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Mobula kuhlii cleaning station identified at an inshore reef in southern Mozambique

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Abstract

Cleaning interactions between the short fin devil ray, *Mobula kuhlii,* and the blue streaked cleaner wrasse, *Labroides dimidiatus*, were observed at two sites on a single reef in southern Mozambique. Cleaning interactions were filmed and described, with the number and location of interactions recorded and subsequently binned into six distinct body patches. Cleaners preferentially foraged within certain ray body patches, and this was found to vary between the two sites, possibly signifying that variations in a habitats composition can influence cleaning. *Mobula kuhlii* were not found to clean sympatrically with their close relatives in the *Manta* genus, implying their cleaning requires a distinct habitat or that niche partitioning is required to stem competition for host cleaner fishes attention. In total, 15 individuals were observed interacting with cleaners, and they never arrived alone, suggesting they may travel to cleaning areas in an aggregative manner.

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Introduction

The *Mobula* genus contains nine dramatically understudied species. Currently three are classified by the I.U.C.N. as data deficient, four as near threatened, one as vulnerable to extinction, and one as endangered (IUCN, 2015). There has been an alarming lack of scientific publications focusing on the genus, and as a result particularly little is known about their biology, behaviour or daily movements (Couturier et al., 2013). Here we provide the first description of *Mobula* rays interacting with cleaner organisms.

The subfamily Mobulidae contains the *Mobula* as well as the two species of *Manta* (Ward-Page et al., 2013). Similar to the *Manta* species, *Mobula* are lowly fecund, birthing a single live young per pregnancy (Couturier et al., 2013). As a result, the targeted removal of individuals by directed fisheries has led to ubiquitous global population declines (Couturier et al., 2013). A frequently sighted species in southern Mozambique is the short fin devil ray, *Mobula kuhlii,* a species which is also commonly targeted by local artisanal fisherman (Couturier et al., 2013). Unfortunately, the extent with which they are targeted within the region has not been established as monitoring local artisanal fisheries is difficult along such a remote coastline and Mozambique is yet to record any landings with the F.A.O. (Ward-Paige, Davis & Worm, 2013).

While descriptions of *Mobula* rays' life history are incomplete, their diurnal behavioural patterns, particularly that of nocturnal foraging, significantly resembles the manta rays (Croll et al., 2012; Couturier et al., 2013). Both the bent tail devil ray, *Mobula thurstoni*, and the spine tail devil ray, *Mobula japonica*, have been shown to feed near exclusively on euphasiids which nocturnally migrate to shallow waters (Gadig, Namora & Motta, 2003; Croll et al., 2012). During the hours of daylight, *Mobula* have been reported to remain in warm, shallow waters (Croll et al., 2012). Temperature can significantly influence poikilotherm physiological processes, and this is likely a key benefit to remaining in warm shallow waters, despite the decreased opportunities for foraging (Hochachka and Somero, 2002). Migrations inshore could also be attributed to social interactions, predator avoidance or their need to visit cleaning stations (Dewar, Mous & Domeier, 2008; Marshall, 2009; O'Shea, Kingsford & Seymour, 2010).

Cleaning ecology describes the interactions between client species and specialised cleaner organisms. Manta rays, the closest living relative to the *Mobula* species, are regularly observed interacting with cleaner fish hosts at aggregation sites worldwide (Dewar, Mous & Domeier, 2008; Marshall, 2009; O'Shea, Kingsford & Seymour, 2010). They, in addition to a diverse set of client species, regularly visit reef systems to have mucus, algal build-up, necrotic tissue and ectoparasites removed by the cleaners (Grutter and Bshary, 2003). The most studied marine cleaner species is *Labroides dimidiatus*, the blue streaked cleaner wrasse. The wrasse primarily forages on ectoparasites, and preferentially targets gnathiid isopods (Grutter, 1997; Grutter and Poulin, 1998; Grutter and Bshary, 2003). The blue streaked wrasses presence on reefs has been shown to both increase species diversity and positively influence client health (Grutter, Murphy & Choat, 2003; Ros et al., 2010). Herewithin, we provide the first description of mobula rays being serviced by the blue streaked cleaner wrasse.

Materials and Methods

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Following numerous opportunistic encounters and reports from dive operators where mobula rays were observed soliciting cleaning interactions at a shallow reef in the Inhambane Province, 5.17 hours of SCUBA dive transects (n = 7) were conducted to survey for established cleaning stations. The study reef, colloquially named “Two Mile”, is located within the Bazaruto Archipelago National Park, which is situated in the northern extent of the Inhambane province of southern Mozambique.

Subsequently, across two days and five separate S.C.U.B.A. dives, three and a half hours were spent recording cleaning interactions between *Mobula kuhlii* and *Labroides dimidiatus* (Fig. 1). Observations were split between two sites on ‘Two-Mile Reef’. Between low and mid tide, the two sites are separated by a rocky ridge breaking the water’s surface. One hour and five minutes were spent observing cleaning interactions at Fish Bowl, which sits at a depth of 8-14m on the leeward side of the reef. Two hours and twenty five minutes were spent observing cleaning interactions at Devil's Dance, which lies on the reefs seaward side at a depth of 16-20m. All research was conducted under approval of the National Administration of Conservation Areas (Department under the Environment Ministry of Mozambique) and was ethically approved by the Marine Megafauna Foundation.

During dives, two observers were present. One video-recorded the cleaning interactions, while the other positioned themselves on the edge of visibility to avoid influencing behaviours, but remaining accessible for safety. Videos were downloaded, replayed frame by frame, and interactions documented. A single interaction was characterised by a cleaner’s mouth making contact with the ray's body. The location of each interaction was noted on a template of a *M. kuhlii* rays' body, and then binned within the six ray body patches for analysis (Fig. 2).

Statistical analysis was performed within R statistics (R version 3.1.3: "Smooth Sidewalk"). Chi squared testing was used to examine if interactions between the cleaner wrasse and rays differed from a uniform distribution between the six body patches and if interaction distributions varied between the two sampled sites.

Results

Mobula kuhlii are regularly encountered in southern Mozambique. Despite the authors, and other members of their team, completing 1,853 survey dives in the region (2003-2015) including the intensive surveillance of 10 inshore reefs known to host manta cleaning stations, no *Mobula* species have ever been seen interacting with cleaner fish other than on the single reef monitored in this study.

Preliminary surveying transects (n =7) were conducted on both the ocean, and lee, side of the study reef to identify established cleaning stations. Rays were only present on three of these initial transects but when present had a mean sighting of 3.67 ± 2.66 (mean ± SE). During this period of surveying, 11 *Mobula kuhlii* were observed cleaning in two specific areas of the reef known locally as 'Fish Bowl' and 'Devil's Dance'. At a later stage, during focal dives (n = 5) to observe cleaning behaviour, 15 individuals were observed interacting with cleaners. On two of

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the dives rays were absent but when present the mean sighting was 5 individuals ± 0.58 (mean ± SE) per dive.

The recorded cleaning bouts at the monitored cleaning stations lasted for a mean time of 162s ± 32s with the rays receiving direct cleaning interactions from the host fish for 67s ± 15s (mean ± SE). During cleaning bouts, the rays spent a large proportion of their time repositioning themselves in order to pass over spatially finite areas of the reef (t = 95s ± 23s, (mean ± SE)). A maximum of three rays were observed receiving simultaneous interactions, despite six being contemporaneously present.

The distribution of interactions varied significantly between the six body patches ($x^2 = 23.419$, df = 5, $p < 0.001$). Overall, cleaners seemed to favour ventral patches, with the body patch receiving the highest absolute number of interactions (Fig. 5). Across the dorsal surface, the head patch received the most interactions from cleaner fish (Fig. 3).

Cleaner individuals also varied their patch specific foraging between the sampled sites ($x^2 = 42.895$, df = 5, $p < 0.001$). At Devil's Dance, all six patches received interactions. The majority were concentrated in the two head patches whilst the ventral body also received a relatively high number of interactions (Fig. 4). The interactions recorded at Fish Bowl were much less evenly distributed between the patches and were highly dominated by the two pelvic patches (Fig. 4).

Discussion

As cleaning interactions provide individuals with tangible health benefits, it is widely regarded as an important aspect of a species life history (Ros et al., 2010). Cleaning behaviour has not previously been investigated for a *Mobula* species, however several reports describe both of their close relatives in the *Manta* genus cleaning habitually (Dewar, Mous & Domeier, 2008; Marshall, 2009; O'Shea, Kingsford & Seymour, 2010). During this study in southern Mozambique we observed *Mobula kuhlii* soliciting interactions from the blue streaked cleaner wrasse. These initial observations are both unique to the region and are the first time cleaning interactions similar to those commonly seen in manta rays have been reported for a *Mobula* species.

Despite almost 2,000 research dives being completed in the region across 13 years mobula rays have only ever been seen cleaning on this single reef. Intensive research has shown that manta ray species display distinct preferences for the reefs within the region that they visit to be serviced by cleaners (Marshall et al., in prep). However, despite regular surveys of over 10 major reef systems in the local area with established cleaning stations for manta rays, *Mobula* were never seen to solicit cleaning from host cleaner fish in these areas. It is likely that either mobula rays have their own, distinct, preferences for the reefs they visit to solicit cleaning services or they purposefully are partitioning their habitat to avoid competition with these larger rays species.

On the study reef in the Bazaruto Archipelago National Park *Mobula kuhlii* is commonly encountered and regularly observed being cleaned by host fish. Exhaustive survey work in the immediate area (40 km on either side of this particular reef) has failed to produce similar observations. Studies have shown that clients have the ability to recognise a cleaning station, and then regularly return to it; a phenomenon often linked with the quality of the cleaning received (Tebbich, Bshary & Grutter, 2002). Variations in quality most likely arise from varying cleaner species abundance and composition, and propensity of cleaners to cheat (removal of non beneficial items by cleaners). Since *L. dimdiatus* is a true cleaner and is abundant throughout the surveyed sites, i.e. not a limiting factor in reefs shallower than 50 meters, reef preferences may rather be influenced by variations in topography and conditions, which may affect the range of movement of the cleaners and the quality of the service the cleaners can provide. Reef preference may also simply be a result of the reefs proximity to key habitats such as foraging grounds.

Group, or social, behaviour has been proposed as an important aspect of a manta ray's life history (Deakos, 2010a). Being part of a group is generally thought to increase a species awareness of predators and result in a greater probability of avoidance (Magurran, 1989; da Silva and Terhune, 1998). As of yet, no investigations have focused on *Mobula* ray group behaviour. Mobulidae species have no form of parental care, and so any groupings are likely not driven by familial bonds, meaning individuals congregate opportunistically or as part of a roving clade (Deakos, 2010b). During this preliminary study, no ray arrived at the designated cleaning stations alone, indicating they travel to cleaning areas as part of a structured group of some kind. Despite several rays being present around the cleaning station at once, individuals did not receive simultaneous interactions from the cleaners. So while social groups may navigate to cleaning stations together, it initially appears that at least the two monitored cleaning stations have a carrying capacity limiting the number of individuals that can be serviced at any one time. Certain individuals were noted to 'take turns' being cleaned, while other rays, that did not receive cleaning services at all, appeared to wait in the vicinity for others to be finished before together moving away from the area.

Whilst on the cleaning station, individuals spent more of their time circling than actually cleaning in order to continually pass over specific areas of the reef where the cleaner hosts were aggregating. These observations suggest that at least the cleaning stations on this reef may be located in quite spatially finite regions, defined by the host fish themselves. The cleaners did not follow the rays into the water column, instead remaining within their territories until the ray returned, suggesting they themselves dictate the areas within which the rays can clean, a fact that has been proposed in previous cleaning studies (Nakashima et al., 2000; Tebbich, Bshary & Grutter, 2002). As ram ventilators (Correia, Graca & Hirofumi, 2008), mobula rays like manta rays are obligated to continually swim, meaning they are unable to hold position above a cleaners territory for long periods of time. This biological requirement, when coupled with the spatial limitations of cleaning areas, possibly limits the efficiency of the service and may dictate where this species is able to clean and under what conditions.

The distribution of cleaning interactions varied significantly between the two sites of the reef. The most obvious variations between the sites appeared to be their topography and substrate cover. Fish Bowl’s benthos was covered with a bed of soft coral interspersed with loose rock, whilst Devil's Dance consisted of many large rocky outcrops encrusted with hard corals. Such differences likely influence the range and behaviour of the cleaner fish, and may alter both the wrasse’s approach and their effectiveness as cleaners. Although no differences were noted during our observations, varying environmental conditions, such as current strength, may also limit the cleaners movements, and may contribute to observed variations.

A fish's ectoparasite load positively correlates to body surface area and may be linked to the time a species is required to clean (Grutter, 1995; Sikkel, Fuller & Hunter, 2000). Descriptions of *Manta alfredi* cleaning have shown on average they clean for approximately twice the amount of time than the *M. kuhlii* observed within this study (Marshall et al., in prep). With surface areas orders of magnitude smaller than those of manta rays *M. kuhlii* may have much lower ectoparasite loads, which in turn may decrease the time and frequency of their cleaning requirement. Also unlike manta rays which are noted to be cleaned by a wide variety of cleaners (Marshall, 2009; O'Shea et al. 2010), *Mobula kuhlii* was only attended by a single cleaner species despite several known manta ray cleaners being present on the reef. If individual *Mobula* do indeed have low ectoparasite loads relative to an average manta ray, they may be perceived as less energetically rewarding clients for cleaner fish, perhaps explaining why interactions were only received from the small bodied, obligate cleaner, *L. dimidiatus*. With some studies indicating that cleaner fish species preferentially target certain parasite types (Marshall, 2009; Oliver et al., 2011), an alternate explanation may be that the parasites that these rays commonly possess may be favoured by this cleaner species explaining why they are attended solely by *L. dimidiatus.*

Cleaner fish should target body regions representing the most efficient foraging opportunities (Oliver et al., 2011). *L. dimidatus* has previously been shown to qualitatively assess a foraging opportunity and preferentially target it (Grutter, 1997). An uneven between-patch energy reward may explain why the wrasse favoured certain body patches in *M. kuhlii*. The ventral body patch received the highest number of interactions suggesting the area may represent high quality foraging for the cleaners. The level of attention that this patch received may also have been exacerbated by the cleaner fish's approach from a benthic territory or by the patches relatively large surface area (Tetsuo, 1984; Green, 1994). However, as the vast majority of the recorded interactions were concentrated around the gill slits, the cleaners were more likely selectively targeting this region. Gnathiid isopods form the vast majority of *L. dimidiatus's* diet, and manta rays are known to host dense aggregations of these parasites in their gill slits (Grutter and Poulin 1998; Marshall, 2009). It is quite possible that the observed *M. kuhlii* may also have high gnathiid isopod loads in their gills, influencing the cleaners to forage in this area.

Conclusions

Cleaning has never previously been investigated for a *Mobula* species. As their closest relatives, the giant and the reef manta ray (*Manta birostris, Manta alfredi*) extensively clean at inshore reefs, it is reasonable to assume that *Mobula* species seek out cleaning services as well. While this is the first reported account of cleaning in *Mobula*, this is likely due to lack of scientific effort. Alternatively, a variety of factors may result in these species being less heavily parasitised than manta rays requiring them to spend less time engaged in cleaning activities. It will be important to follow up on this preliminary study not just in this region or this species but across the rays in this genus. Understanding an animal's behaviour, habitat use, and movement patterns has significant implications on how it is most prudently managed. Further efforts must aim to

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quantify the importance of this behaviour to mobula rays and better determine their use of inshore habitats during daytime hours. Being able to accurately describe the patterns of use of these critical inshore habitats may provide managers with the detail needed to more effectively safeguard these threatened species.

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1

A *Mobula kuhlii* interacting with *Labroides dimidiaus* individuals during a pass over a cleaning station on the site "Devils Dance".

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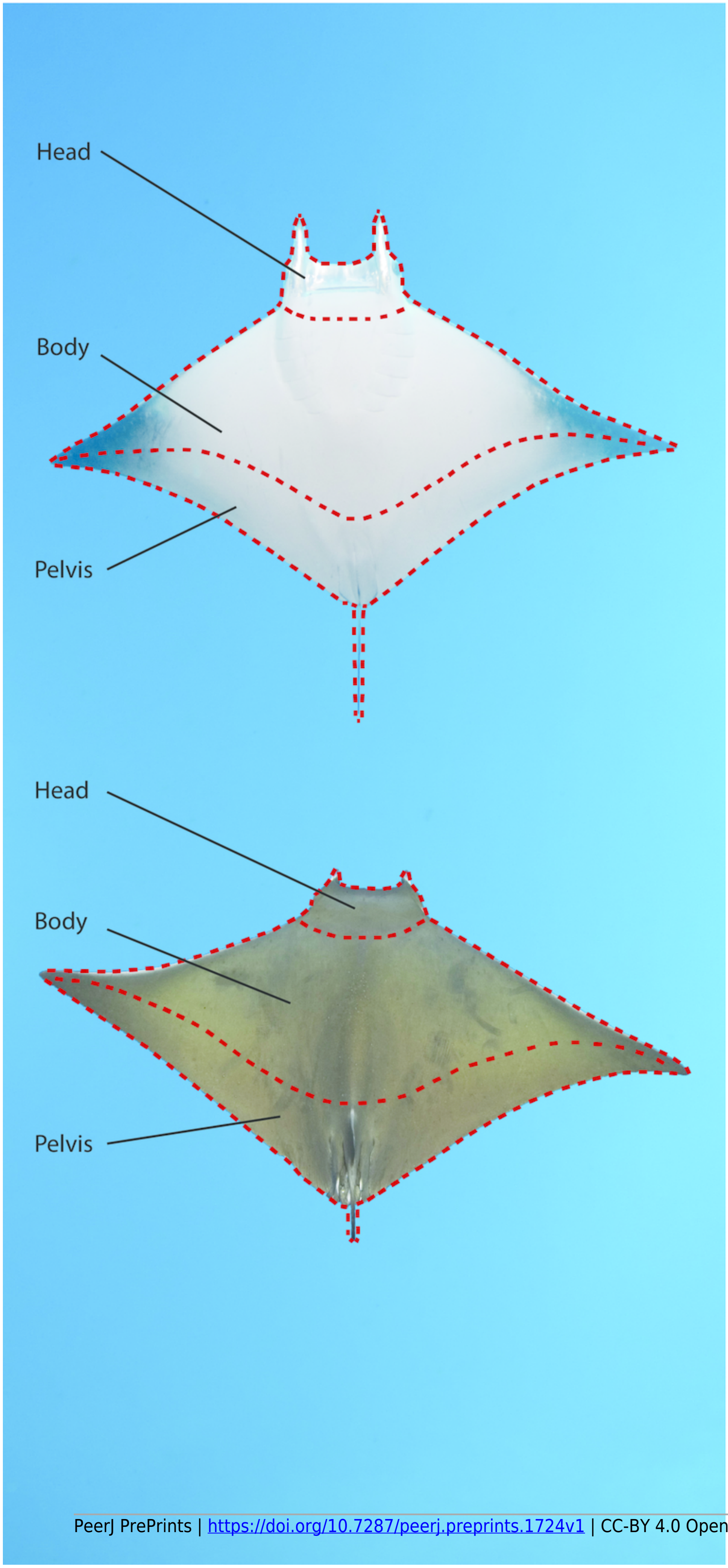
2

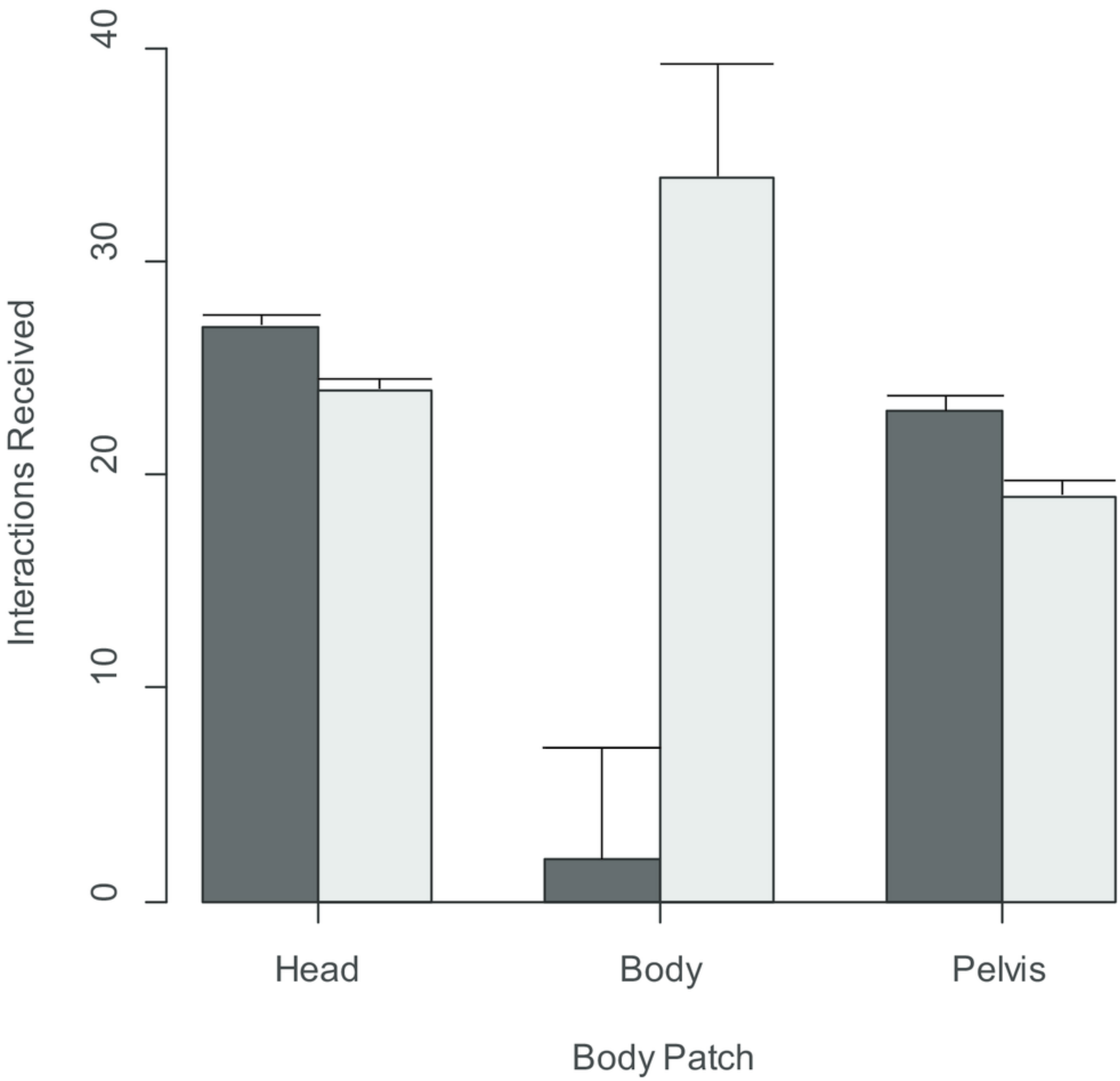
The body patches that recorded cleaning interactions between *Mobula kuhlii* and Labroides dimidiatus were binned within.


Head
Body
Pelvis
Head
Body
Pelvis

3

The mean number (± SE) of interactions that a ray's body patch received from cleaners.

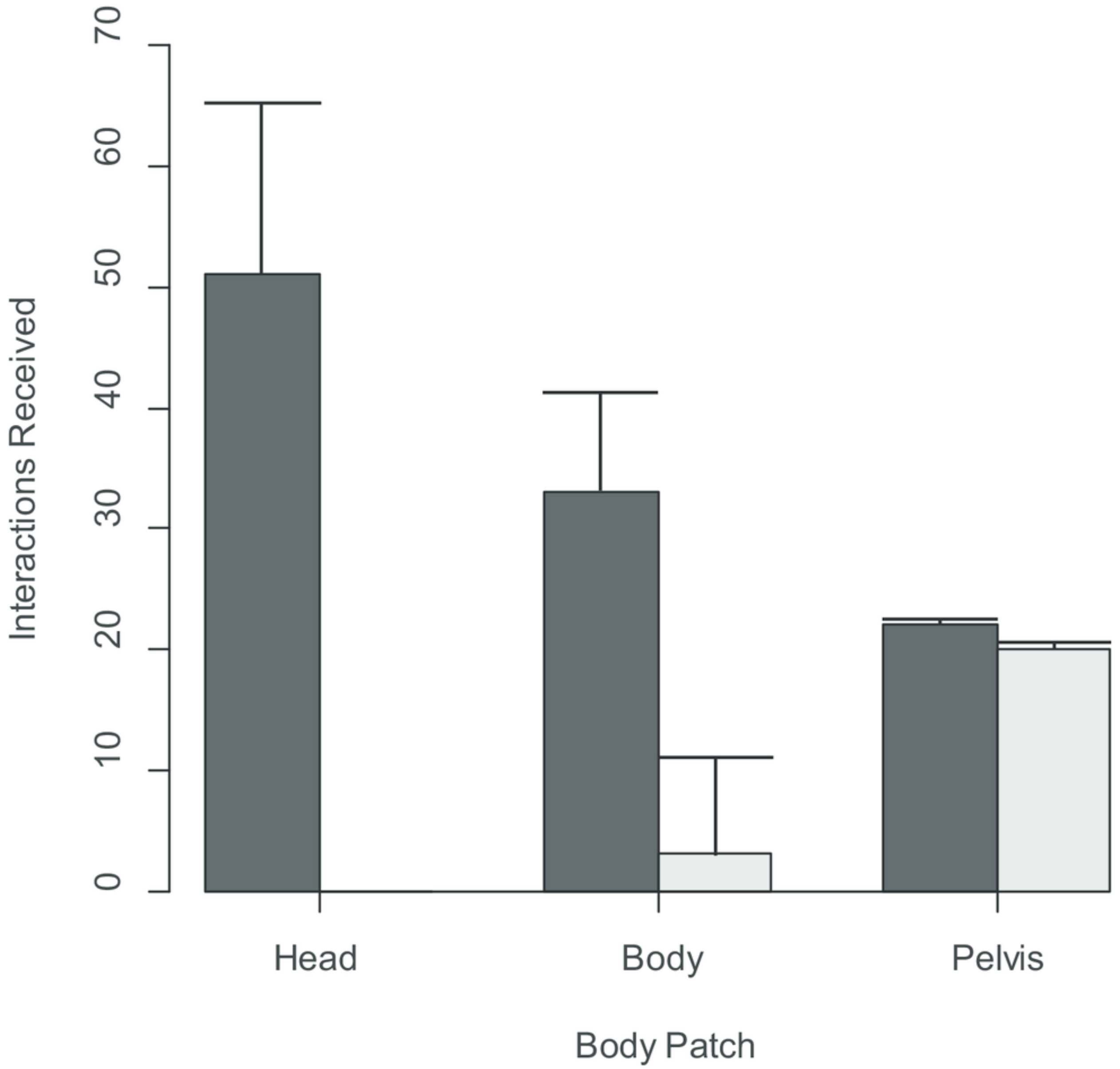
Light bars denote the ventral surface, and dark the dorsal. [b]



4

The mean number (± SE) of interactions a ray’s body patch received from the cleaner fish *Labroides dimidiatus*.

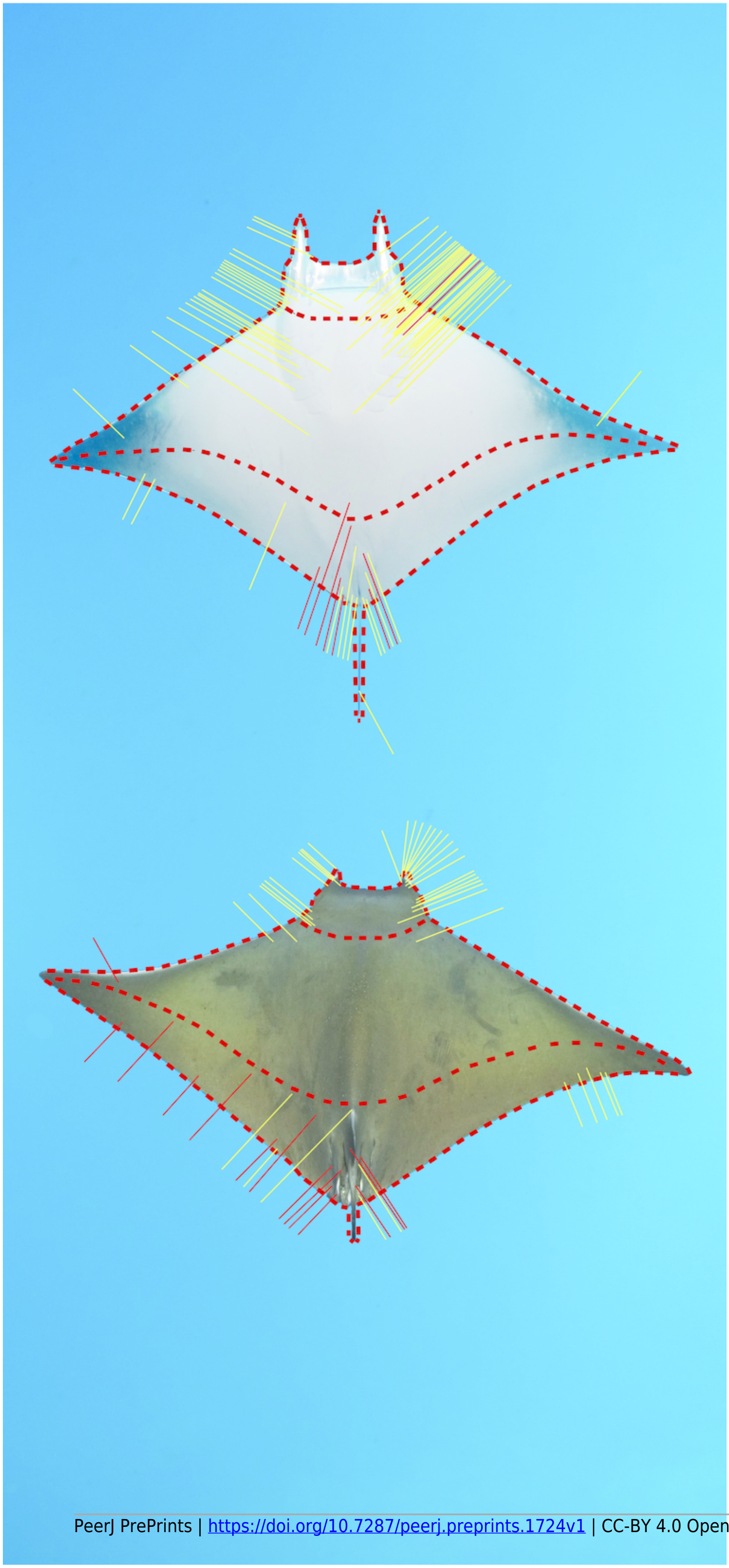
Light bars symbolise the reef “fish bowl”, and dark “Devil's dance”.



5

Recorded cleaning interactions between the fish *Labroides dimidiatus* and *Mobula kuhlii*.

The origin of a line represents the point at which contact occurred. Red lines represent the site “Fish Bowl” and black lines the site “Devil's Dance”.



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