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Research Article

Taxonomy, bionomics and predatory potential of *Eocanthecona concinna* (Walker) (Hemiptera: Pentatomidae: Asopinae)

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ABSTRACT: *Eocantheocna concinna* (Walker) is recorded as an important predator of lepidopteran pests in tea plantations of South India. It is described for the first time based on male and female genitalia. Biology of this predator was studied on *Corcyra cephalonica* larvae. Egg incubation period was 14.3 ± 0.4 days. Five nymphal instars were developed in a period of 33–36 days. Feeding efficacy of different instars of *E. concinna* was evaluated on third instar tea looper, *Biston suppressaria*. Results showed fourth and fifth instars of *E. concinna* attacked faster on *B. suppressaria*. The study describes *E. concinna* as a potential predator of various lepidopteran pests in tea plantations and a promising candidate for biological control of looper pests.

KEY WORDS: Biology, predatory stink bug, predatory efficiency, lepidopteran pests, taxonomy

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INTRODUCTION

The members of the subfamily Asopinae, are commonly known as predatory stink bugs, characterized by a strong four segmented rostrum. First segment of rostrum is thickened and free which makes it easier to prey upon. This subfamily comprises 66 genera worldwide and *Eocanthecona* is represented by 20 species around the world (Rider, 2017). They feed on insects especially lepidopteran larvae and are efficient biological control agent against several pests. The tea flushworm, *Cydia leucostoma* (Meyr.) (Tortricidae: Lepidoptera) and tea leaf-roller, *Caloptilia theivora* (Walsm.) (Lepidoptera: Gracillariidae) are minor lepidopteran pests but often becomes serious (Murthy and Chandrasekaran, 1979). Looper caterpillar, *Biston suppressaria* (Guenee) is one of the major defoliating pests of tea (Fig. 7). This pest was first collected from Nowgong district of Assam (Cotes, 1985). It is one of the common pests of tea (Antram, 1911). The looper is an active defoliator of tea and its infestation may become devastating within a short period (Rahman and Bhola, 2012).

During fieldwork the authors collected aninteresting predatory stinkbug, *Eocanthecona concinna* (Walker, 1867) in tea. This is the first report of this predator in tea plantations. This species was first reported by Walker in 1867 as *Canthecona concinna* from Hong Kong, China. This species is recently described from Kolhapur district of Maharashtra (Waghmare and Gaikwad, 2017). There is no report on the biology and predatory potential of this efficient predator.

The present study is the first attempt to study the biological parameters and predatory efficacy on larvae of *B. suppressaria*. Apart from this *E. concinna* is described based on male and female genitalia for the first time.

MATERIAL AND METHODS

Morphological characterization

Photographs were made using Leica DFC 420 camera mounted on a Leica M205A stereo zoom microscope and by using the software Automontage®. The dissections were carried out under the stereomicroscope Leica S8APO. Photographs were edited using Adobe Photoshop CS (Version 8.0). The procedure to dissect male genitalia as detailed by Ahmad (1986) was followed. The female genitalia was dissected after boiling the whole abdomen in hot water for about 10–15 minutes with 10% Potassium Hydroxide (KOH). The internal contents were cleared after thoroughly washing it in distilled water for 2–3 times and with the help of fine forceps, the terminalia and spermatheca were detached from abdominal ventrites. All measurement are given in millimetres and presented as minimum and maximum values. The following dimensions were measured: Body length (from apex of mandibular plates to apex of

membrane or apex of tergite VIII, dorsal view), head length (from apex of mandibular plates to anterior margin of pronotum, dorsal view), head width (width of head including compound eyes, dorsal view), interocular width (between inner margins of compound eyes, dorsal view), length of each antennal segment, length of each labial segment, pronotum length (medially, from anterior to posterior margin of pronotum, dorsal view), pronotum width (maximum width between humeri in dorsal view), scutellum length (medially from base to apex) and scutellum width (maximum width at base between basal angles of scutellum). Morphological terms used for male and female genitalia follow Tsai *et al*. (2011). Basic terms are followed from Schuh and Slater (1995) and Tsai *et al*. (2011), terms associated with metathoracic scent glands follow Kment and Vilímová (2010).

Laboratory rearing

First instar nymphs of *Eocanthecona concinna* were collected from tea plantations at UPASI Tea Research Foundation, Coimbatore, Tamil Nadu, India (12.45 N and 75.40 E; elevation 1050 m above sea level). The stink bug nymphs were collected in polythene bags, and tightly closed with rubber bands, before been brought into the laboratory. They were reared in groups in muslin cloth covered glass bottles (500 ml capacity) maintained at 22–26°C and 60–70% R.H. *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) larvae, obtained from a colony maintained at UPASI Entomology Division laboratory, were used as prey for rearing. Two to three tea shoots (each with three leaves and a bud) were wrapped together with wet cotton and inserted tightly into a glass vial (5 cm long × 2.5 cm wide) to serve as supplement food to first instar nymphs.

Males and females that emerged (10 individuals each) were paired (Fig. 4) and allowed to mate in the glass rearing bottles covered with muslin cloth. The rearing bottles and muslin cloths were carefully examined every 24 h, and the muslin cloths were replaced and examined once eggs were deposited on it. Pre- and post-oviposition periods, numbers of egg clutches, and total numbers of eggs (fecundity) were recorded for each pair (i.e., 50 replicates) in the parental generation.

Predatory efficacy

The predatory efficacy of the predator was conducted on *Biston suppressaria* larvae. All the stages of the predator were supplied with 5 larvae of *B. suppressaria*. Pre-starved first, second, third, fourth, fifth, male and female of *E. concinna* was provided with third instar larvae (5 Nos.) of *B. suppressaria* in long glass tubes (16.5 long × 4.0 cm wide). Observations were recorded on number of prey attacked and fed upon for 1 h, 2 h, 3 h, 24 h and 48 h. The experiment was replicated for five times.

RESULTS AND DISCUSSION

Taxonomy

Eocanthecona concinna (Walker, 1867) (Figs. 1 & 2)

Colouration: Body above chocolate brown with pale ochraceous markings scattered over head, pronotum-scutellum and corium. Each basal angles of scutellum with one round, dark yellowish orange spot. Metallic sheen over head and pronotum especially on humeral angles. Connexivum with anterior half and posterior 1/4th of connexival segments, black with green metallic sheen, tooth on posterolateral angles of each ventrite, black. Antennal segments light black, segment V with proximal half lightochraceous. Labium, pale ochraceous except segment IV, brownish black. Ventral side of body pale ochraceous with well expressed brown or black markings with metallic sheen as follows: pro, meso and metapleura including ventral side of humeri, one large spot each at anterior and posterolateral angles of ventrite III and IV, anterior angles of ventrite V-VII, scattered coarse, round spots laterally on each ventrites, large, semicircular spot on ventrite VII. Legs with femora paler proximally and black distally; fore tibiae, black; mid and hind tibiae, black with median pale ochraceous region; tarsi, black except basitarsus, pale ochraceous.

Integument and Vestiture: Body above including head covered with dense, concolorous to black or metallic green punctures. Connexivum with punctae fine, dense and concolorous. Pleura with coarse, dense punctures, metallic green. Abdominal ventrites laterally with less dense, scattered and coarse punctures. All femora with scattered, coarse punctures.

Structure: Head (Fig. 3) nearly parallel to body axis, not declivous, as long as wide with apex rounded, not narrowing towards apex rather with more or less uniform width. Mandibular plates as long as clypeus, apex of mandibular plates rounded, not meeting in front of clypeus; clypeus open anteriorly; head posteriad of eyes surrounded by anterior pronotal margin. Compound eyes moderately large, rounded, protruding out of the head outline in most of their width. Ocelli small, situated posteriorly close to compound eyes and widely separated. Antenniferous tubercles small, sessile, visible from above. Antennae 5 segmented. Antennal segments from shortest to longest: I<IIa<IIb<III>IV; antennal segment I cylindrical, shortest and stoutest; antennal segments III longest. Bucculae short, rather narrow. Labrum flat and narrow, labial segment I stout, incrassate as characteristic to this subfamily; apex of labium reaching basal abdominal segment or second visible abdominal segment.

Pronotum: (Fig. 3). Anterior pronotal margin deeply arcuately concave; anterolateral angles each with one laterally directed, short, blunt tooth; anterolateral margins narrowly and slightly carinate with indistinct teeth, convex anteriorly and concave posteriorly. Humeri moderately produced broad, lateral margins of humeri with truncated appearance and with slight sinuation postmedially. Posterolateral margin nearly straight, posterolateral angles with minute hook-like process resting over base of clavus (Fig. 3), posterior margin nearly straight; disc of pronotum convex above.

Scutellum: Subtriangular, longer than wide at base; one third apex of scutellum narrow and U-shaped, apex of scutellum not surpassing anterodistal angles of corium. Two third disc of scutellum with lateral sides slightly impressed, basal one third slightly convex.

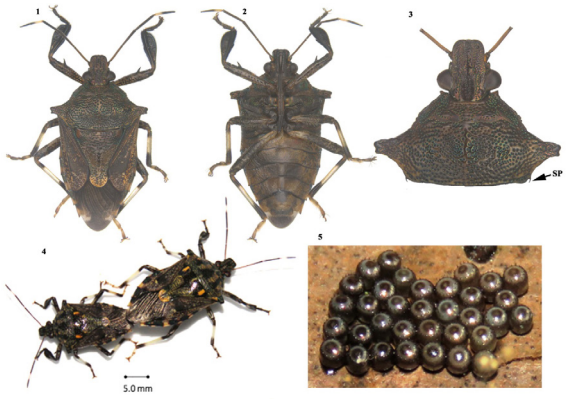
Hemelytra: Clavus narrowly triangular, lateral sides of corium more or less straight; anterodistal angles rounded apically, distinctly surpassing apex of scutellum. Membrane black basally and translucent apically except extreme apex light brown; membrane without reticulate venation, distinctly surpassing apex of abdomen.

Thoracic pleuron and sternum: Pro and mesosternum medially with narrow continuous longitudinal carina, not contiguous with metasternal carina, mesosternal carina broader and roughly rounded in outline. Peritreme modified into peritremal disc (Fig. 6), evaporatorium small developed on metapleuron, forming narrow stripe encompassing ostiole and peritreme and prolonged laterad along posterior margin of metathoracic spiracle, on mesopleuron forming a narrow stripe on anterior margin of metathoracic spiracle and extended to whole lateral margin of mesopleuron.

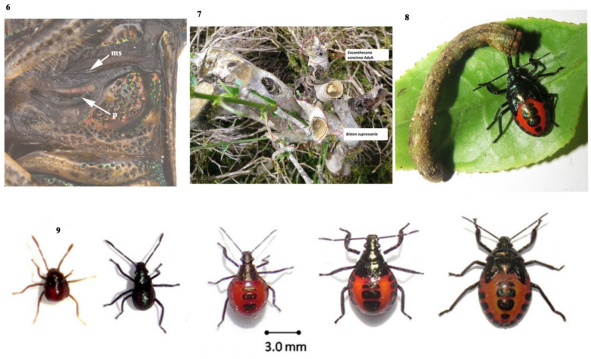
Legs: Forefemora with preapical spine, foretibiae lamellate, femora of mid and hind leg unarmed; all tarsi with segment II shortest, all tarsal segments regularly rounded, not grooved. Tibiae of mid and hindleg dorsally with median longitudinal groove.

Pregenital abdomen: Connexivum exposed dorsally; each ventrite with minute tooth on its posterolateral angles. Abdominal venter slightly convex medially, basal ventrite with a median, short spine directed forward over the posterior part of metasternum. Spiracles on ventrite II covered by metapleuron; two trichobothria situated transversely posterior to spiracle on each side of abdomen.

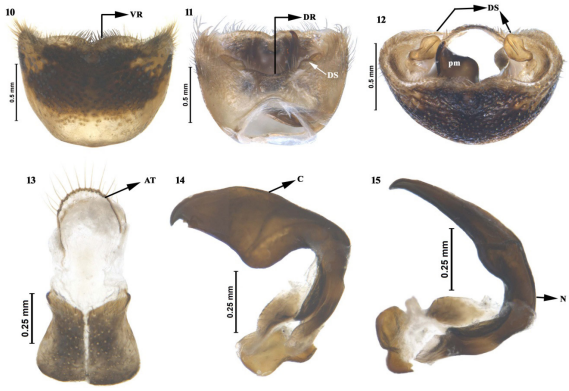
Male genitalia: (Figs 10–19). Genital capsule as long as broad, dorsoventrally flattened, dorsal rim (Fig. 11) con-



Figs. 1-5. ***Eocanthecona concinna*** **(Walker). 1, habitus (dorsal); 2, habitus (ventral); 3, head and pronotum; 4, mating pair; 5, Eggs. Abbreviation: SP- spine like or hook-like process.**



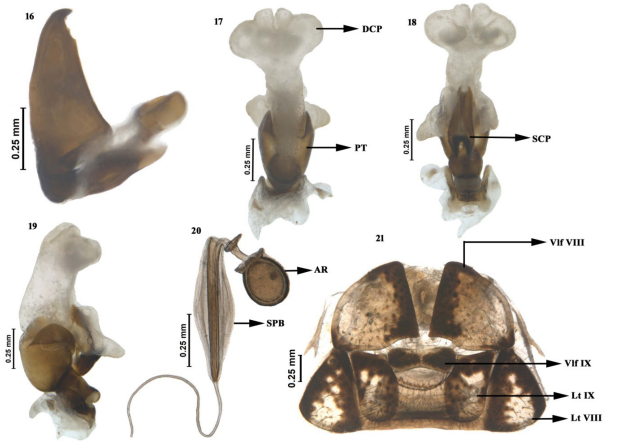
Figs. 6-9. 6, External scent efferent system- ***Eocanthecona concinna*** **(Walker); 7, bush infested with** ***Biston suppressaria*****; 8, Fifth instar nymph of** ***E. concinna*** **predating on larva of** ***B. suppressaria*****; 9. First to fifth Nymphal instars of** ***E. concinna*****.**



Figs. 10-15. ***Eocanthecona concinna*** **(Walker). 10, genital capsule (ventral); 11, genital capsule (dorsal); 12, genital capsule (caudal); 13, proctiger; 14 and 15, paramere (different views).Abbreviation: AT- anal tube; C-crown; DR- dorsal rim; DS- Dorsal sclerite; N- neck; VR- ventral rim.**

cave with 1 + 1 dorsal sclerite sublaterally, dorsal sclerite roughly saddle-shaped (Fig. 12); ventral rim slightly wavy with minute V-notch medially (Fig. 10), ventral side of genital capsule with small rounded depression medially adjacent to ventral rim anteriad to median notch, posterior 2/3rd of ventral side of genital capsule sclerotized black with coarse, dense and brown punctae, dorsal side of genital capsule with fine, dense hairs laterally. Paramere (Figs 14–16) with large, expanded triangular crown, neck short and narrow, stem short and stout, crown apically acute, inwardly curved with two smaller excavation on the dorsolateral margin adjacent to apex (Figs 14, 16). Phallotheca short, convex dorsally and narrowed proximally, thecal processes broad, expanded collar-like (Fig. 19) encompassing membranous conjunctival processes; dorsal conjunctival process (Figs 17, 18) membranous, saccular, elongate with hood-like apex subdivided into a couple of lateral arms ventrally, one pair subapically and the second pair basally; ventral pair of conjunctival processes with its contralateral counterparts fused along midline except their extreme apices; ventral conjunctival processes encompassing narrow, tubular aedeagus.

Female genitalia (Figs 20, 21)*:* Valvifers VIII subquadrate with posterior margin slightly concave towards inner posterior angles, valvifers IX fused to narrow transverse stripe; laterotergite IX long semiovate, not reaching apex of abdomen, laterotergite VIII posteriorly encompassing laterotergite IX and segment X and posteromedially connected with narrow transverse band. Spermatheca (Fig. 20) with median dilation narrow; distal invagination of spermathecal duct (=spermathecal rod) narrow, cylindrical; intermediate part of spermtheca (=spermathecal pump) short, delimited by distal and proximal flange; proximal flange shorter than distal flange; distal flange adpressed to apical receptacle; apical receptacle large, orbicular, without finger-like processes (Fig. 20).



Figs. 16-21. ***Eocanthecona concinna*** **(Walker). 16, paramere; 17, phallus (dorsal); 18, phallus (ventral); 19, phallus (lateral); 20, spematheca; 21, terminalia. Abbreviation. AR- apical receptacle; DCP- dorsal conjunctival process; PT- phallotheca; SCP- second conjunctival process; SPB- spermathecal bulb; Lt VIII- laterotergite VIII; Lt IX- laterotergite IX; Vlf VIII- valvifers VIII; Vlf IX- valvifers IX.**

Material examined: INDIA: Tamil Nadu: 1♀, Valparai, UPASI, 10.ix.2016, K.K. Srikumar; 4♀, Valparai, UPASI, 10.x.2017, K.K. Srikumar; 2♂, Valparai, UPASI, 10.x.2017, K.K. Srikumar.

Measurements (in mm): Males (n = 2); minimum-maximum. Body length 11.16–11.57; length of head 1.98–2.10, width across eyes 2.07, interocular distance 0.96–0.97, lengths of antennal segments (I) 0.31–0.41: (II) 1.29–1.32: (III) 1.31–1.40: (IV) 1.62–1.76: (V) 1.49–1.62; lengths of labial segments (I) 1.00–1.13: (II) 1.24–1.25: (III) 1.18–1.26: (IV) 1.00–1.03; median length of pronotum 2.68–2.76; humeral width 6.00–6.14; length of scutellum 3.61–3.76; basal width of scutellum 3.45–3.54.

Females (n = 5)*:* minimum–maximum. Body length 11.92–14.47; length of head 2.36–2.64, width across eyes 2.24–2.41, interocular distance 1.10–1.25, lengths of antennal segments (I) 0.32–0.48: (II) 1.30–1.64: (III) 1.51–1.61: (IV) 1.76–1.90: (V) 1.56–1.60; lengths of labial segments (I) 0.99–1.33: (II) 1.46–1.68: (III) 1.29–1.52: (IV) 1.09–1.23; median length of pronotum 2.89–3.52; humeral width 6.76–7.51; length of scutellum 4.29–4.70; basal width of scutellum 3.85–4.30.

Differential diagnosis: This species can be distinguished from its other congeners by the possession of truncate humeri and presence of small hook-like spinous structure on the posterior angles of pronotum.

Predatory potential

Eggs of *Eocanthecona concinna* (Fig. 5) were hatched in 13–16 days. There were five instars with the total nymph developmental period of 34.4 ± 1.1 days. The developmental duration for five instars (Fig. 9) were 4.1 ± 0.3, 6.7 ± 0.2, 6.9 ± 0.1, 8.2 ± 0.1, 8.4 ± 0.3 days respectively. Percent nymphal survival ranged from 68.0–78.0. The longevity of the male was 23.3 ± 0.9 while female was 19–46 days. Percent adult survival was 73.1 ± 0.1. *Eocanthecona concinna* laid 3.1 ± 0.3

egg batches/female with 36.4 ± 2.7 eggs/batch (Table 1). *Alcaeorrhynchus grandis* (Dallas) in the laboratory conditions showed 59–60 days for egg to adult with egg stages taking 15–16 days (Richman and Whitcomb, 1978). The total developmental period for *Stiretrus anchorage* (Fabricius) was 25–35 days and the egg stage lasted six to seven days (Waddill and Shepard, 1974; Richman and Whitcomb, 1978).

Table 1. Biological parameters of *Eocanthecona concinna*

Parameters	Mean ± SE	Range
Egg incubation period	14.3 ± 0.4	13–16
Per cent egg hatch	90.5 ± 0.1	88–93
Instars		
1	4.1 ± 0.3	3–5
2	6.7 ± 0.2	6–7
3	6.9 ± 0.1	6–7
4	8.2 ± 0.1	8–9
5	8.4 ± 0.3	7–9
Total nymphal developmental period	34.4 ± 1.1	33–36
Per cent nymphal survival	71.7 ± 0.1	68–78
Longevity		
Male	23.3 ± 0.9	19–26
Female	30.9 ± 4.5	19–46
Percent adult survival	73.1 ± 0.1	65–82
Pre oviposition period	19.9 ± 0.5	18–22
Post oviposition period	13.0 ± 0.6	10–15
Fecundity		
No. of batches/female	3.1 ± 0.3	2–4
No. of eggs/batch	36.4 ± 2.7	25–48
Sex ratio (F : M)	1.0 : 0.5	

The predatory efficacy test was conducted to ascertain feeding preferences of different stages of *Eocanthecona concinna* to *Biston Suppressaria* (third instar larvae) (Table 2). The study showed that significant difference in prey consumption by different stages. During 2–3 h fifth instar of *E. concinna* attacked significantly faster than other stages (Fig. 8). During 48 h the prey attacked by third, fourth, fifth, male and female were statically on par and higher than first and second instars. It is reported that different stages of tomato looper, *Chrysodeixis chalcites* (Esper) (Lepidoptera: Noctuidae) were attacked higher when fourth and fifth instar nymphs of the predators, *P. maculiventris* (Say) and *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) were released (De Clercq *et al*., 1998).

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Table 2. Predatory efficiency of *Eocanthecona concinna* life stages on *Biston suppressaria* larvae

Stages	Time duration (h)				
	1	2	3	24	48
I	0	0 .0 (0.0a)	0 .0 (0.0a)	5.0 (6.7a)	10.0 (13.3a)
II	0	0.0 (0.0a)	0.0 (0.0a)	20.0 (26.6b)	25.0 (29.7a)
III	0	0.0 (0.0a)	27.5 (31.4b)	32.5 (34.5b)	52.5 (46.6b)
IV	0	20.0 (26.6b)	35.0 (36.2b)	40.0 (39.1c)	75.0 (64.01b)
V	0	35.0 (36.1c)	40.0 (39.1c)	40.0 (39.1c)	75.0 (64.01b)
Male	0	0.0 (0.0a)	0.0 (0.0a)	32.5 (34.5b)	60.0 (51.0b)
Female	0	0.0 (0.0a)	27.5 (31.4b)	40.0 (38.9c)	60.0 (54.8b)
P = 0.05	0	3.58	6.78	13.9	27.16
SE (m)	0	1.2	2.27	4.38	9.07

The values in parenthesis are arc square transformed and in the same row followed by same letters are not significantly different at *P = 0.05*

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