The fishing mantid: predation on fish as a new adaptive strategy for praying mantids (Insecta: Mantodea)

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Abstract

Observations in unmanipulated, semi-natural conditions were made of a single individual of the praying mantid *Hierodula tenuidentata*, while hunting and capturing an unusual prey for this kind of insect, guppy fish, *Poecilia reticulata*. This repetitive fishing behavior, recorded daily, is reported here for the first time and discussed in relation to the adaptive behavioral plasticity of praying mantids. We speculate regarding learning from experience as a hunting strategy.

Key words

behavior, evolution, India, learning, vision

Introduction

Mantids can be considered generalist predators but they are known to feed mostly on other insects, especially on fly-like insects (Prete et al. 1999). Vertebrates as prey for mantids are historically considered "anomalous data" based on anecdotal records, mostly from caged or in some way "induced" encounters between mantids and small birds, lizards, frogs, newts, mice, snakes and turtles (reviewed in Kevan 1985, Prete and Wolfe 1992, Costa-Pereira et al. 2010).

Several observations in the literature (i.e. Butler 1949, Hildebrand 1949, Prescott 1968) describe the predation of birds by mantids. However, McCormick and Polis (1982) point out that these observations are inconclusive since the birds captured by mantids were ultimately freed by concerned ornithologists. It is, however, stated that large praying mantids have the ability to kill small birds like hummingbirds and brown creepers. Recently, passerine birds trapped in mist nets have also been reported as occasional prey for mantids (Copete 2006). A recent overview of mantid predation on birds suggests that this behavior may be frequent in mantids, having already been recorded for 12 large-sized mantid species (including the genus *Hierodula*) in 13 different countries world-wide, preying on over 24 species of birds, with a marked preference for hummingbirds attracted to artificial bird-feeders (Nyffeler et al. 2017). Moreover, even if without scientific validation, it is not difficult to find several pictures and reports on the internet of caged (induced or manipulated) encounters/fights between mantids and a variety of small vertebrates.

Materials and methods

A single, 5.6 cm large male specimen of *Hierodula tenuidentata* Saussure, 1869, unequivocally recognizable by a white antennomerus on the right antenna, was occasionally observed in a private roof garden in Karnataka, India, preying on guppy fish, *Poecilia reticulata* Peters, 1859 (Fig. 1). The predations were observed every day for five consecutive days from the 7th to the 11th of March 2017 during periodical scans of the habitat from sunset at 6:30 pm to 12:30 am. Therefore, they were unmanipulated and occurred naturally without interference. About 40 fish [mostly *Poecilia reticulata*, few *Danio rerio* Hamilton, 1882 and one *Hypostomus plecostomus* (Linnaeus, 1758)] were contained in an artificial pond made in an earthen planter of 58 cm diameter, under natural light conditions. The mantid was able to reach the fish by perching on leaves of water lilies (*Nymphaeaceae*) and water cabbage (genus *Pistia* Linnaeus, 1785) growing on the surface of the pond.

The garden is located on top of a building about 5 m from the ground and containing about 15 potted plants. Other natural prey for mantids like wasps, butterflies, spiders, etc., have been frequently observed on these plants and in the garden which, even if mostly artificial, can be considered a semi-natural and functional habitat for a mantid like *Hierodula*, which is well-accustomed to gardens and urban areas (Kurosawa et al. 2003, Leong 2009).

Results

During the five days, the mantid was observed capturing and devouring a total of nine guppy fish. In seven cases, the mantid started eating from the tail (Fig. 2). On a single occasion, he started from the head and on another, from the top side. On the first four of the five days, the mantid was observed to hunt and devour

Fig. 1. The artificial pond with the male of *Hierodula tenuidentata* eating a *Poecilia reticulata*. Photo by R. Puttaswamaiah.

two fish. The second fish was hunted within 10–30 mins of consuming the first one. After the fifth day, the mantid disappeared and was not observed again at the pond.

Discussion

Fish do not move like lizards, locusts, hummingbirds or flies. They swim under the usual hunting field of a mantid and are separated by the barrier of water. Some other invertebrates like spiders, and especially fishing spiders, can hunt in water, but the origin of this adaptation occurred more than once in their evolution (Nyffeler and Pusey 2014), and is not well understood. Our observations in this fishing mantid – a unique case at the moment – may indicate the origin of this phenomenon.

Despite the limitations, our observations raise three important fields for speculation. First, this case confirms that in their natural habitat, mantids can and do feed on vertebrates, even on fish. In this case, of the approximately 40 individual fish present in the pond, nine of them were eaten by the mantid within a span of five days, showing the potential for a single invertebrate to have a strong impact on the fish community and, since guppies, like many other small fish, are active predators of aquatic insects, indirectly on the whole pond ecosystem.

Second, although the compound eyes of most mantids are appositional, sensitive to movement, and adapted to vision mostly in daylight (Kral 2012), this male was able to see and catch the fish under the water at night and to overcome refractive challenges. The fish were caught near the water's surface, always after sunset, sometimes late at night and, in general, in low light [compact fluorescent lamp (CFL)] conditions. Male mantids are known to be very active during the night (Battiston et al. 2010), but these fishing events suggest further visual abilities of mantids that should be investigated.

Third, the predation was not just occasional, but repeated. This scenario, from a more speculative perspective, suggests the possibility that the insect learned from the experience where and what to hunt. Mantids are known to use aversive learning to avoid toxic prey (Carle et al. 2018), a first basic learning ability shared by many predators. This case, however, suggests a further step to a more articulated cognitive process, including the ability to learn not only from a single stimulus but from different environmental clues and experiences, for elaborate new hunting strategies.

Many mantids, including *Hierodula*, are known to be sit-and-wait predators (Prete et al. 1999), and there is evidence that at least some species carefully choose their habitat and hunting field (Battiston and Fontana 2010, Watanabe et al. 2013, O'Hanlon et al. 2014). Remembering the prey's abundance at a particular site in relation to their ease of capture and their nutritional content, could be one important factor of this choice and may indirectly influence individual fitness. This should be investigated in further studies.

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Fig. 2. *Hierodula tenuidentata* eating *Poecilia reticulata* from the tail while the fish is still alive and breathing in the water. Photo by R. Puttaswamaiah.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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Supplementary material 1

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Data type: JPEG file
Explanation note: The mantid eating another fish from the head.

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Supplementary material 2

Author: Roberto Battiston, Rajesh Puttaswamaiah, Nayak Manjunath
Data type: JPEG file
Explanation note: The mantid resting under a leaf during the day.

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