Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

ISSN 2320-7078
JEZS 2014; 2 (6): 147-152

Received: 06-11-2014
Accepted: 27-11-2014

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Laboratory Studies on the Life history of *Hierodula ventralis* Giglio-Tos, 1912 (Mantodea: Mantidae)

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Abstract
The life cycle of *Hierodula ventralis* was studied in the present investigation. Being a hemimetabolous insect, *H. ventralis* shows ootheca (egg), nymph and adult stages in the life cycle. The incubation period of egg was about 25 days while nymphal period was about 53 days with seven moults. The average adult life span of male and female was 50 and 71 days respectively. The entire life cycle period of female was more than male by 15 to 20 days. The cannibalism was noticed in overcrowding conditions during rearing and mating in which females devoured the males. The species under study is an important predator of crop pests. This knowledge would be utilized in biological control strategies against pests.

Keywords: adult, cannibalism, Hierodula ventralis, life history, nymphal development, oothecae.

1. Introduction
Mantids are the active predators and exclusively carnivorous, easily identified by their raptorial forelegs. These insects are peculiar in respect of their body form, predatory habit and reproductive behavior and are known to lay eggs in complex ootheca. They are found in diverse habitats and are well camouflaged, known to engage in cannibalism. About 2384 species under 434 genera belonging to 15 families are known from the world [3]. According to Updated Checklist of Indian Mantodea published by Zoological Survey of India, 184 species of mantids under 73 genera and 11 families are known from India [8]. These are moderate to large (1–5 cm long) predators classified in 8 to 15 families [6]. Being a hemimetabolous insects, mantids go through three life stages; egg, nymph and adult.
The mantis *Hierodula ventralis* of the family Mantidae was first described by Giglio-Tos [5] and then Vyjayandi [12]. Ghate *et al.* [4] enumerated 56 species of mantids in Fauna of Maharashtra without *H. ventralis*. However, Koli *et al.* [9] has reported this species from Chandoli National Park of Maharashtra. The life cycle study of insects is important in managing insects because the habit, habitat and appearance of an insect may change dramatically through the course of life cycle. Beeson [1] has given very brief information about life history and adult morphology of *H. ventralis*. No detailed diagnostic characters and lifecycle information of this species is available anywhere. Hence, efforts have been made to give detailed information on the lifecycle and taxonomic characters along with the color photographs in the present communication.

2. Materials and Methods
The life cycle of *H. ventralis* was studied during March 2014 to July 2014 under laboratory conditions at 25 to 30 ˚C and 75%-80% RH. Initially single ootheca was collected along with twig of *Pongamia pinnata* from Herle, Kolhapur ($16^0$74’50.51’’N & $74^0$32’60.00’’E) on 15th March 2014. The ootheca was then kept in rearing cage of size 15cm X 15cm X 22cm and allowed to hatch. Newly hatched nymphs were segregated into 5 groups of 50 each group and transferred in the different cages of same size and observations were made. Emerged early instars were fed a diet of *Drosophila spp.*, *Musca domestica* and aphids. Later instars were fed a diet of nymph and adult grasshoppers, crickets, ladybird beetles and plant hoppers. The measurement of ootheca, each nymphal instar and adults were taken with vernier caliper along with photography and statistical analysis was done. Early instars were anesthetized with carbon dioxide [11] to take measurements, while later developmental stages were measured without anesthesia.

3. Results and Discussion

In the present study, life cycle details of the *Hierodula ventralis* are provided. Duration of the each stage of life cycle is given in Table 1 and measurement details are given in Table 2-4.

Table 1: Duration of different life stages of *Hierodula ventralis* in days.

Stages	Duration (days)		Mean	SD	SEM
	Minimum	Maximum			
Ootheca (Egg)	24	26	24.8	0.83666	0.37416
Ist instar	6	8	6.8	0.78881	0.24944
Iind instar	5	7	6.1	0.73786	0.23333
IIIrd instar	6	7	6.4	0.51639	0.16329
IVth instar	6	8	6.4	0.87559	0.27688
Vth instar	8	10	8.8	0.78881	0.24944
VIth instar	10	13	11.8	1.37032	0.43333
VIIth instar	12	14	13.2	0.73786	0.23333
Adult male	40	60	50	7.45356	2.48452
Adult female	55	90	71.5	12.9394	4.89064

n=10

Table 2: Width of Head capsule of different life stages of *Hierodula ventralis.*

Stages	Width of Head capsule (mm)		Mean	SD	SEM
	Minimum	Maximum			
Ist instar	2	2.07	2.037	0.72211	0.22835
Iind instar	3.17	3.78	3.754	0.03062	0.00968
IIIrd instar	4.6	4.65	4.632	0.01813	0.00573
IVth instar	5.1	5.21	5.153	0.04448	0.01406
Vth instar	5.91	6.04	5.986	0.04779	0.01511
VIth instar	6.74	6.91	6.793	0.06912	0.02186
VIIth instar	7.75	7.87	7.815	0.04326	0.01368
Male	8.41	8.8	10.003	0.16234	0.05133
Female	9.65	10.6	13.2	0.35096	0.11098

n=10

Table 3: Length of Pronotum of different life stages of *Hierodula ventralis.*

Stages	Length of Pronotum (mm)		Mean	SD	SEM
	Minimum	Maximum			
Ist instar	3.12	3.16	3.144	0.01429	0.0045
Iind instar	4	4.09	4.046	0.03438	0.01087
IIIrd instar	6.95	7.1	7.022	0.05391	0.01704
IVth instar	10	10.2	10.11	0.29601	0.09360
Vth instar	12	12.3	12.184	0.10762	0.03432
VIth instar	15.5	15.8	15.648	0.11650	0.03684
VIIth instar	17.4	17.64	17.51	0.08379	0.02649
Male	17.8	18.95	18.4	0.47375	0.14981
Female	20.79	21.84	21.03	0.43107	0.13631

n=10

Table 4: Total body length of different life stages of *Hierodula ventralis.*

Stages	Total body length (mm)		Mean	SD	SEM
	Minimum	Maximum			
Ist instar	6.28	6.35	6.316	0.02547	0.00805
Iind instar	12	13.3	12.79	0.50376	0.15930
IIIrd instar	20.75	21.5	21.14	0.28797	0.07435
IVth instar	27.5	28.25	27.972	0.26694	0.08441
Vth instar	34	36	35.082	0.75770	0.33885
VIth instar	38	42	39.8	1.52479	0.68190
VIIth instar	48	51	49.86	1.08187	0.34211
Male	55.12	63	59.004	2.91201	0.92086
Female	62.21	74.88	68.448	4.67041	1.47691

n=10

4. Oothecae and Hatching

Field collected ootheca was dark dirty brown measuring 13.89 mm X 14.23 mm X 19.84 mm (Fig.1); while reared mated female placed 2 oothecae which were same in color and larger in size with dimensions 15.56 mm X 16.64 mm X 32.30 mm and 16.50 mm X 16.88 mm X 32.69 mm (Fig. 2) than field collected ootheca. More or less similar findings were made by Beeson [1]. During rearing, it was observed that the time for

oothecae deposition was during early morning hrs from 4 am to 6 am on 03rd June 2014. The female takes about 2 hr 30 min to construct the oothecae and after 24 days of incubation period oothecae started to hatch on 27th June 2014(Fig.1) supporting the functions of Beeson [1]. All nymphs were hatched out from ootheca within a day as reported by Crosby [2]. However, Heath [7] reported hatching for a period of several weeks in some mantid species. From the field collected ootheca 160- 180 nymphs were hatched out on 27th March 2014; while oothecae obtained from reared female gave 180-190 nymphs from each ootheca on 28th June 2014.

5. Nymphal development

During nymphal development, it was observed that early instars found to be feed on *Drosophila spp.* while late instars and adults were fed on grasshoppers. In all seven moults were observed and 52-68 days nymphal period. However, Beeson [1] reported 8-9 moults and 70-110 days nymphal period in *H. ventralis* in July to October. Suckling [11] reported six molts and minimum of 11 week nymphal period in *Orthodera ministralis* in Palmerston North, New Zealand climate and *O. ministralis* was fed with a diet of blow fly and *Musca domestica*. The difference in number of moults and nymphal period was might be due to difference in the climatic conditions of the study area and the provided diet.

1st instar: First instar was green, semitransparent with mid-dorsal line running antero- posterior, legs are paler than rest of the body and having reddish-brown patches. It was measured 6.32mm long with 3.15mm pronotum (Fig. 3). After hatching, nymphs showed motionless behavior and then became active, runs in the cage. They feed on provided *Drosophila spp.* The first instar period lasts for 5-7 days then it moults for the first time.

2nd instar: The second instar nymphs were very active feeds on *Drosophila spp.,* green in color with prominent mid-dorsal brown line running from pronotum to abdominal tip. On the abdomen and legs brownish patches were appeared. The body length was 13mm long with 4 mm pronotum (Fig. 4). It moults for the 2nd time within 6 - 8 days.

3rd instar: It was green with brown patches on mid and hind legs. The abdomen became broad and flat, the brown patch appeared on the thoracic sternum. It feeds on *Drosophila spp.* and measured 21 mm long with pronotum size 7 mm (Fig. 5). The duration of this instar was 6-7 days after which it moults in to 4th instar.

4th instar: It was dark green colored with brick cored mid and hind legs along with brown patches. The lateral margins of pronotum and abdomen was brick-red and thoracic sterna brown patch became prominent. A pair of white spots was developed on dorsal side of each abdominal segment centro-laterally. It was feed on provided nymphs of grasshoppers and doesn't prefer *Drosophila spp*. They became larger in size and also showed cannibalism. The body length is 28 mm and pronotum was 10 mm long (Fig. 6). This stage lasts for 7-8 days and transformed in to 5th instar after moulting.

5th instar: Morphologically 5th instar was like 4th instar except in size. It was measured 36 mm long with 12 mm pronotum (Fig.7). Within 1-10 days 5th instar was transformed into 6th instar.

6th instar: The body colour of this instar was dark green and brown patches of mid and hind legs became paler and greenish. It was found to be feed voraciously on grasshoppers. Important feature of this stage was, wing pads are developed. Total length was 44 mm and pronotum was 16 mm (Fig. 8). This stage lasts for 10-13 days and then 6th moult was occurred.

7th instar: Body color was dark green and brick-red colored tinge of abdomen was disappeared completely. Mid-dorsal line was disappeared and converted into whitish one and prominent white small spots developed on terga of abdomen laterally. Wing pads were well developed and became larger. The body length was 48 mm and pronotum was 16 mm long (Fig. 9). This stage lasted for 10-15 days after which it was transformed in to adult stage.

Adult: Morphological features (Fig. 10) of this species have already been given by Vyjayandi [12] and are not repeated here. A few additional features are however given below. Average length (vertex to the abdominal tip) was found to be 59.004 mm for male and 68.448 mm for female. The head was wide and triangular with globular compound eyes, pentagonal frons and rhomboidal clypeus (Fig. 13). Pronotum was elongated with supracoxal dilation and indistinct mid-longitudinal carina (Fig.14). Bases of the pro and meso-sterna were with transverse bands. The meso-sternum contains paired brown blotches with tubercles (Fig.15). The femur of raptorial leg was with spines viz. 4 discoidal (dark brown), 7 longer internal (dark brown except last) and 8 shorter internal (greenish with brown tip except first) (Fig. 16). In addition, femur was modified with 4 external (greenish with brown tip) and tibia was with 10 external and 14 internal spines (Fig.17). Most of species with 5 spines on left fore coxa and 4 spines on right fore coxa (Fig. 18), while some of the examples had 5 spines on each fore coxa as described by Vyjayandi [12]. The fore wings were opaque; the costal area of fore wing was opaque with cream colored sigma mark posterior to the subcostal. Antennal size was about 23 mm and 20 mm long in male and female respectively (Fig.10). Female body size was 75.94 mm with 21.84 mm pronotum and male measured 61.84 mm long with 20 mm pronotum. The adult male and female lived for 40-60 and 55-90 days respectively. According to Beeson [1] adult life of *H. ventralis* is about 100 days.

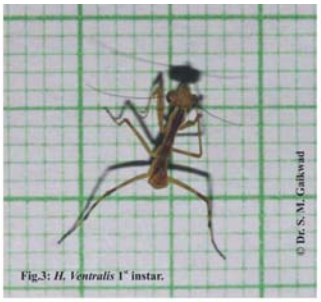
Food: Immediately after hatching, newly hatched nymphs were provided with diet of on *Drosophila spp.,* flies and aphids. However, it was observed that, up to early 3 instars they prefer and feed on *Drosophila spp.* and thereafter from the 4th instar onwards starts feeding on grasshoppers only. The late instars are voracious feeders than early instars endeavor one or two medium sized grasshoppers daily. Beeson [1] mentioned that *H. ventralis* adults are reputed to able to kill sunbirds.

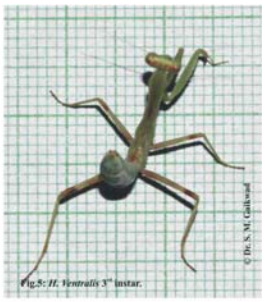
Mating: The same pair of *H. ventralis* was mated for two times in their life span (Fig. 11). For the first time, mating started at 03.00 pm and it was continued up to 06.00 pm. The second time mating was observed at 08.00 pm and it was lasts up to 11.00 pm. During second mate, female devoured male completely after 10.30 pm from head to abdomen. Even then, headless male continued mating process (Fig. 12).

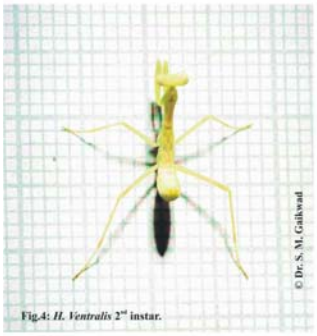
6. Cannibalism

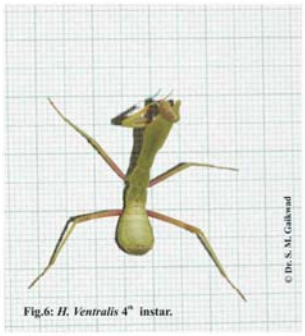
During nymphal development, the cannibalism was not observed up to 3rd instar. From 4th instar onwards cannibalism

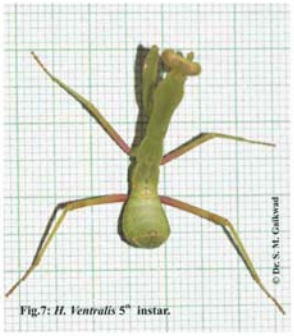
was noticed. It might be due to nymphs growing in size and overcrowding in the cage. But it was reduced in the cages having less number of nymphs. It indicates that high density of nymphs face the competition for food and security also. The cannibalism in adult noticed in female during mating (Fig. 12). The mantids are the part of valuable section of insectivorous animals which feed on any insect that becomes abundant and this is most useful group in checking periodical wave - increase of insect, which are only pests when in great abundance [10]. Hence life cycle studies of such biological control agents of pests would be useful for formulating pest control strategies.

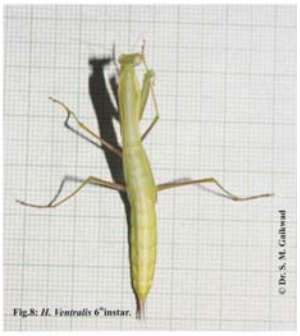


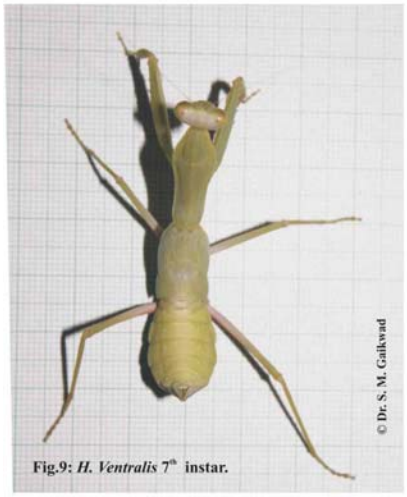












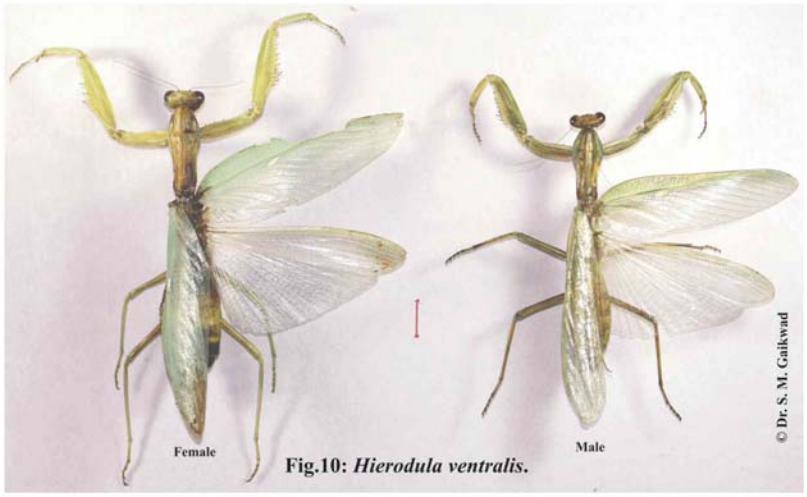


Fig.13: *H. Ventralis* Head: Frontal view.

Fig.14: *H. Ventralis* Pronotum(male).

Fig.15: *H. Ventralis* Bands & blotches with tubercles on sterna.

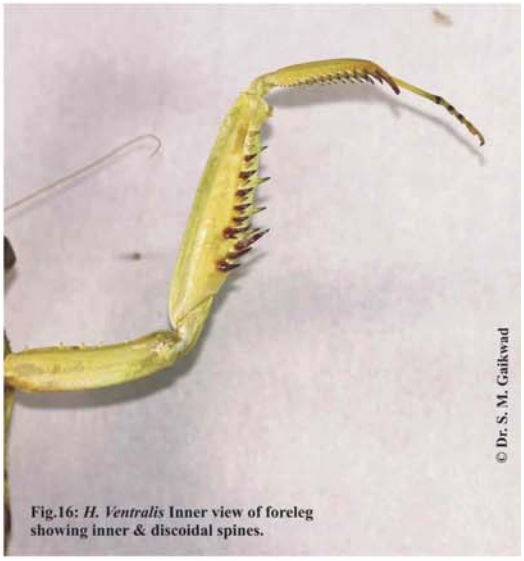


Fig.16: *H. Ventralis* Inner view of foreleg showing inner & discoidal spines.

Fig.17: *H. Ventralis* Outer view of foreleg showing outer spines.

Fig.18: *H. ventralis* Coxal spines.

7. Acknowledgements

The authors are grateful to University Grant Commission (UGC), New Delhi for financial support during the work. The authors are also thankful to Head, Department of Zoology, Shivaji University, Kolhapur for laboratory facilities.

8. References

1. Beeson CFC. The ecology and control of the forest insects of India and the neighboring countries. Government of India press, New Delhi, 1941, 726-727.
2. Crosby TK. Observations on the winter survival of the praying mantis, *Orthodera ministralis* (Mantodea: Mantidae), in Auckland (New Zealand). New Zealand Entomologist 1984; 8:90-96.

3. Ehrmann R. Mantodea: Gottesanbeteinnen der Wett.Natur and Tier-Verlag, Munster, Germany, 2002, 519.
4. Ghate HV, Jadhav SS, Sharma RM. Fauna of Maharashtra. Insecta: Mantodea. State fauna series 20 (Part 2). Zoological Survey of India, 2012, 441-445.
5. Giglio-Tos. Mantidi Esotici V Mantes *Tenodera, Hierodule, Rhomboderae.* Bull Soc Entomolital 1912; 43:3-167.
6. Gullan PJ, Craston PS. The Insects: An Outline of Entomology, Edn 2, Wiley Blackwell Science, 2010, 565.
7. Heath GL. Rearing and studying the praying mantids. Amateur Entomologist's Society leaflet 1980; 36:1-15.
8. Zoology Servey of India. http://zsi.gov.in.
9. Koli YJ, Bhawane GP. Mantid Fauna of Chandoli National Park, Maharashtra, India. The Bioscan, 2011, 77-80.
10. Lefroy HM. Indian Insect life, Agricultural Research Institute, Pusa, 1909, 318.
11. Suckling DM. Laboratory studies on the praying mantis (Mantodea: Mantidae). NZ Ent 1984; 8:96-101.
12. Vyjayandi MC. Mantid Fauna of Kerala. Zool Surv India Occ 2007; 267:154.