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Studies on Biology of Pentatomid bug *Andrallus spinidens* (F) and its Predatory Potential in Rice Field of Vidarbha

D D Barsagade and A A Salwe*

P. G. Department of Zoology,
MJF Educational Campus, RTM Nagpur University, Nagpur - 440 033, Maharashtra, India
*Department of Zoology,
S. N. Mor College of Arts, Commerce and Smt. G. D. Saraf Science College, Tumsar - 441 912, Maharashtra, India

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A B S T R A C T

Pentatomid bug *Andrallus spinidens* (F) is a predator on a wide range of insect pests in rice fields of east Vidarbha. The life cycle of *A. spinidens* was studied during the year 2018-2019 revealed that a single female laid an average number of 250 eggs in 3 to 8 batches and each batch contained 32 to 65 eggs. Incubation period on an average was 6.6 ± 0.03 days and 95-100% eggs hatching rate at 24 to 30°C temperatures with high humidity. Pri-oviposition and oviposition period was 1- 4 days. First, second, third, fourth, and fifth stages of the nymphal period were 2.3 ± 0.03, 3.3 ± 0.03, 3.6 ± 0.03, 3.6 ± 0.03 and 6 ± 0.05 days respectively. Second to fifth stages nymphs and adults of *A. spinidens* were feeding different stages larvae and pupae of a number of harmful lepidopteran pests in the rice field. In vivo and field study suggested that the first instar nymph of *A. spinidens* was non-feeding while, second, third, fourth and fifth stages nymphs were voraciously fed on 3, 4, 7 and 12 number of larvae and pupae of *Melanitis leda* respectively. Similarly, adult bugs fed on average 30 rice pest larvae of *Melanitis leda* and confirmed their predatory role in the rice field of Vidarbha region in Maharashtra.

Key words: *Andrallus spinidens*, Biology, *Melanitis leda*, Predatory potential, Rice fields

Andrallus spinidens (Fabricius) is a predatory bug belonging to family Pentatomidae and sub-family Asopinae. It is a cosmopolitan species, wide distributed around the world. This predatory bug feeds on various larvae of Lepidoptera, Coleoptera and Hymenoptera found in different crop fields such as wheat, mustard, soybeans, tomato, vegetable and rice (Distant 1902). *A. spinidens* has short life- cycle, continuous and aggressive feeding behavior for several hours, these all character favor to make it potentially useful biological control agent of rice pests (Manley 1982). It has been recorded to feed on a variety of insect pests by inserting their proboscis to puncture and suck body juice from them (Rao and Rao 1979, Rajendra and Patel 1971). The field study shows that *A. spinidens* produce three or four generations a year and is most abundant from September to December (Shintani *et al*. 2010). The rice cultivation is found to be more in east Vidarbha region and *A. spinidens* species show predatory behavior on pests found in rice fields. Keeping this in mind, the present study was undertaken to study biology and predatory potential of *A. spinidens.*

***Corresponding author:** A. S. Salwe, Department of Zoology, S. N. Mor College of Arts, Commerce and Smt. G. D. Saraf Science College, Tumsar - 441 912, Maharashtra

e-mail: aaszoology@gmail.com

MATERIALS AND METHODS

Adults of the predatory stink bug *A. spinidens* were collected from rice fields of east Vidarbha (Gondia, Bhandara, Gadchiroli, and Chandrapur District) of Maharashtra during September to November 2018-2019. For in-vivo rearing, two males and females of *A. spinidens* were reared and allowed mating in plastic container (top: 10 cm diameter; bottom: 9cm diameter; 7.5cm height). The entrances of the plastic container was covered with masculine cloth. Males were separate from females after mating kept in another plastic container. After egg laying,

the female transferred to another plastic container. Wet cotton plugs are kept in eggs containing plastic container to maintain humidity. The newly molted second to fifth instar nymphs were fed on sufficient numbers of lepidopteran larvae. As a food of bugs 4th, 5th stages larvae and pupa of serious pest of rice i.e. *Melanitis leda* was supplied to rearing bugs. The rearing containers were covered with masculine cloth, supplied with sufficient prey, and furnished with paper towels to absorb excreta of the predator and provide hiding places. Simultaneously, field observations were carried out in the local rice field. Every day the containers were cleaned and provided new prey with these predator survivals, mortality, and molting data were recorded.

RESULTS AND DISCUSSION

Life history

Eggs

Andrallus spinidens deposit its eggs in two rows along the stem or ventral side of leaves. The eggs were placed in contact with each other and cemented by black color substance on the surface. Freshly laid eggs were creamy white in color and turned dark brown with a golden shine within an hour. A day before hatching, the eggs changed into dark red color. Eggs were barrel shaped, convex ventrally and flattened dorsally with 14 to 20 micropylar processes. Length of egg was 1 ± 0.05 mm and diameter was 0.7 ± 0.03 mm. Eggs were laid in 3 to 8 batches and each batch contains 32 to 65 eggs. A single female laid a total 250 eggs in an average within 2-3 days. Incubation period was approximately 6.6 ± 0.03 days and 95-100% hatching rate at 24 to 30°C temperatures. Hatching mostly took place in the morning hour from 7 am. to 11 am.

Nymphs

Five molting and five nymphal instars were observed in *Andrallus spinidens* and the total nymphal period was 19 ± 1.73 days. The mortality rate was found very high in the early nymphal stage as compared to later stages. Each instar is described here in detail.

Table 1 Size of different stages of *A. spinidens*

S. No.	Developmental stages		Length (mm)	Width (mm)	Antenna (mm)
1.		Eggs	1.0 ± 0.05	0.7 ± 0.03	-
2.	Nymphs	1st Instar	1.1 ± 0.05	0.9 ± 0.03	1.1 ± 0.05
		2nd Instar	2.1 ± 0.03	1.4 ± 0.17	2.1 ± 0.08
		3rd Instar	4.4 ± 0.12	2.3 ± 0.29	3 ± 0.05
		4th Instar	5.9 ± 0.2	3.6 ± 0.08	3.9 ± 0.08
		5th Instar	9.2 ± 0.63	4.8 ± 0.05	5.4 ± 0.03
3.	Adult	Female	14 ± 0.57	6.7 ± 0.05	7 ± 0.03
		Male	11.1 ± 0.6	6.3 ± 0.03	7 ± 0.03

First Instar: Freshly hatched nymph was red in color with black eyes and it turned black and red when the cuticle had sclerotized. The length of fully developed first instar nymph was 1.1±0.05 mm in length and 0.9±0.03 mm in width. Antenna, head, thorax and legs were black in color. The abdomen red color with three black bands on the mid dorsal region of 3-7 abdominal segments, while six pairs of black spots appeared on the dorso- lateral side of abdomen. The antennae and rostrum was four segmented. The last segment of antenna was longer than other segments. The duration of the first nymphal instar was in an average 2.3 ± 0.03days. After hatching, first instar nymphs were gregarious and tended to congregate on egg mass for the first two days.

Table 2 Duration of life stages of *A. spinidens*

S. No.	Developmental stages		Ranges day	Mean
1	Incubation period		6-7	6.6±0.03
2	Nymphs	1st Instar	2-3	2.3±0.03
		2nd Instar	3-4	3.3±0.03
		3rd Instar	3-4	3.6±0.03
		4th Instar	3-4	3.6±0.03
		5th Instar	5-7	6±0.05
3	Total Nymphal Period		16-22	19±1.73
4	Total Development period		22-29	26±2.08

Second Instar: Second instar nymph appeared morphologically similar to the first instar except body size and band present on dorsal surface of abdomen. The body was measured about 2.1 ± 0.03 mm in length and 1.4 ± 0.17mm in width. The abdomen contains four black bands on the mid dorsal region of 3-7 abdominal segments, first and fourth band smaller than two central bands and seven pairs of black spots appeared on the dorso-lateral side of abdomen. The second instar nymphal period was noted for 3.3 ± 0.03 days.

Third Instar: Morphologically the third instar was similar to the second instar except in color; it changes to dark brown and black. Two yellow dots appeared on the second and third abdominal segment near to the wing pads area. Four black bands present on the mid dorsal region of

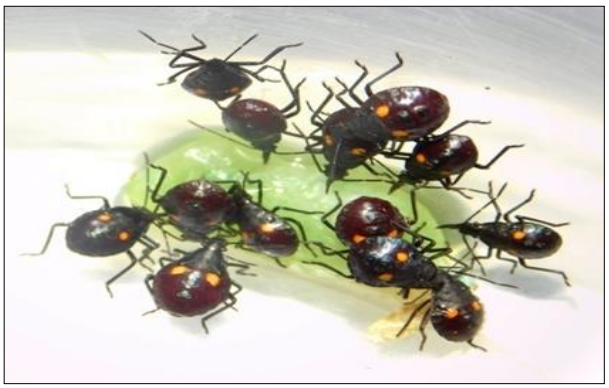
3-7 abdominal segments and seven pairs of black spots on dorso-lateral side of abdomen same as the second instar. The nymph measured about 4.4 ± 0.12 mm in length and 2.3 ± 0.29mm in width. Third instar nymphal period was about 3.6 ± 0.03 days.

Egg

1st instar

2nd instar

3rd instar



4th instar

5th instar

Just molt out adult

Mating

Fig 1 Life cycle of *Andrallus spinidens* (Fabricius)

Fourth Instar: The fourth instar nymph was similar in appearance to the third instar except rudiment wing pad and size, measured about 5.9 ± 0.2 mm in length and 3.6 ± 0.08 mm in width. The nymphal duration was about 3.6 days.

Fifth Instar: The fifth instar nymph was larger in size than earlier instars. The color of head and thorax appears black while the abdomen becomes brown in color with enlarged yellow spots. The yellow spots were partially covered by a well-developed wing pad. The length and width of the fifth instar nymph increased significantly and measured about 9.2 ± 0.63 mm and 4.8 ± 0.05 mm respectively. The nymphal period was longer than all other instars and noted about 6 ± 0.05 days.

Adult

Adult bug was pentagonal in shape and the newly molted adult was orange to pink in color, which changes to pale brownish within hour. Female bug measured about 14 ± 0.57 mm in length and 6.7 ± 0.05 mm in width while male measured about 11.1 ± 0.6 mm in length and 6.3 ± 0.03 mm in width.

The head of the adult was lobular and long with black line on each side of the clypeus. The antennae were 5 - segmented, dark brown in color with very fine setae and measured 7 ± 0.03 mm in length and rostrum measured 5.8 ± 0.05 mm in length. Pronotum showing lateral pronotal spine, at the base of this spine a short spine also present and two yellow bands running straight from the pronotal angle. The scutellum is long, slender, triangular, and mid-dorsal region containing yellow dots.

The bugs mated during morning hours or late evening hours. The mating period ranged from 3 to 5 hrs. Male actively participated in mating. Initially, male approached the female, climbed on the back of the female and copulation started. During this condition female and male faced in the same direction, within half an hour male turned over and moved in opposite directions, attached with each other by copulatory apparatus and they separated with slightest disturbances. Longevity of adult females was 13 to 30 day in an average 21.5 days and male was 10 to 25 days in an average 17.5 days. The total nymphal period was 19 ± 1.73 days. Total developmental periods from egg to adult was 26 ± 2.08 days.

Table 3 Predation rate of *A. spinidens*

S. No.	Developmental stages	Ranges Day	Mean
1	1st instar	Non feeding stage	-
2	2nd instar	2-4	3±0.5
3	3rd instar	4-5	4.3±0.3
4	4th instar	6-9	7.3±0.8
5	5th instar	11-13	12±0.5
6	Adult	25-37	30.6±3.4
7	Total feeding rate	48-68	57.3±6.1

Predatory behavior

After hatching, first instar nymphs were gregarious and tended to congregate on egg mass for the first two days. The first instar nymphs showed non-feeding behavior and suck only water until they molt into the second instar nymphs, third day of the first molting (2nd instar) they move in search of food scattered everywhere. The second to fifth instar nymph fed continue on prey, they stop feeding only a few hours before and after the molt until a new cuticle has sclerotized. After sclerotization nymphs become aggressive predators, attacking almost all sizes of pest larvae. Sometimes all stages of nymphs were feeding together gregariously on larvae of lepidopteran pests. The nymph and adult follow the prey and extend their proboscis into the host body, and anchor it so firmly that proboscis remains inserted into the host body till feeding is over. Fourth and fifth instar nymphs were mostly solitary and showed cannibalistic behavior during the scarcity of food.

The single second, third, fourth and fifth instar fed on 3 ± 0.5, 4.3 ± 0.3, 7.3 ± 0.8, 12 ± 0.5 fourth and fifth stages larvae and pupa of *Melanitis leda* respectively, while adult fed on 30.6 ± 3.4 larvae throughout their period. Single *A. spinidens* predators killed on average 57.3 ± 6.1 larvae in their lifespan in rice fields.

The stink bug *Andrallus spinidens* (F) has a critical role in regulation of the rice pest population (Navaee *et al.* 1998). Earlier Manley (1982) recorded the life cycle of *A. spinidens* containing egg, nymph and adult. During the present study it has been observed that the life cycle of predatory bug *A. spinidens* passes through egg, five nymphal stages, followed by adults. The nymphal period was observed about 19 ± 1.73 days while the life cycle was completed within 26 ± 2.08 day similar to the observation of Manley (1982). Rao *et al.* (1979) recorded the total development period of *A. spinidens* were 24.2 days and Uematsu (2006) recorded 32 days. During the present study, the life cycle period of *A. spinidens* was recorded approximately 26 days, may be due to temperature and other environmental conditions in Vidarbha region. Lam (2000) recorded the longevity of this bug was 24.08 days. In present study longevity of adult females was in an average 21.5 days and male was in an average 17.5 days. According to Singh (1989), virgin male and female survived more than mated male and female. The virgin female survived 32.2 days and mated female 15.2 days while, virgin male survived 24 days and mated male 10.6 days. In the present study it has been observed that the virgin female survived 30 days and mated 13 days while, virgin male survived 25 days and mated 10 days. This result shows similarity in the survival period of bugs and supports the earlier study of Singh (1989).

During the present study it has been observed that *A. spinidens* nymphs and adults both fed on lepidopteran

larvae. The bugs insert their proboscis in the body of lepidopteran larva and sucked body fluid. The first instar nymphs do not show feeding behavior while, second to fifth instar feeds voraciously and supports the earlier findings of Manley (1982). The single second, third, fourth and, fifth instar of *A. spinidens* fed on 3 ± 0.5, 4.3 ± 0.3, 7.3 ± 0.8, 12 ± 0.5 numbers of larvae and pupa of *Melanitis leda* respectively while, adult fed on 30.6 ± 3.4 larvae throughout their period. Chitrashankar *et al*. (2017) recorded second, third, and fourth stage nymph of *A. spinidens* fed on 7.9, 8.3, 26.3 third stage *Spodoptera mauritia* larvae, respectively and Singh (1989) recorded second, third, fourth, and fifth stages nymph fed on 1.1, 1.8, 2.2 and 7.6 *Rivula* species larvae per day respectively. According Khodaverdi (2012) second, third, and fourth instars of *A. spinidens* fed on12.22, 26.22, and 41.28 of *Spodoptera littoralis* larvae respectively. During present study it has been noticed in variation of consumption of host larvae in the rice field may be due to feeding on *Melanitis leda* larvae and not the *Spodoptera littoralis, Rivula* species larvae as well as different climatic conditions in the study area. According to Hyodo *et al.* (2014), group predation is advantageous for an individual nymph because it is able to capture large prey that could not hunt alone. De-Clercq (2000) reported that some predaceous pentatomid bugs show group feeding gregarious behavior including foraging efficiency in early nymphal period. During the present study group predation observed in *A. spinidens.* The second and third nymphal stages formed a number of groups, aggregated around the host larva and started group feeding, but fourth and fifth nymphal instar stages were mostly fed in solitary conditions and support the findings of earlier workers. On the basis of continuous feeding habit of pentatomid bug *A. spinidens* they control pest population of *Melanitis leda* in the rice fields and confirmed their role as efficient biological control agents (predator) in Vidarbha region of Maharashtra.

The Pentatomid bug *Andrallus spinidens* (F) is a potential biocontrol agent in the rice field. It feeds on a variety of lepidopteran pests. We can conserve this bug in the field, for management of pest population. Without indiscriminate use of insecticide, we can control pest population.

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