

**OVIPOSITION AND HATCHING IN THE PRAYING MANTIS,  
*HIERODULA PATELLIFERA* (SERVILLE) IN SINGAPORE  
(MANTODEA: MANTIDAE: PARAMANTINAE)**

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**INTRODUCTION**

The genus *Hierodula* Burmeister, 1838 is presently one of the most speciose groups of praying mantids in the world, with a geographically broad distribution, predominant in the Australasian realm. At least 105 species are currently recognised in this genus (Ehrmann, 2002; Vyjayandi & Narendran, 2003). Because of the numerous members cumulatively assigned to this genus, *Hierodula* is in dire need of careful taxonomic revision to verify the validity of available species names and determine their respective diagnostic characters, so as to aid current and future entomologists in morphological recognition and reliable identification. In Singapore, at least three morphospecies of *Hierodula* have been recorded from various parts of the island. One of them, *Hierodula patellifera* (Serville, 1839) is easily recognisable by the presence of two white coxal spines on the proximal, inner face of its fore-coxa. The white marking has a well-defined, tear-drop shape, present in both males and females. An account of the egg-laying and subsequent hatching processes are documented for this species in Singapore.

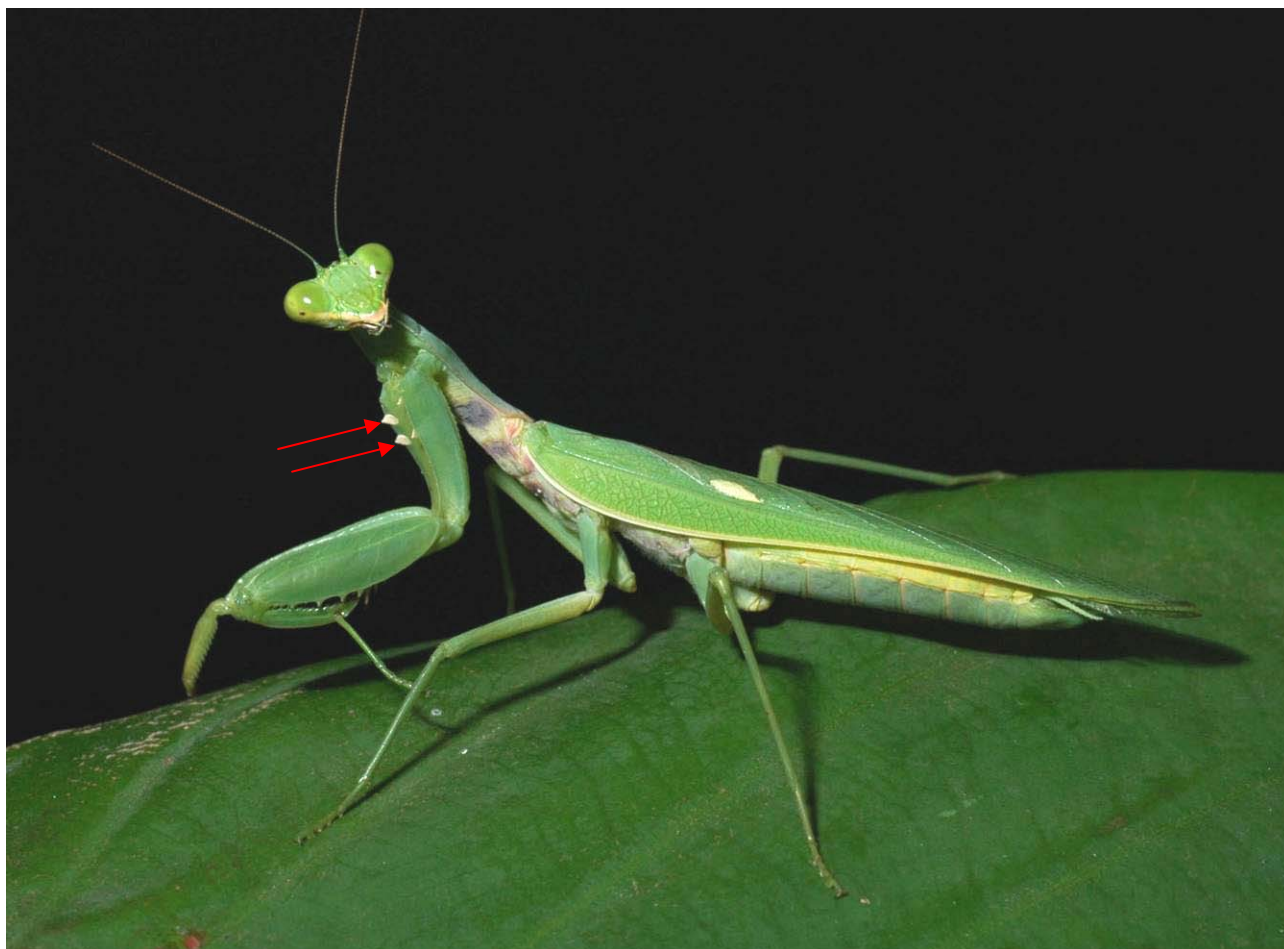


Fig. 1. Adult male *Hierodula patellifera* (ZRC.6.20948, total length: 57 mm) found on 8 Dec.2007 in the vicinity of Clementi Road. A readily recognisable morphological characteristic of this species is the distinct pair of white coxal spines on the proximal, inner face of its fore-coxa (arrowed).

### OBSERVATIONS

The author has personally encountered live examples (adults and nymphs) of *Hierodula patellifera* in Singapore from secondary forests, forest edges, scrubland, gardens, and parks. At the entomology section in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research, National University of Singapore, at least six adult specimens (one male, five females) of this particular species are available as vouchers for examination. In life, these mantids are an overall green, but this colour fades to yellow upon preservation, after a few years. Basic morphological measurements were made for these specimens and these include: total length (TL), head width (HW), pronotum length (PL), pronotum width (PW), forewing length (FW), fore-femur length (FE), fore-coxa length (CX).

The earliest available specimen was collected at Kent Ridge by Dennis H. Murphy (D. H. M.) on the night of 16 Jan.1986 (ZRC.6.20949, female, TL: 59 mm, HW: 9 mm, PL: 18 mm, PW: 7 mm, FW: 49 mm, FE: 18 mm, CX: 13 mm). From Lim Chu Kang mangrove forest, D. H. M. also collected another adult on 10 Sep.1989 (ZRC.6.20950, female, TL: 55 mm, HW: 9 mm, PL: 17 mm, PW: 7 mm, FW: 44 mm, FE: 17 mm, CX: 13 mm). On the night of 19 Feb.2005, the author encountered one just outside the Science Library of the Science Faculty, National University of Singapore (ZRC.6.20946, female, TL: 63 mm, HW: 9 mm, PL: 17 mm, PW: 7 mm, FW: 51 mm, FE: 18 mm, CX: 13 mm). In Jun.2005, Tan Heok Hui found one at Marina Bay (ZRC.6.20947, female, TL: 61 mm, HW: 9 mm, PL: 18 mm, PW: 7 mm, FW: 51 mm, FE: 20 mm, CX: 14 mm). On 8 Dec.2007, Vanessa Chang found one at Clementi Avenue 2 (Fig. 1, ZRC.6.20948, male, TL: 57 mm, HW: 8 mm, PL: 15 mm, PW: 6 mm, FW: 42 mm, FE: 16 mm, CX: 11 mm).

On the evening of 3 Sep.2008, the author found a gravid female *Hierodula patellifera* crawling along the ground at a car park in Marine Drive, between Blocks 77 and 78. Its abdomen was clearly distended and too laden to fly. It was reared in captivity and nourished with crickets. On the morning of 5 Sep.2008, the female was observed to be perched on the underside of its holding tank and depositing its eggs within a foamy, green ootheca (Figs. 2, 3).

Thereafter, the female mantis was preserved as a voucher specimen (ZRC.6.20945, TL: 60 mm, HW: 9 mm, PL: 17 mm, PW: 7 mm, FW: 46 mm, FE: 18 mm, CX: 13 mm). The ootheca turned hard and became brown within the following days and was measured to have a length of 16 mm, width: 12 mm and vertical height: 14 mm. The shape and size of the ootheca was consistent with those deposited by *Hierodula* species, in having a globular appearance with a pointed apex where the female finished off (Bischoff et al., 2001).



Fig. 2. Lateral view of adult female *Hierodula patellifera* (ZRC.6.20945, total length: 60 mm) close to completion of oviposition and ootheca construction on the morning of 5 Sep.2008. When freshly deposited, the ootheca was initially green, but gradually turned a light golden brown within a few days.

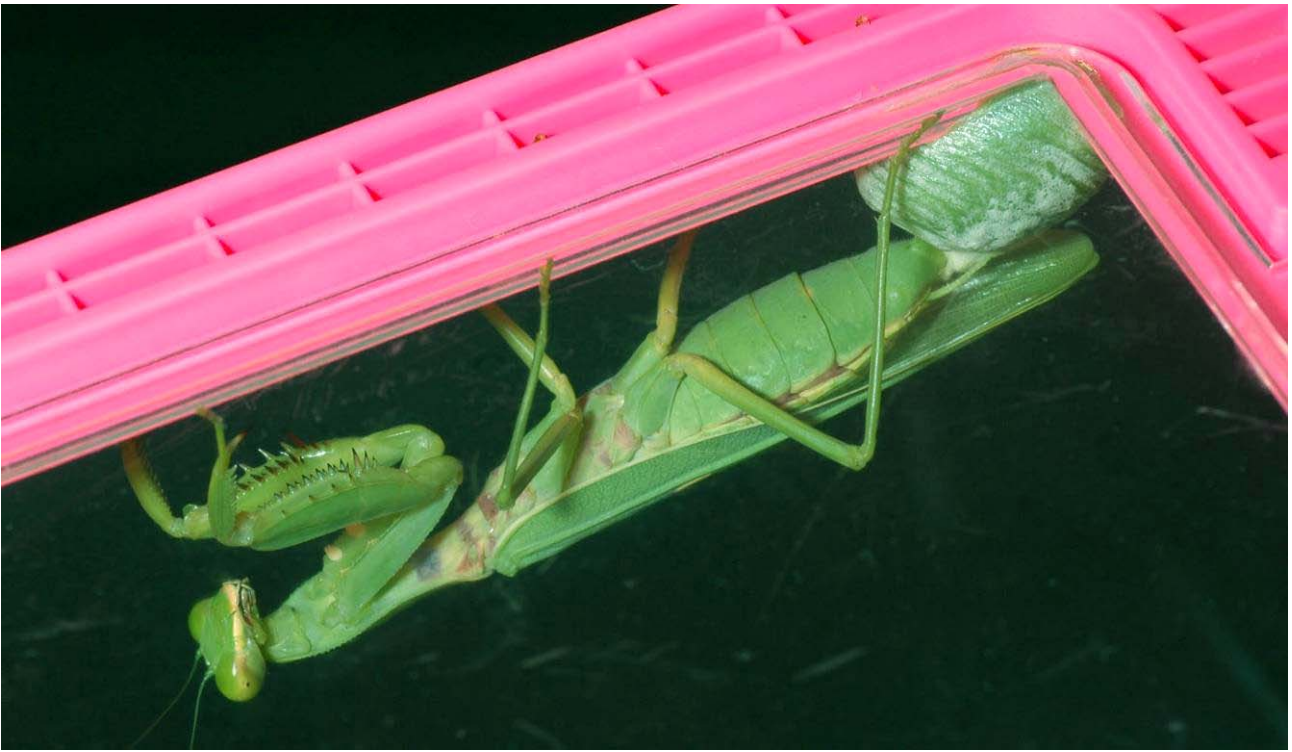


Fig. 3. Ventral view of adult female *Hierodula patellifera* (ZRC.6.20945) towards the end of its oviposition process. The characteristic white coxal spines on its fore-coxa are noticeable from this perspective. When the ootheca was eventually completed, it was measured to be 16 mm long by 12 mm wide by 14 mm high.



Fig. 4. On the late night of 30 Sep.2008 (ca. 2300 hours), the hatchlings began to emerge sequentially from the ootheca, in a head-down position and descending by a fine silken thread trailing between the ootheca and the tips of their abdomens. After a descent of 20–30 mm below the ootheca, the hatchling immediately began the process of its first nymphal moult. When first hatched (a), the nymph is ca. 4–5 mm long, its abdominal segments are clearly constricted, and all its limbs are grouped together, outstretched, and unfolded. Within minutes, it began to extricate itself from the exuvia by arching its thorax downwards (b). As the antennae, limbs, and abdomen were almost liberated from the exoskeleton, it continually flexed its body to hasten the process (c).



Fig. 5. Once liberated from its exuvia, the limbs began to articulate, while its antennae remained facing upwards momentarily (a). After the limbs had acquired their functional postures and the antennae had descended (b), the freshly hatched/moulted mantis detached itself completely from the exuvia either by vigorous wriggling of its body or grabbing onto a solid surface and pulling away.

After 25 days, the mantid eggs began to hatch on the night of 30 Sep.2008, with an estimated total of 140 nymphs emerging over a two-hour episode. The hatching and simultaneous moulting of the mantid nymphs were carefully observed and photographed at close range to document the unfolding sequence of events (Figs. 4, 5).

Upon its exit from the ventral apex of the ootheca, the nymph gradually descended for 2–3 cm via a silken thread attached to the tip of its abdomen. Its body appeared to be initially compressed, with the abdomen clearly constricted in between the segments, while all its limbs were bunched together and held away from the head (Fig. 4a). The moulting process began as soon as it arched its thorax downwards, as it attempted to pull itself out of the exuvia (Fig. 4b). As the head, thorax, and abdomen slid out, so did the antennae, and all three pairs of limbs.

The body size had increased noticeably by now and the nymph was able to arch its abdomen backwards and forwards to facilitate the exit from the exuvia (Fig. 4c). Once the antennae had moulted entirely, they gradually began to descend. The limbs also began to articulate accordingly and start conforming to the typical mantid posture (Fig. 5b). At this point, the nymph attempted to detach itself from the remnant exuvia at the tip of its abdomen by either wriggling its body vigorously or grasping onto a solid surface to pull away.

The entire batch of mantid nymphs completed emergence after midnight (1 Oct.2008), leaving behind the suspended string of exuviae still dangling from the bottom of the ootheca (Fig. 6). By morning, all the nymphs were actively crawling around the inside of the holding tank. Each of them had darkened considerably since they hatched and were coloured honey brown, with blackish bands on the limbs (Fig. 7).

By this time, most of them were already demonstrating self-preening behaviour, fastidiously cleaning their antennae, eyes and limbs with the femoral brush on their fore-femur. On the same afternoon, the mantid nymphs were promptly released in secondary forest at Kent Ridge Campus, National University of Singapore (Fig. 8). A few representative voucher specimens were retained for preservation (ZRC.6.20945).



Fig. 6. The last remaining mantids to hatch emerged past midnight of 1 Oct.2008. In total, approximately 140 young mantids hatched out successfully, leaving behind an aggregation of moulted exuviae still dangling from the ootheca by accumulated strands of fine silk. The entire empty ootheca and associated exuviae were subsequently preserved (ZRC.6.20945).

## DISCUSSION

As a consequence of the inherently high diversity within the genus *Hierodula* and its widespread geographical occurrence, considerable research has selectively focused on a few species. More often than not, only a single species was studied. Nevertheless, such studies have opened windows into the many fascinating aspects of behaviour and ecology of praying mantids.

For example, a most detailed account of the intricate sequence of ootheca formation and its structure in *Hierodula saussurei* Kirby, 1904 [now a junior synonym of *Hierodula patellifera* (Serville, 1839)] was earlier published by Kershaw (1910), who based his descriptions from ‘several hundred egg cases collected for some years’. There have also been reports on stalking, predation and documented prey items, for example, for *Hierodula wernerii* (Giglio-Tos, 1912) in Australia (Ridpath, 1977) and *Hierodula patellifera* in Hawaii (Nguyen & Maxwell, 2008).



Fig. 7. On the morning after their mass nocturnal emergence, the young mantids had acquired a dark, honey brown colour, with black bands on their limbs. They were already exhibiting adult-like behaviour, such as cleaning their antennae, eyes, and limbs with meticulous care. The dorsally arched abdomen is a typical posture of a mantis nymph.



Fig. 8. On the afternoon of 1 Oct.2008, the hatchlings (body lengths: 8–9 mm) were promptly released in secondary forest at Kent Ridge, National University of Singapore.

The notorious behaviour of female mantids consuming the males during or after mating has certainly not gone unnoticed, with studies on sexual cannibalism in *Hierodula membranacea* Burmeister, 1838 (Birkhead et al., 1988). Prior to the actual mating itself, the behavioural rituals of mate attraction and courtship have also been explored. One of the most enlightening findings was revealed by studies on wild and captive populations of *Hierodula patellifera* in Japan by Perez (2005). It was discovered that only virgin female mantids would initiate mating by adopting a characteristic posture with abdominal pulsations, accompanied by the simultaneous release of pheromones to attract males in the vicinity. The female is able to produce three oothecae after a single mating and does not advertise its availability thereafter.

While behavioural and ecological studies of mantids have revealed a wealth of insights into their private lives and intricate interactions, the taxonomic and systematic perspectives cannot be neglected. As DNA sequencing techniques become increasingly employed to elucidate phylogenetic relationships, we are indeed coming closer to obtaining a clearer picture of the various lineages among extant representatives of praying mantids (e.g., Svenson & Whiting, 2004). Nevertheless, recognition of distinct morphological characters (including reproductive structures) among mantids remains a fundamental tool for entomologists to accurately discern between respective taxa.

#### ACKNOWLEDGEMENTS

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#### LITERATURE CITED

- Birkhead, T. R., K. E. Lee & P. Young, 1988. Sexual cannibalism in the praying mantis *Hierodula membranacea*. *Behaviour*, **106**(1–2): 112–118.
- Bischoff, I., R. Bischoff, C. Heßler & M. Meyer, 2001. *PraxisRatgeber: Mantiden—Faszinierende Lauerjäger*. Edition Chimaera, Frankfurt. 191 pp.
- Ehrmann, R., 2002. *Mantodea—Gottesanbeterinnen der Welt*. Natur und Tier-Verlag, Münster. 519 pp.
- Kershaw, J. C., 1910. The formation of the ootheca of a Chinese mantis *Hierodula saussurii*. *Psyche, Journal of Entomology*, **17**(4): 136–141.
- Nguyen, D. T. & M. R. Maxwell, 2008. Stalking of stationary prey by a praying mantid (*Hierodula patellifera* Serville) (Mantodea: Mantidae). *Entomological News*, **119**(4): 425–427.
- Perez, B., 2005. Calling behaviour in the female praying mantis, *Hierodula patellifera*. *Physiological Entomology*, **30**(1): 42–47.
- Ridpath, M. G., 1977. Predation on frogs and small birds by *Hierodula wernerii* (Giglio-Tos) (Mantidae) in Tropical Australia. *Journal of the Australian Entomological Society*, **16**(2): 153–154.
- Svenson, G. J. & M. F. Whiting, 2004. Phylogeny of Mantodea based on molecular data: evolution of a charismatic predator. *Systematic Ecology*, **29**(3): 342–352.
- Vyjayandi, M. C. & T. C. Narendran, 2003. A new species and a key to Indian species of *Hierodula* Burmeister (Mantodea: Mantidae). *Entomon*, **28**(4): 315–320.