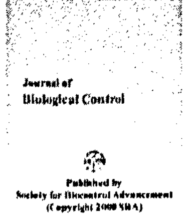

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Research Article

Electrophysiological response of *Tetrastichus schoenobii* Ferriere (Hymenoptera: Eulophidae), an egg parasitoid of rice stem borer, *Scirpophaga incertulas* (Walker) (Lepidoptera: Crambidae) to the extracts of plants collected from rice ecosystem

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ABSTRACT: *Tetrastichus schoenobii* Ferriere is an efficient egg parasitoid on rice yellow stem borer, *Scirpophaga incertulas* (Walker). The electrophysiological response of females of *T. schoenobii* to the extracts of plants collected from rice fields was studied under laboratory conditions. The highest response was noticed to the host plant of the pest, *S. incertulas* and honey solution. Response was also noticed to the flowers of *Hyptis suaveolens*, a common weed in rice fields, mostly by female parasitoids to the flowers of the non-crop vegetation.

KEY WORDS: *Tetrastichus schoenobii*, *Scirpophaga incertulas*, electrophysiology, *Hyptis suaveolens*

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INTRODUCTION

Rice is infested by several species of pests and among them, the yellow stem borer, *Scirpophaga incertulas* (Walker), is considered as a serious pest throughout the Orient (Dale, 1994). It is regarded as monophagous with exclusive host specificity to rice. However, Zaheurdden and Prakasa Rao (1983a,b) have shown that wild rice species such as *Oryza rufipogon* Grift, *O. nivara* Sharma et Shastry, *O. latifolia* Desv. and *O. glaberrima* (Steud) and a grass weed, *Leptochloa panicoides* (J. Presl.) act as potential alternate host plants for *S. incertulas*. Before the introduction of chemical pesticides, natural enemies played a significant role in maintaining the pest populations of rice at lower levels (Yasumatsu, 1967). Stem borers are parasitized by around 100 species of parasitoids (Nickel, 1964) and although all juvenile stages are attacked, eggs suffer highest parasitism (Ressig *et al.*, 1986). Three groups of egg parasitoids, namely, *Telenomus* spp., *Tetrastichus* sp. and *Trichogramma* spp. dominate the parasitoid complex (Ooi and Shepard, 1994). In India, five species of egg parasitoids have been recorded on the eggs of *S. incertulas* from different regions, *viz.*, *Telenomus dignus* (Gah.), *T. dignoides* Nixon, *T. rowani* (Gah.), *Tetrastichus schoenobii* and *Trichogramma japonicum* Ashmead (Hikim, 1979; Rai and Gowda, 1977). *T. schoenobii* is endoparastic on stem borer eggs, but later instars of the parasitoid become predacious on other host eggs within the egg mass (Rothschild, 1970; Kim and Heinrichs, 1985). Each developing instar of *T. schoenobii* is capable of destroying 3-4 eggs before completing its development and therefore this species is considered as the best among the egg parasitoids. *T. schoenobii* is also considered to be a more predominant parasitoid than *Telenomus rowani* (Islam, 1991). The role of *T. schoenobii* as an efficient parasitoid was studied from several parts of India (Ram *et al.*, 1996, 1997; Pandya *et al.*, 1995) and in some geographical areas parasitization was observed up to 95% (Kim and Heinrichs, 1985; Kumar *et al.*, 2008).

Besides rice borer, *T. schoenobii* parasitizes borers of corn, sugarcane, wheat and many other grass species in South East Asia and India and a total of 10 stem borer hosts have been reported for *T. schoenobii* (Khan *et al.*, 1991). The detailed biology of this species was studied by several authors (Bhuiuyan and Sufian, 1986). Hymenopteran parasitoids visit plants not only in search of hosts but also for feeding and mating (Jervis *et al.*, 1993). Volatiles of undamaged plants are important for the location of flowers as food sources (Wäckers, 2004) and for the location of the prey (Elzen *et al.*, 1983; Benrey *et al.*, 1991). The behaviour of parasitoids is mediated by volatiles emanating from host plants as well as host insects. While host plant volatiles are known to act as long range attractants, host kairomones act as short range attractants. Studies on the behaviour of *T. schoenobii* are limited (Qiu *et al.*, 1984; Ding *et al.*, 1991; Bhuiuyan and Sufian 1986; Zhang and Zhang, 1985). He (1984) reported eight kinds of sensilla on the antenna of *T. schoenobii* through scanning electron microscopy studies and *sensilla placodeum* Type I is involved in the oviposition behaviour of females. The assemblage of vegetation in a crop ecosystem may have profound influence on the behaviour of the host insects and their natural enemies. Several weed species are observed along the bunds and adjoining fields of rice which may have an influence on the behaviour of the parasitoids of stem borer. The behaviour of *T. schoenobii* to plant cues is not known till date. The present studies were conducted to understand the influence of the plant volatiles on the electrophysiological response of *T. schoenobii* and these studies are important to understand whether *T. schoenobii* utilizes plants for food or shelter.

MATERIAL AND METHODS

Cultures of *T. schoenobii*

Field collected egg masses of *S. incertulas* were brought to the laboratory and kept in small plastic vials (10 cm length and 2 cm dia.) for the emergence of adult parasitoids at 26±2°C, 70±5% RH and a 12 hour photophase. After emergence, the adults of *T. schoenobii* were separated and reared in vials in groups along with 50% honey.

Preparation of plant extracts

A survey was conducted to find out the weed flora of rice ecosystem in and around Mandya, Karnataka. All the plants found within and adjoining rice fields and harvested fields adjacent to rice fields were collected in polythene bags, brought to the laboratory and identified. After identification, one gram (fresh weight) from each plant material was weighed and extracted with 100ml of hexane (Analytical reagent grade, 95% purity, SD Fine Chemicals, Mumbai) in a rotary shaker at a speed of 100 rpm for 60 minutes. The extract was filtered through a Whatman's filter paper and the final solution was made up to 100 ml to represent 1% (weight/volume) concentration.

Details of plant species studied

Plant species	Location from where collected
Alternanthera ficoidea (L.)	Mandya
Asclepias curassavica L.	Mandya
Aristida sp.	Channapatna
Calotropis gigantea (L.)	Mandya
Cassia tora L.	Mandya
Cleome viscosa L.	Channapatna
Grass	Mandya
Hyptis suaveolens (L.)	Mandya
Malvastrum coromandelianum (L.)	Channapatna
Melia dubia Cav.	Channapatna
Morus alba (L.)	Mandya
Oryza sativa L.	Mandya/Channapatna
Panicum setigerum (Roth.)	Mandya
Parthenium hysterophorus L.	Channapatna
Spilanthes acmella (Murri.)	Mandya
Tephrosia purpurea (L.)	Mandya

Electroantennogram studies

Electroantennogram (EAG) studies were conducted in a Syntech® electroantennogram consisting of EAG amplifier (model AM-02) and Stimulus Controller (model CS-05) and IDAC (Intelligent Data Acquisition Controller) card of type AM 02 supplied by Syntech, Netherlands along with the Syntech EAG recording system for Windows version 2.6 (1997) EAG software supplied by Syntech, Netherlands. Two-day-old females of *T. schoenobii* were selected for the electroantennogram studies. The antennae of the adults were excised from the head carefully with minimal disturbance and the tip was trimmed and fixed between the two capillary electrodes filled with electroconductivity gel (Dia med make manufactured by, Sakthi Mediwin India, Puducherry), forming a continuous electrical circuit. Pure air filtered through activated charcoal granules was blown on the antennal preparation @ 720 ml per minute and a stimulus was given @ 720ml per minute through the stimulus controller. For the delivery of odours a non-adsorbent, odourless polystyrene tube (6mm outer diameter and 4 mm inner diameter) was used which was connected to the continuous flow and stimulus air flow delivery knobs by appropriate Y-tube connector with the Synthech stimulus controller unit (Model CS 05) on one hand and to the stainless steel stimulus delivery unit (type ST-02, Syntech, Germany) on the other hand. The tip of the stimulus delivery unit was placed around 0.5mm distance from the antennal preparation. The stimulus was given for a period of 0.4 seconds and the recordings were done for a period of five seconds. An amount of 0.1 ml of the extract from the plants (containing 10ug of the plant material) was impregnated in a small strip of 75mm length and 1.5mm breadth Whatmann filter paper and presented as a stimulus to the antenna. Diluted honey (50%) was used as the control stimulus as diluted honey elicits good response in most of the parasitoids we have studied. The potential difference between the antennal tip and the base on stimulation with the odours was recorded through the EAG software® supplied by Syntech. Three replications were maintained for each treatment. The maximum amplitude recorded for different treatments in different replications was analysed through Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

This is the first electronantennogram study on any of the *Tetrastichus* spp. The lowest response of electrical conductivity was recorded to the air, indicating lower response due to mechanical receptors. The highest response of antenna was observed for honey, rice leaf extract and flowers of *Hyptis suaveolens* (Table 1). The response to honey indicates that the parasitoid utilizes the honey from plant sources for its survival. The least response was noticed to most of the leaf extracts of different plants including the monocot plants. Response to the leaves of rice indicated that *T. schoenobii* responded to the volatiles of the plants. Since the parasitoid is an obligate parasitoid of rice stem borer, obviously its response should have been tuned to the volatiles of rice. Strikingly important is the response of the antenna to the extracts of *Hyptis*

Table 1. Electroantennogram response of *T. schoenobii* to the extracts of some plants

Name of the treatment	Mean electrical response (in negative volts)	Standard error
Air	0.036^{a}	0.036
Honey	3.129^{de}	0.016
Leaf extract		
Parthenium hysterophorus	0.998^{bc}	0.360
Grass	1.018^{bc}	0.131
Calotropis gigantea	1.343^{c}	0.256
Asclepias curassavica	1.344^{c}	0.534
Mulberry	1.421^{c}	0.263
Panicum setigerum	1.604^{c}	0.246
Cleome viscosa	1.418^{c}	0.340
Hyptis suaveolens	1.675^{c}	0.233
Melia dubia	1.947^{cd}	0.424
Tephrosia purpurea	1.697^{cd}	0.059
Alternanthera ficoidea	1.970^{cd}	0.053
Cassia tora	1.852^{cd}	0.112
Spilanthes acmella	1.811^{cd}	0.306
Asistida sp.	1.667^{cd}	0.137
Malvastrum coromandelianum	2.128^{cde}	0.391
Oryza sativa	3.327^{e}	0.301
Flower extracts		
Calotropis gigantea	1.659^{cd}	0.375
Hyptis suaveolens	2.769^{cde}	0.295

Values with the same alphabets are not significantly different from each other by DMRT.

suaveolens flowers. *T. schoenobii* is reported to parasitise other borers such as *Chilo auricilius* Dudgeon, *C. partellus* (Swinhoe), *C. polychrysus* (Meyrick), *C. suppressalis* Walker, *Scirpophaga innotata* (Walker), *S. nivella* (Fabricius) and *Sesamia inferens* (Walker) apart from *S. incertulas* (Khan *et al.*, 1991). However, *H. suavelons* is not known to be a host plant for any of the hosts of *T. schoenobii*. Floral compounds such as 1,8, cineole, β-caryophyllene with least amounts of α-copaene, α- phyllandrene, β- elemene and eugenol were identified earlier from the flowers of *H. suaveolens* (Peerzada, 1997). The EAG response of *T. schoenobii* may be attributed to one and or all the above volatiles, as the role of some these volatiles as an attractant or repellant for several insect species was well established earlier (Elzen *et al.*, 1984; Colazza *et al.*, 2004.; Elfekih and Abderrabba, 2008; FengQin *et al.*, 2008). *T. schoenobii* was also known to respond to the extracts from the anal tuft of female moths (Ding *et al.*, 1981). Mucopolysaccharides from salivary glands and calcium oxalate of oothecae of cockroaches act as kairomones for the closely related species, *T. hagenowii*, a parasitoid on the oothecae of cockroaches (Vinson and Piper, 1986).

This study gives an indication that adults of *T. schoenobii* probably utilize the honeydew of other plants for their survival. However, it is difficult to predict the role of *H. suaveolens* as an attractant or repellant based on EAG studies. Behavioural assays are necessary to confirm the behaviour of *T. schoenobii* to the volatiles of *H. suaveolens*. It is quite feasible that *T. schoenobii* utilizes the florets of rice and flowers of other plant species for their survival and to increase their fitness, which needs to be further studied in the context of using them as ecofeast plants.

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