a hawksbill turtle in the Red Sea. Our observation provides evidence that this interaction is probably not localised but may represent a more widespread behavioural pattern than previously thought. This chafing behaviour is suggested to remove external parasites, and our observation documents the behaviour of the scraper and the scraped animal, as well as the reaction of the parasites during the same event, clearly demonstrating that chafing behaviour aims at the removal of parasitic copepods (Caligidae). We also report the evasive behaviour of the copepods during the event, providing novel information on parasite removal in reef fishes.

KEY WORDS: interspecies chafing, scraping, parasitic copepods, evasive behaviour, *Sphyraena*, *Eretmochelys*.

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INTRODUCTION

Fishes carry external parasites and developed several strategies for the ectoparasites' removal. These strategies range from establishing symbiotic relationships with various cleaner species (fish or shrimp) to chafing against sand or hard surfaces such as rocks (e.g. DeLoach 1999; Losey et al. 1999; Barber et al. 2000; Vaughan et al. 2017; Sazima 2023). Intra- and interspecies chafing behaviour is a less common strategy usually involving smaller fishes rubbing against larger species, such as elasmobranchs as scraping surfaces, due to their rough skin covered with dermal denticles (Eibl-Eibesfeldt 1955; Wicklund 1969; Papastamatiou et al. 2007; Williams et al. 2021; Thompson & Meeuwig 2022). For instance, grey reef sharks (*Carcharhinus amblyrhynchos*), silky sharks (*C. falciformis*) and Galapagos sharks (*C. galapagensis*) use whale sharks (*Rhincodon typus*) as chafing surfaces (Pancaldi et al. 2022; Gobbato et al. 2024). Chafing of cleaner fish (*Labroides* spp.) against reef manta rays (*Mobula alfredi*) is also reported (Krajewski et al. 2017).

Copepods are commonly observed ectoparasites on barracuda species such as *Sphyraena enis*, *S. argentea*, *S. sphyraena* and *S. barracuda*, with primary infection sites being the gills and mouth (Causey 1960; Bravo–Hollis 1981; Williams & Bunkley-Williams 1996; Grossman et al. 2009; Musaliyarakam et al. 2018; Minaya Angoma et al. 2021). Such ectoparasites can have profound effects on fish populations and thus marine ecosystems by causing lesions, and/or acting as disease vectors (Johnson et al. 2004; Hadfield & Smit 2019; Bass et al. 2021; Narvaez et al. 2021).

Here, we report that great barracudas use swimming sea turtles as chafing surfaces and that the targeted parasitic copepods respond by actively evading dislodging attempts.

MATERIAL AND METHODS

The chafing events described here occurred on 15 January 2024, at a depth of 17–20 m, during a SCUBA dive in El Quadim Bay (Egypt; 26.157288N, 34.248117E). The event was video recorded with a frame rate of 50 fps, which allowed to adequately document the rapid movement of the copepods as well as the chafing path on the turtle carapace. Size estimation of the total length (TL) for *S. barracuda* was done to the nearest 5 cm. A picture of the barracuda closely passing rocks on a sand area was used to measure the distance between the identified rocks. TL was then calculated by direct comparison in the picture. Turtle carapace length (CL) was estimated by comparison from a picture taken during the chafing event.

RESULTS

Great barracudas, some of which display copepod infestations (Caligidae), are regularly observed in El Quadim Bay (Fig. 1A). The chafing interaction described here lasted about 1 min 10 sec. Before the event, the barracuda (TL = 95 cm) was slowly swimming along the reef. The start of the interaction [*T* = 00:00 (min:sec)] was defined by the first reaction of the barracuda to the approaching hawksbill turtle (CL = 40 cm). This time point was marked by a change in the direction of the barracuda toward the turtle and by an increase in the movement of the caudal fin, initiating a slight acceleration (Supplemental Data: Video 1). It then started to tail the turtle (*T* = 00:20). Although the turtle noticed the movement of the barracuda, it did not significantly change its behaviour at this stage of the interaction. The first chafing event occurred after about

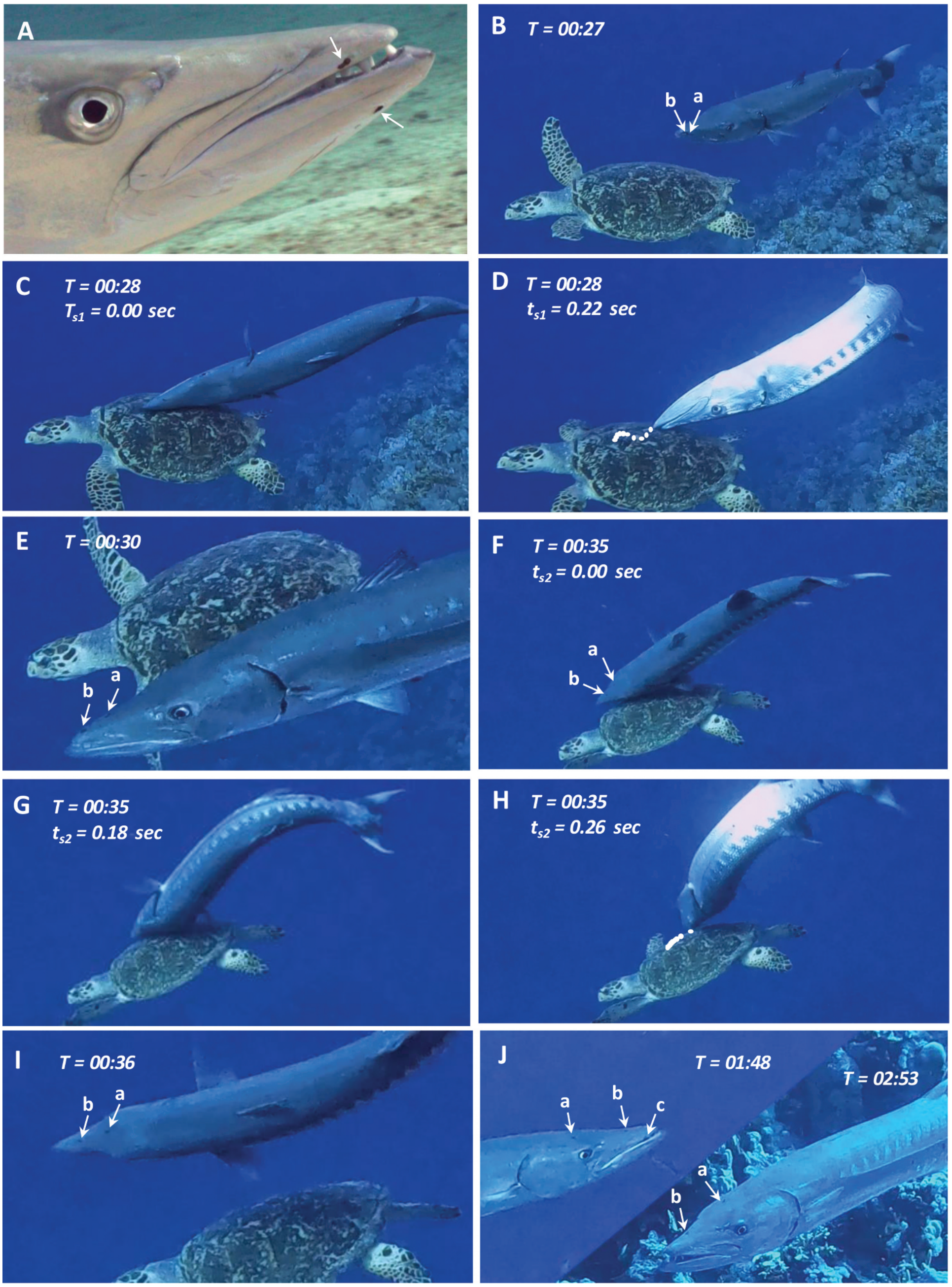

Fig. 1. — Images of the first two chafing events. The letters a, b and c are used to trace individual copepods, whose position is highlighted by white arrows. (A): Close up of the copepod infestation of the observed great barracuda. (B–D): First chafing event. (B): Tailing behaviour by the great barracuda [*T* = 27 sec after the barracuda reacted to the approaching hawksbill turtle (*T* = 00:00)]. White arrows a and b indicate two copepods positioned on the left side of the barracuda's mouth. (C-D): Chafing event

28 sec (Fig. 1B–D) and targeted copepods positioned on the left side of the barracuda's snout (Fig. 1B, arrows a and b). The very rapid chafing movement was performed in about 0.22 sec and followed a path from the front to the back on the turtle's carapace (Fig. 1D, dotted line). The chafing event was not successful as the copepods reacted by moving from the left side to the upper side of the barracuda's snout (Fig. 1E).

After repositioning, the second chafing event targeted the upper head as the copepods had moved to this position (Fig. 1F, white arrows). The duration of the contact was similar, and the movement also followed a path from the front towards the back of the carapace (Fig. 1F–H). In this case, the turtle displayed an accentuated evasive behaviour, moving about 3 m deeper after the event. Again, the second chafing attempt was unsuccessful as the copepods were still visible on the upper side of the head (Fig. 1I). About 20 sec after the second event, the barracuda displayed a third chafing attempt. This attempt was not as clearly observed and documented, as it occurred at greater distance than the previous ones. However, in this case, the chafing did not seem to target the copepods positioned on the top of the head as the contact with the carapace was made within the gill region (Supplemental Data: Video 1). The turtle reacted to this third attempt by immediately sinking onto the reef and remaining immobile there. After circling once above the turtle, the barracuda finished the interaction. It then shortly continued swimming in its original direction (Fig. 1J; $T = 01{:}48$) before taking a stationary position on the reef (Fig. 1J; $T = 02{:}53$). Documentation of both sides of the head confirmed that the two copepods "a" and "b" moved from the left side of the mouth to the upper side of the head during the interaction. A third copepod "c" is visible on the right side of the snout (Fig. 1J).

As regards copepods, they displayed evasive manoeuvres prior to the actual contact of the barracuda with the turtle's carapace, moving rapidly from the left side of the snout to the upper side (Fig. 2). Based on the used video frame rate (50 fps), the first copepod did so within approximately 0.2 sec (Fig. 2A–D, arrow a), and this evasive movement was initiated about 0.6 sec before the barracuda made contact and initiated chafing (Fig. 2E). The movement of the second copepod (Fig. 2F, arrow b) was less pronounced, but a repositioning towards the upper side of the snout was clearly visible (Figs 2F and 1E–J). A third copepod is visible on the right side of the snout (Fig. 2E, arrow c), but it does not seem to have moved during any of the chafing events (Fig. 1J), which all targeted the barracuda's left side.

DISCUSSION

Chafing behaviour of great barracudas using turtle carapaces as chafing surfaces is reported only from the Southwestern Atlantic off north-eastern Brazil (Grossman et al. 2009), and this is the first record from the Red Sea. Therefore, we suggest that

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beginning from estimated first contact (C; $t_{s1} = 0.00$ sec) to breaking of the contact with the carapace (D; $t_{s1} = 0.22$ sec). The chafing path across the carapace (white dots) was determined by following the movement of the tip of the barracudas 'mouth during the 11 frames (recorded at 50 fps) of the event. (E): Copepod positions after the first chafing event are highlighted by white arrows. (F-H): Second chafing event, beginning from estimated first contact (F; $t_{s2} = 0.00$ sec) to breaking of the contact with the carapace (H; $t_{s2} = 0.26$ sec). The chafing path across the carapace (white dots) was determined by following the movement of the tip of the barracudas 'mouth during the 13 frames (50 fps) of the event. (I): Copepod positions after the second chafing event are highlighted by white arrows. (J): Close up to copepod positions after the third chafing event.

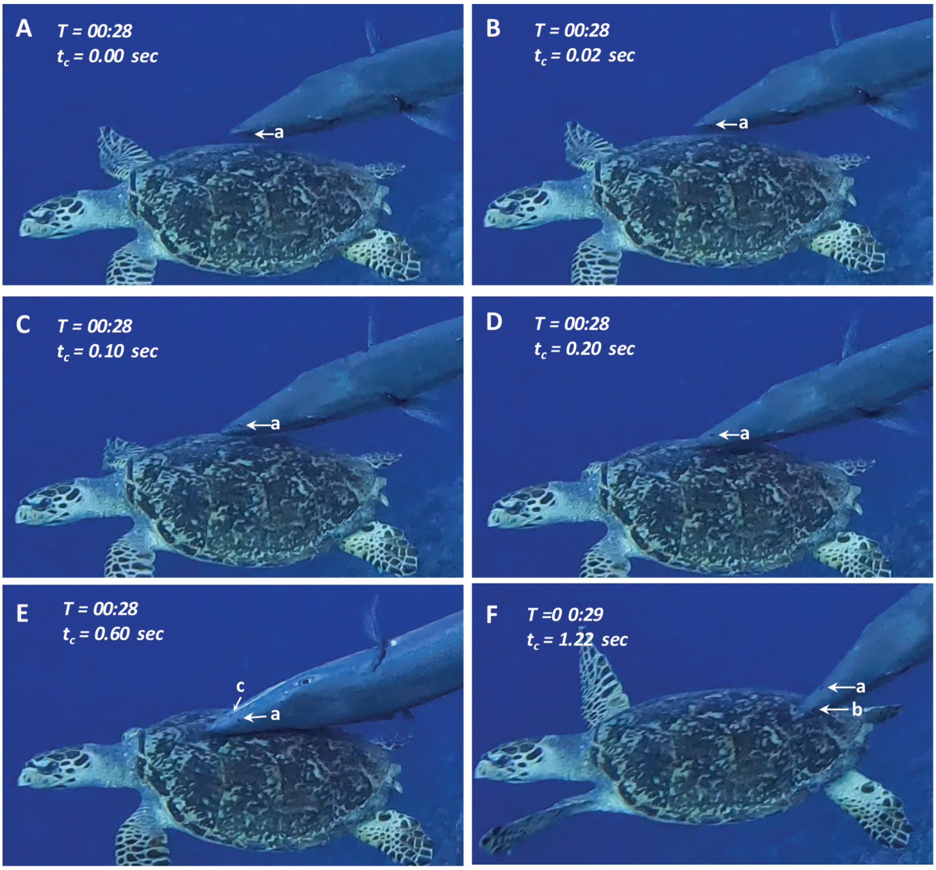

Fig. 2. — Close up to the evasive behaviour of the copepods prior and during the chafing event. The letters a, b and c are used to trace individual copepods, whose position is highlighted by white arrows. (A): Initial position of one of the copepods (arrow a, t_C: timer for copepod movement). (B-E): Evasive movement of copepod "a" as the snout of the barracuda approaches and then contacts the carapace (E). (F): Repositioning of the second copepod to the upper side of the snout (arrow b).

this interaction represents a behaviour of great barracuda that may be more widespread than previously thought (Grossman et al. 2009).

Our observation that the great barracuda finished the chafing attempts as soon as the turtle sank down onto the reef and remained immobile strongly supports the suggestion of Grossman et al. (2009) that swimming turtles are a more convenient chafing surface than motionless ones. The sequence of events we recorded between the barracuda and the sea turtle bears similarity to the chafing behaviour various fish species perform on sharks or manta rays in a sort of mobile cleaning station in which the scrapees are first tailed and chafing is then timed according to their movements (Wicklund 1969; Papastamatiou et al. 2007; Krajewski et al. 2017; Williams et al. 2021; Thompson & Meeuwig 2022; Gobbato et al. 2024).

Our observations differ from those reported by Grossman et al. (2009) in the way the chafing is performed. Grossman et al. (2009) report that the barracuda moved along the carapace from the rear to the front, contacting the rear end of the scutes. The chafing movements that we report for the first and the second attempt run from the font to the rear of the carapace, including a sideward movement. We think that the position of the copepods on the snout influences the chafing movement. This is especially evident when the two first chafing attempts are compared. Although both movements are performed from the front to the rear of the carapace, the barracuda clearly adapts its position according to the localisation of the copepods, with the second chafing attempt targeting the copepods that moved upwards on the barracuda's head. The third chafing attempt that we observed follows a path from the rear to the front of the carapace and seems to target the gill region. Great barracudas are cleaned by the sharknose goby (*Elacatinus evelynae*) in the Western Atlantic (Johnson & Ruben 1998), but cleaner gobies are small (about 3–5 cm total length TL) and feed on gnathiid isopods (Grutter 2002). The caligid copepods that we observed on the barracuda are larger than the isopods and probably the gobies are unable to remove them. This supposed lack of cleaners able to remove the large caligids would be a reasonable explanation for the great barracuda rubbing the parasitised body parts against sea turtles' carapace. Our thorough documentation of the reaction of the parasites constitutes a novel aspect of the field. This work thereby demonstrates the hypothesis proposed in the literature (Grossman et al. 2009; Williams et al. 2021; Pancaldi et al. 2022; Gobbato et al. 2024) that this behaviour aims to remove parasites.

During the chafing interaction, the behaviour of the turtle changes from simply enduring the first attempt to an evasive behaviour in the second and third attempts. In recent years, the scientific debate concerning the transfer of microbial and parasitic species between hosts is increasing (Narvaez et al. 2021, 2022; Williams et al. 2021; Sazima 2023). Infestation with small copepod species (approx. 1–2 mm) such as *Balaenophilus manatorum* and *Balaenophilus umigamecolus* are reported for different turtle species, such as loggerhead turtles (*Caretta caretta*), olive ridley turtle (*Lepidochelys olivacea)* and black turtle (*Chelonia mydas agassizi*) (Lazo-Wasem et al. 2007; Crespo-Picazo et al. 2017). Except for the nuisance associated with the chafing event, we suppose that there is no further detrimental effect of the interaction between barracudas and sea turtles.

In conclusion, we show that great barracudas scrape the carapace of sea turtles for direct parasite removal. An important new aspect consists in the first description of the parasite's reaction, which seems to actively evade the dislodging attempts made by the fish. The parasites' behaviour is a kind of caligid run, and our report is a novelty in the literature about parasite removal in reef fishes.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

AUTHOR CONTRIBUTION

M.Y. Wiesinger and S. Haan collected and analysed the data. I. Sazima reviewed the data. S. Haan prepared the figures and videos. M.Y. Wiesinger, I. Sazima and S. Haan wrote the manuscript.

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SUPPLEMENTAL DATA

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