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# Defecation behaviour of the Lined Bristletooth Surgeonfish *Ctenochaetus striatus* (Acanthuridae)

**R. Krone · R. Bshary · M. Paster · M. Eisinger · P. van Treeck · H. Schuhmacher**

**Abstract** The feeding and defecation behaviour of the surgeonfish *Ctenochaetus striatus* was investigated at Ras Mohammed National Park (South Sinai, Red Sea). The fish feed on coral rock mainly by sweeping loose sediment with their flexible broom like teeth into their mouths. Feeding occurred exclusively on coral rock, but defecation took place only outside the grazing area above sand in small, precisely defined areas.

**Keywords** Red Sea · Defecation behaviour · *Ctenochaetus striatus* · Sediment export

## Introduction

Some terrestrial animal species like badgers, ants and geckos use specific places for defecation (Carpenter and Duvall 1995; Neal and Cheesman 1996; Moore 2003; Poulsen and Boomsma 2005). In the marine environment, the herbivorous damselfish *Plectroglyphidodon lacrymatus* uses 1–4 specific sites around the edge of its small territory ($\sim$1 m$^2$, Polunin and Koike 1987). The herbivorous surgeonfish *Acanthurus glaucopareius* and *Acanthurus lineatus* display similar behaviour and defecate mostly during non-feeding time, whilst outside their territories (Robertson 1982). The herbivorous reef-scraping parrotfish *Chlorurus gibbus* also defecates away from its reef crest feeding grounds (Bellwood 1995).

The surgeonfish *Ctenochaetus striatus*, which has been previously reported to defecate at the border of its home range (Bellwood 1995), was the subject of the present study. During surveys on several fringing reefs in the Gulf of Aqaba and on the main Red Sea coast in October 2004 (Fig. 1). *C. striatus* were found to be repeatedly leave the reef flat in search of specific sandy areas in order to defecate. These areas were situated either seawards of the reef crest, in the lagoon or in the deep wells of the reef flat. This article describes and quantifies the spatial defecation pattern.

## Materials and methods

The Lined Bristletooth Surgeonfish *C. striatus* (Quoy and Gairmard 1825) is one of the most abundant reef-fish species throughout the Indo-Pacific (Choat 1991). It is a diurnal detritivore (Montgomery et al. 1989; Randall and Clements 2001), which picks at the surface of reef rock using its bristle-like teeth (Purcell and Bellwood 1993) or using the rasping edge of its upper jaw (Krone et al. 2006), consuming sedimentary matter and algal turf.

The study was carried out during October and November 2005 at Marsa Bareika, in the Ras Mohammed National Park on the southern tip of the Sinai Peninsula, Egypt

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R. Krone (✉)
Division Marine Animal Ecology, Alfred-Wegener-Institute for Polar and Marine Research, Bürgermeister-Smidt-Straße 20, 27568 Bremerhaven, Germany
e-mail: Roland.Krone@awi.de

R. Bshary
Institute of Biology, University of Neuchâtel, Emile-Argand 11, 2009 Neuchatel, Switzerland

M. Paster · P. van Treeck · H. Schuhmacher
Department of Hydrobiology, University Duisburg-Essen, 45117 Essen, Germany

M. Eisinger
Centre of Microscale Ecosystems, University Duisburg-Essen, 45117 Essen, Germany

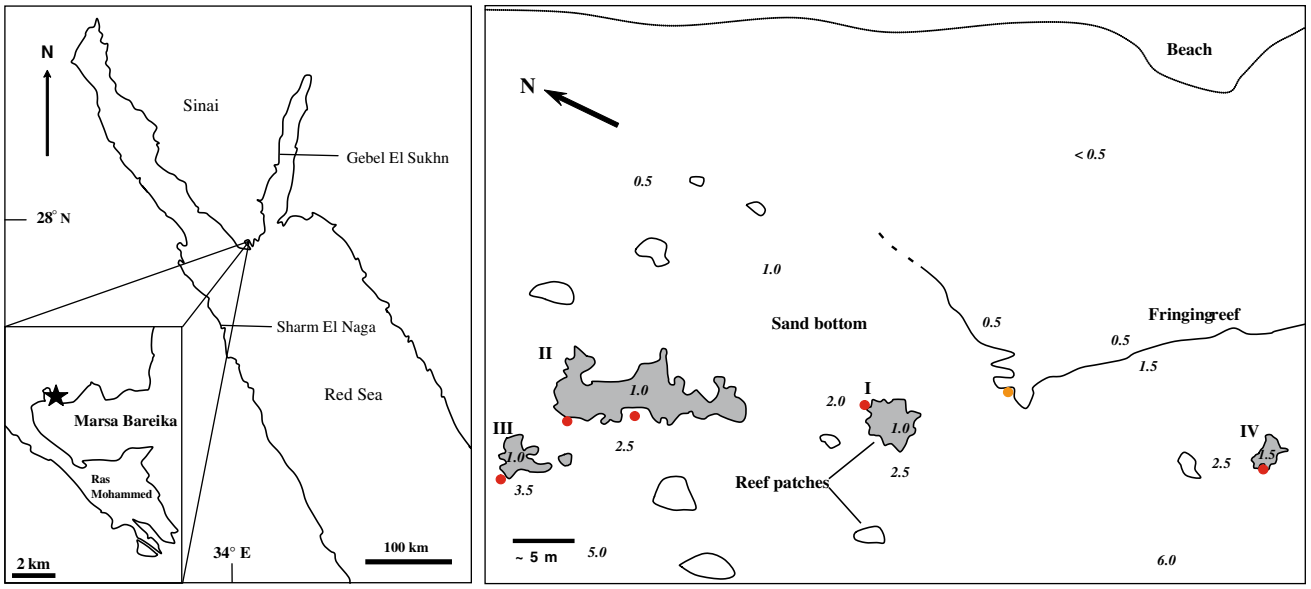


**Fig. 1** Research location in the northern Red Sea, at Marsa Bareika (black star). Right-hand diagram: positions of defecation areas (red dots) of *Ctenochaetus striatus* adjacent to four reef patches (I–IV, grey). Individuals living close by on the adjacent fringing reef also used a single site for defecation (orange dot). Numbers = water depth in metres

(Fig. 1). At this site there is a shallow reef which consists a narrow fringe and different sized patches situated 25–80 m from the shore line in depths of 0.5–6 m (Fig. 1) on the sand plain that extends 100 m seawards to a depth of 8 m. Living coral cover on these patches ranged from 5 to 50%. Eleven adult *C. striatus* (standard length 12–14 cm) inhabiting four of the small reef patches (9–27 $m^2$) were subject to detailed observations.

Reef patches were selected since they were completely surrounded by sand, and it was therefore possible to closely monitor where the fish were defecating. These patches were measured and marked in squares (1.5 × 1.5 m) using small styrofoam balls at the grid intersections (floating 1 m above the bottom). Individual *C. striatus* could be identified from prominent scars or from a distinct white spot on their caudal fin. Swimming tracks, feeding locations, and fish positions were recorded at 2-min interval and recorded on maps. Observation periods were terminated after a minimum of four defecations per fish, resulting in 4–22 observed defecations per individual. The distance between the second last and last foraging spot and between the last foraging spot and the defecation location were compared to show the spatial separation of feeding and defecation. The percentage of observation above hard substrate vs. sandy areas was computed and analysed using non-parametric statistics.

## Results and discussion

All 11 *C. striatus* displayed the same feeding and defecation pattern: from 3 h after sunrise until sunset the fish were continuously browsing the reef rock (compare Montgomery et al. 1989). Defecation took place every 5–10 min on the sandy area outside the reef. Typically a fish would cease feeding on the reef rock and immediately swim to a defecation spot beyond the reef edge. It then stopped or reduced speed, whilst about 20 cm above the sand-covered bottom, assumed an oblique head-upward position, spread its pectoral fins and deposited a faecal pellet. It then returned to continue grazing on the reef rock. Throughout, this behaviour, fish were neither disturbed by the presence of the observer nor by swimmers nearby. All 11 individuals visited a single-confined area of a few square decimetres (Fig. 2a, b; Table 1). Each defecation comprise a percentage of the total home range and was not used for other purposes. Neighbours and individuals inhabiting almost the same range usually shared the same area for defecation (Fig. 2b), but the individual areas did not overlap. All defecation sites shared three common features; they were located on the seaward side of the reef, were deeper than the foraging area, and in an area where the current flowed seaward. *C. striatus* individuals that were observed on the continuous reef flat nearby seemed to avoid the shallow backreef area, but defecated on the seaward edge also at distinct spots (Fig. 1).

All observed individuals spent most time above rocky substrate (median 87%), but defecated exclusively over sand (100%), thus defecating significantly more often over sand than predicted by their preferred residence duration (Wilcoxon-test, $n = 11$, $T = 0$, $P = 0.001$). All 11 fish swam greater distances from their rocky foraging area to

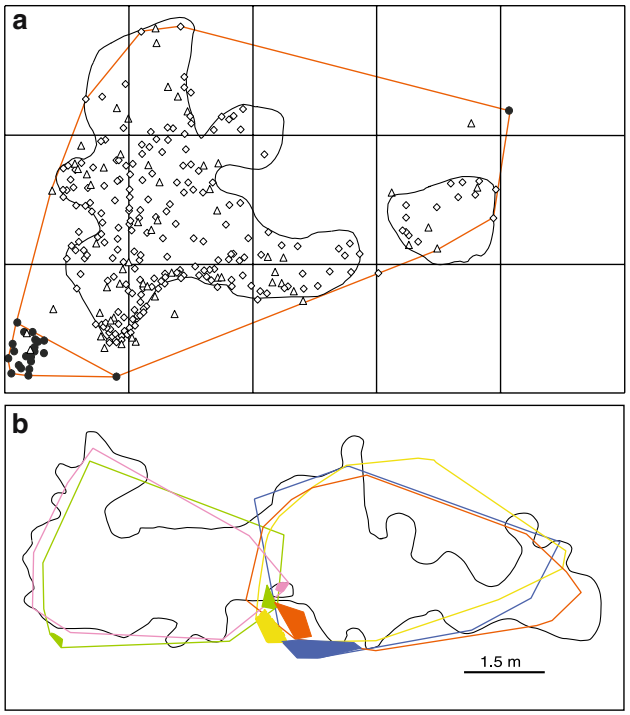


**Fig. 2** (**a**) Detailed behaviour of a single *Ctenochaetus striatus* (No. 1 in Table 1) during a period of 118 min on reef patch III (Fig. 1): defecations (black dots), 2 min interval positions (triangles), feeding points (rhombi). This specimen was exceptional for defecating once outside its usual area (compare also No. 4 in Table 2). The red line encloses the entire home range. Grid squares = 1.5 m. (**b**) The home range of five individuals (marked by different coloured lines) including their defecation sites (filled areas) (reef patch II Fig. 1)

the defecation site than between the last two feeding spots (on average 2.3 times further, Wilcoxon-test, $n = 11$, $T = 0$, $P = 0.001$) (Fig. 3, Table 2). The use of a single location to defecate was particularly striking because they could have swum in any direction (including a shorter distance) to defecate on sand.

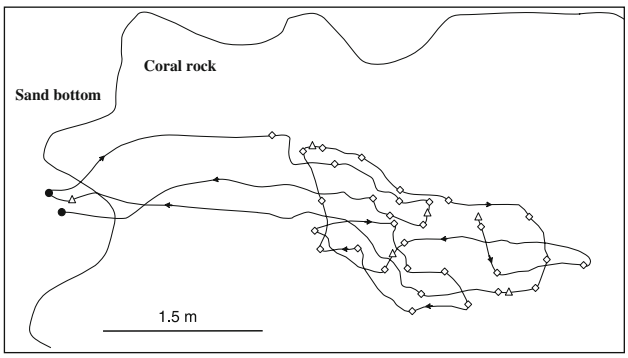


**Fig. 3** Example behaviour of an individual *Ctenochaetus striatus* during a 10-min period. The fish feeds (rhombi) in the rocky zone, where it spends most of the time (triangles) (reef patch I Fig. 1) and swims to defecate over the sandy bottom (black dots)

In the case of *C. striatus*, the use of a single-distinct area to defecate rather than a general preference for sand might simply be due to the small size of the home range, where there is only one optimum place. However, this behaviour does not hold for the herbivorous damselfish *Plectroglyphidodon lacrymatus*, which uses 1–4 specific defecation sites around its small ($\sim 1$ m$^2$) territory (Polunin and Koike 1987). In a larger home range (e.g., of the parrotfish *Chlorurus gibbus*, Bellwood 1995) fish use any sandy substrate away from the reef. Notwithstanding these differences, there is a similar pattern for all these species of defecating away from the foraging area, which may be a function of removing sediment to improve the growth of the grazer's food sources (*C. striatus* diet includes inorganic matter; Choat 1991; Purcell and Bellwood 1993), and/or by defecating away from foraging areas the risk of re-infection with endoparasites may be reduced (Choat 1991).

**Table 1** Home range and the corresponding defecation site of 11 *Ctenochaetus striatus* individuals

| Individual no. | Reef patch no. | Home range total (m$^2$) | Defecation spot (m$^2$) | Share of defecation spot of the whole home range (%) | Number of defecations (*n*) |
|---|---|---|---|---|---|
| 1 | III | 15.9 | 0.41 | 2.6 | 22 |
| 2 | III | 10.7 | 0.24 | 2.2 | 6 |
| 3 | II | 13.0 | 0.03 | 0.2 | 6 |
| 4 | II | 13.3 | 0.07 a | 0.5 a | 4 |
| 4 | II | 13.3 | 0.03 b | 0.2 b | 7 |
| 5 | II | 16.4 | 0.26 | 1.6 | 12 |
| 6 | II | 16.0 | 0.38 | 2.4 | 10 |
| 7 | II | 16.0 | 0.23 | 1.4 | 10 |
| 8 | I | 7.7 | 0.05 | 0.7 | 8 |
| 9 | I | 9.4 | 0.21 | 2.2 | 6 |
| 10 | IV | 5.8 | 0.03 | 0.5 | 7 |
| 11 | IV | 8.0 | 0.01 | 0.1 | 4 |

The individual number four used two spots (a and b) for defecation

**Table 2** The ratios of the distance (cm) between the last two feeding events before defecation (way 1) and the last feeding event and defecation (way 2) of *Ctenochaetus striatus*

| Individual no. | Reef patch no. | Defecations (*n*) | Way 1 (cm) | Way 2 (cm) | Ratio way 1/way 2 |
|---|---|---|---|---|---|
| 1 | III | 21 | 57 ± 46 | 233 ± 111 | 0.2 |
| 2 | III | 5 | 50 ± 20 | 303 ± 99 | 0.2 |
| 3 | II | 6 | 123 ± 65 | 239 ± 115 | 0.5 |
| 4 | II | 10 | 45 ± 45 | 216 ± 216 | 0.2 |
| 5 | II | 10 | 115 ± 115 | 242 ± 149 | 0.5 |
| 6 | II | 9 | 113 ± 57 | 227 ± 125 | 0.5 |
| 7 | II | 8 | 79 ± 33 | 333 ± 155 | 0.2 |
| 8 | I | 7 | 162 ± 120 | 257 ± 97 | 0.6 |
| 9 | I | 8 | 114 ± 73 | 146 ± 59 | 0.8 |
| 10 | IV | 5 | 247 ± 117 | 329 ± 236 | 0.8 |
| 11 | IV | 3 | 151 ± 114 | 347 ± 98 | 0.4 |

Mean ± SD. The average ratio way 1/way 2 was 0.4 (±0.2 SD)

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