



Aggression of an orange-fin anemonefish to a blacktip reef shark: a potential example of fish mobbing?

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Figure 1 In Moorea, French Polynesia, **a, b** an orange-fin anemonefish, *Amphiprion chrysopterus* (TL = 13.6 cm), approaches and **c** bites a blacktip reef shark *Carcharhinus melanopterus* (TL = approx. 140 cm) **d, e** causing the shark to respond with a jolt and tail flick, and **f** the anemonefish returns to its territory, or **g** an orange-fin anemonefish remains within its host anemone, *Heteractis magnifica*, as a blacktip reef shark passes within its territory (on average once every 2.5 h)



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Anemonefishes are highly territorial, showing aggression towards same sex conspecifics, potential competitors for reproductive status, as well as towards heterospecifics, such as *Dascyllus trimaculatus*, which are competitors for space and food as well as predators of anemonefish eggs (Ross 1978). Anemonefishes can also be highly aggressive to intruders that feed on their host sea anemones, such as reef fishes (e.g. Chaetodontidae) and turtles (Godwin and Fautin 1992), and even towards humans within their territory, with targeted attacks on dive masks or hands, especially when guarding eggs.

Anemonefish aggression towards potential predators is however unprecedented. Mobbing is a behaviour by one individual or a group that includes approaching or harassing a predator to prevent predation or spoil an ambush, and is found in birds, mammals, insects and fishes (e.g. Carlson et al. 2018). During studies on the outer reef of Moorea, French Polynesia (17°31'04.4"S 149°51'02.0"W), we filmed an adult orange-fin anemonefish, *Amphiprion chrysopterus*, showing unprovoked aggression towards a potential predator, a passing blacktip reef shark, *Carcharhinus melanopterus*. Sharks, including *C. melanopterus*, are piscivores, foraging nocturnally and diurnally on small or juvenile fishes, including damselfishes (Pomacentridae), fish of a similar size range to anemonefish (e.g. Dudley and Cliff 1993; Papastamatiou et al. 2006; Frisch et al. 2016). The photographs in Fig. 1a–f show an orange-fin anemonefish (TL = 13.6 cm) biting the tail of a blacktip reef shark (TL = approx. 140 cm) (also see ESM, Video S1). The video shows the shark swimming within the anemonefish territory, upon which the anemonefish swims directly from the anemone and bites the shark's caudal fin causing it to jolt. Sudden jolts by fish are a well-recognised response of clients to a bite by a cleanerfish (Nedelec et al. 2017). After the attack, the anemonefish quickly returns to its territory.

Blacktip reef sharks swim within the territories of anemonefishes once every 2.5 h (based on 12.5 h of video surveillance during which time five blacktip reef sharks passed within the territories of 25 orange-fin anemonefish in Moorea), and on detecting their presence, anemonefishes, as most prey, seek refuge or reduce activity (Fig. 1g). Our finding of mobbing in anemonefishes opens the door to several research avenues in behavioural ecology and evolution, including the adaptive significance of mobbing, the costs and benefits, as well as the presence of anemonefish threat-specific antipredator behaviours. Further studies could also examine whether changing anthropogenic or environmental conditions are rendering either anemonefishes more aggressive (e.g. boat noise pollution, Mills et al. 2020) or blacktip reef sharks less vigilant (possibly due to proximity to current or former provisioning locations).

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Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval No animal testing was performed during this study.

Sampling and field studies No permits were needed for the present observational field study.

Data availability Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Author contribution RB and SCM conceived and designed research. AB and JS conducted video footage. JS, RB and SCM wrote the manuscript. All authors read and approved the manuscript.

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