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Research Article

Diversity and abundance of parasitoid fauna associated with the pests of certain medicinal plants of West Bengal

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ABSTRACT: A preliminary study was conducted from 2021 to 2022 to explore the parasitoid fauna associated with insect pests and their per cent parasitism levels in the field as well as to understand the diversity of parasitoids in the medicinal plants ecosystem under northern tracts of West Bengal. In course of the study, a total of ten parasitoid species belonging to 5 families from 2 orders were observed in this ecosystem. Hymenopteran parasitoids were dominant, *i.e.,* more than 90% and only one fly parasitoid species from Diptera belonging to the family Tachinidae was observed. Amongst the hymenopteran parasitoids, braconids were the prime species, found parasitizing various insect pests. All these parasitoids were observed attacking lepidopteran caterpillars which were predominant defoliators on various medicinal plants. The per cent parasitism by *Copidosoma* sp. on *Helcystogramma hibisci* was 38% which was the highest and found effective in the suppression of pest population.

KEYWORDS: Diversity, insect pests, medicinal plants ecosystem, parasitoids, parasitism

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INTRODUCTION

Parasitoids are beneficial insects that usually parasitize harmful phytophagous insects, kill them eventually, thus keep the pest population in check. These are one of the important biological factors of natural control that contribute to reduction of rapidly growing pest population and maintenance of the balance in nature (Huffaker *et al.,* 1971). The life-style of parasitoids is highly specialized. They possess an elongated sharp ovipositor to insert eggs on/inside the host body and have unique successive larval instars that are drastically vary in form. Majority of the parasitoids have very narrow host range and usually attack only 1-2 species (Waage and Hassell, 1982; Heimpel and Casas, 2008).

Parasitoids are identified from 87 families belonging to 5 insect orders *viz.,* Hymenoptera, Diptera, Coleoptera, Neuroptera and Lepidoptera (Audi and Biliyaminu, 2018). The order Hymenoptera has diversified parasitoid taxa, which contain more than 200,000 species. However, earlier estimates indicate that only a small fraction of total parasitoid species have been described and there are thousands of species yet to be identified (Waage and Hassell, 1982; Forbes *et al.,* 2018). Hymenoptera is the second largest insect order in species diversity, nearly 78% of the total identified parasitoid species belong to this order and hence it is known as the most useful order for mankind. However, the irrational use of broad-spectrum insecticides in agricultural ecosystems leads to a complete loss of parasitoid fauna (El-Wakeil *et al.,* 2013).

Several medicinal plants are endemic to India, particularly to the northern part of West Bengal situated in the Terai zone and eastern Himalayan hills, where they are normally grown in the wild *viz.,* forests, barren and wastelands (Anonymous, 2003). Three predominant medicinal plants *viz.,* Muskdana, *Abelmoschus moschatus* (L.), Nirgundi, *Vitex negundo* L. and Dhataki, *Woodfordia fruticosa* Kurz were selected for the present study based on their medicinal importance. Muskdana is a malvaceous medicinal plant that is commonly grown in Deccan plateau and the forests of the

sub-Himalayan region including West Bengal. All parts of the plant are beneficial, the leaf and root decoction is used to cure ailments like gonorrhoea, rheumatism, snake bite, Kapha, and Vata. The tender pods and shoots are consumed as a minor leafy vegetable and the seeds are aromatic, and used as a flavouring agent in liquors and coffee in India (Hansda *et al*., 2017; Rani *et al*., 2022). Nirgundi, also known as nisinda belonged to the family Verbanaceae, having multifarious uses including valuable medicinal properties like anti-inflammatory, anti-nociceptive, hepatoprotective, anti-hyperglycemic, anti-microbial, anti-tumor activity and being used from ancient times in folk medicine to treat diseases like headache, neck-gland sores, tubercular neck swellings and sinusitis. The plant is found mainly in wastelands and mixed open forests throughout India (Meena *et al*., 2010; Rani *et al*., 2023) and Dhataki or Dhaiphool is a member of the family Lythraceae primarily grown in the northern part of West Bengal adjacent to Sikkim and North-Eastern states (Tayab *et al*., 2021). The plant bears attractive, reddish, tubular flowers which are possessing considerable therapeutic properties and are extensively used in wound healing. The flower and leaf extracts contain the properties like anti-microbial, hepato protective, cardio protective, immune-modulatory, antifertility and anti-tumor (Thakur *et al*., 2021).

There is a great potential for sustenance of parasitoid fauna in such areas, as the pesticide usage or any other disturbances are very limited in these areas. Moreover, these natural enemies are of great value for applied biological control of pests in commercial medicinal plants cultivation which the farmers are taking up in a big way in recent times. Therefore, the present study was carried out to explore the parasitoid fauna of major insect pests damaging various medicinal plants and also to understand the diversity and abundance of these parasitoid species in the medicinal plants ecosystem. The results can be utilized for estimation of the potential of parasitoids for employing in biological control for management of various insect pests.

MATERIALS AND METHODS

Study area

The experimental site of the study was the medicinal plants field, located at Uttar Banga Krishi Viswavidyalaya (UBKV), Pundibari, Cooch Behar that lies within the sub-Himalayan Terai agroecological conditions of northern West Bengal. The climate of the region is typically subtropical and subhumid with an annual precipitation exceeding 3500 mm. This region is characterized by high relative humidity (average maximum and minimum of 95% and 65%, respectively) and moderate temperature (average maximum and minimum of 31°C and 11°C, respectively). The field (26°19’86” N latitude and 89°23’53” E longitude at an elevation of 43 meters above the MSL) where the present study on biodiversity of parasitoid fauna was carried out is situated within the Horticultural Farm block of Uttar Banga Krishi Viswavidyalaya encompassing an area of about 1 acre. The garden is surrounded by forestry and rubber plantations all around with a wide variety of seminatural grasses and weed flora to sustain the survival of natural enemies as well as their perpetuation. The area is totally kept free from application of any harmful agrochemicals so as to conserve and augment natural enemy population and bee fauna. Experiments such as rearing of insect pests and identification of parasitoids was carried out in the Entomology Laboratory, Regional Research Station (TZ), Directorate of Research, UBKV, Pundibari, Cooch Behar, West Bengal.

Collection and rearing of parasitoids

Several rounds of surveys were conducted at weekly intervals during 2021 to 2022 for identifying parasitoids associated with major pests of various medicinal plants and recording their field parasitism levels. In order to determine the identity of parasitoids, the immature stages (egg mass/ larvae/ pupae) of major insect pests damaging various medicinal plants were collected randomly, i.e., 50 numbers per species. The collection was carried to the laboratory and maintained under room conditions, and they were sorted according to life stages of insect pests. The collected egg masses were kept in petri dish (9 cm dia.) and observed regularly for emergence of either neonate larva or any parasitoids. The larvae were transferred into a petri dish and reared individually by providing fresh host plant leaves regularly until they either undergone pupation or died due to any possible parasitism. Dead larvae were isolated and observed daily for emergence of parasitoids, if any. Similarly, pupae were also maintained in the petri dishes until adult moths or parasitoids emerged. The methodology for rearing of parasitoids was based on Saravanan *et al.* (2020). The relative abundance of parasitoids was made on the basis of % individuals of each species over total number of collected specimen, where <5, 5-10 and >10 indicate respectively, as less common (+), common (++) and abundant (+++) by following the methodology of Taye *et al.* (2017) and Borkakati *et al.* (2018).

Identification of parasitoid species

The adult parasitoids emerged were killed and collected into collection vials containing 70% alcohol. The preserved parasitoid specimens were examined under a ZEISS Stemi 508 stereo zoom microscope. Photographs of the wasps were taken using a stereo-zoom microscope fitted with a ZEISS Axiocam 105 color camera and Carl Zeiss Zen 2.5 lite (blue edition) imaging software. Preliminary identification up to family level was done by following keys from previous literature. Further, the parasitoid specimens were sent for

identification to the ICAR – National Bureau of Agricultural Insect Resources (NBAIR), Bangalore, India. All the parasitoid specimens were identified up to their genus level. The level of parasitism by each species was determined by using the following formula.

$$\frac{\text{Number of parasitized egg / larva / pupa}}{\text{Total number of egg / larva / pupa observed}\left(n = 50\right)}$$

RESULTS AND DISCUSSION

The parasitoid fauna associated with major pests (mostly lepidopteran defoliators) of three important medicinal plants under northern parts of West Bengal were represented in Table 1. The most dominant family was Braconidae represented by six genera and one genus each from the families of Encyrtidae, Ichneumonidae, Scelionidae and Tachinidae. The family wise diversity of parasitoids was shown in Figure 1. All the parasitoids present in the medicinal plants ecosystem was shown in Figure 2.

Parasitoid complex of leaf folder, *Helcystogramma hibisci* (Stainton) (Gelechiidae: Lepidoptera) on muskdana, *Abelmoschus moschatus* (L.)

Five larval parasitoids observed during the study period were *Copidosoma* sp. (Fig. 2A) (Encyrtidae: Hymenoptera), *Glyptapanteles* sp. (Fig. 2B), *Dolichogenidea* sp. (Fig. 2C), *Aleiodes* sp. (Fig. 2D) and *Parapanteles* sp. (Fig. 2E) (Braconidae: Hymenoptera). The wasp *Copidosoma* sp. was a minute, blackish, idiobiont, gregarious, endo larval parasitoid which attacked old age larvae of *H. hibisci*. The adult parasitoid made a circular exit hole on the body of the dead host larva for emerging out. Polyembryony was very evident in *Copidosoma* sp., as high as 158 progenies emerged from a single host larva. Natural parasitism was recorded as 38% during the period of our study. The braconid wasp, *Glyptapanteles* sp. attacked middl-aged larvae. It was a solitary parasitoid with a short life cycle i.e., the egg to adult emergence completed within 5-7 days. The per cent parasitism was recorded as 22% by *Glyptapanteles* sp. The other braconid larval parasitoids *viz., Dolichogenidea* sp., *Aleiodes* sp. and *Parapanteles* sp. also attacked the pest, however, they were observed only for a short period and considered as minor parasitoids of *H. hibisci*.

Parasitoid complex of leaf roller, *Sylepta derogata* Fabricius (Lepidoptera: Crambidae) on muskdana

An indeterminate species of Braconidae (*Bracon* sp.) (Fig. 2F) and *Diolcogaster* sp. (Fig. 2G) were the two braconid larval parasitoids of *S. derogata*, the former species was a gregarious parasitoid and more common while the later species was solitary and rarely occurred on the pest species. Nearly 18% natural parasitism was recorded by the indeterminate braconid during the period of study.

Parasitoid complex of defoliator, *Anomis flava* Fabricius (Lepidoptera: Erebidae) on muskdana

A dipteran parasitoid fly (unidentified species) (Fig. 2H) was observed parasitizing the pest, and several matured larvae of this gregarious endo parasitoid emerged out from dead pupae of *A. flava.* However, occurrence of both pest and its natural enemy persisted for very short period on the crop during the month of May.

Parasitoid complex of leaf folder, *Pycnarmon cribrata* (Fabricius) (Lepidoptera: Pyralidae) on nirgundi, *Vitex negundo* L.

The parasitoid, *Diolcogaster* sp. (Braconidae: Hymenoptera) was a solitary parasitoid, medium-sized, blackish in colour and preferred to attack the host in its later

Table 1. Parasitoid fauna associated with various pests of medicinal plants and their relative abundance

S.No.	Medicinal plant	Lepidopteran host	Parasitoid	Family	Relative abundance
1	Muskdana-*Ablemoschus moschatus*	Leaf webber-*Helcystogramma hibisci*	*Copidosoma* sp.	Encyrtidae	+++
2			*Glyptapanteles* sp.	Braconidae	+++
3			*Dolichogenidea* sp.	Braconidae	+
4			*Aleiodes* sp.	Braconidae	+
5			*Parapanteles* sp.	Braconidae	+
6		Leaf roller- *Sylepta derogata*	Indeterminate Braconidae		++
7			*Diolcogaster* sp.	Braconidae	+
8		Defoliator- *Anomis flava*	Unidentified sp.	Tachinidae	+
9	Nirgundi-*Vitex negundo*	Leaf roller- *Pycnarmon cribrata*	*Diolcogaster* sp.	Braconidae	+++
10		Defoliator- *Selepa discigera*	*Telenomus* sp.	Scelionidae	++

+Less common ++ Common +++ Abundant

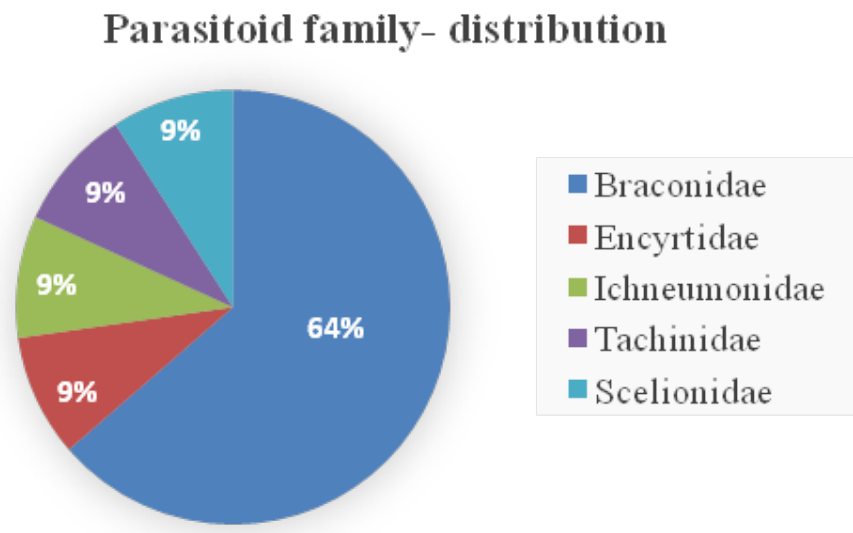

Figure 1. Family wise diversity of parasitoids in the study area.

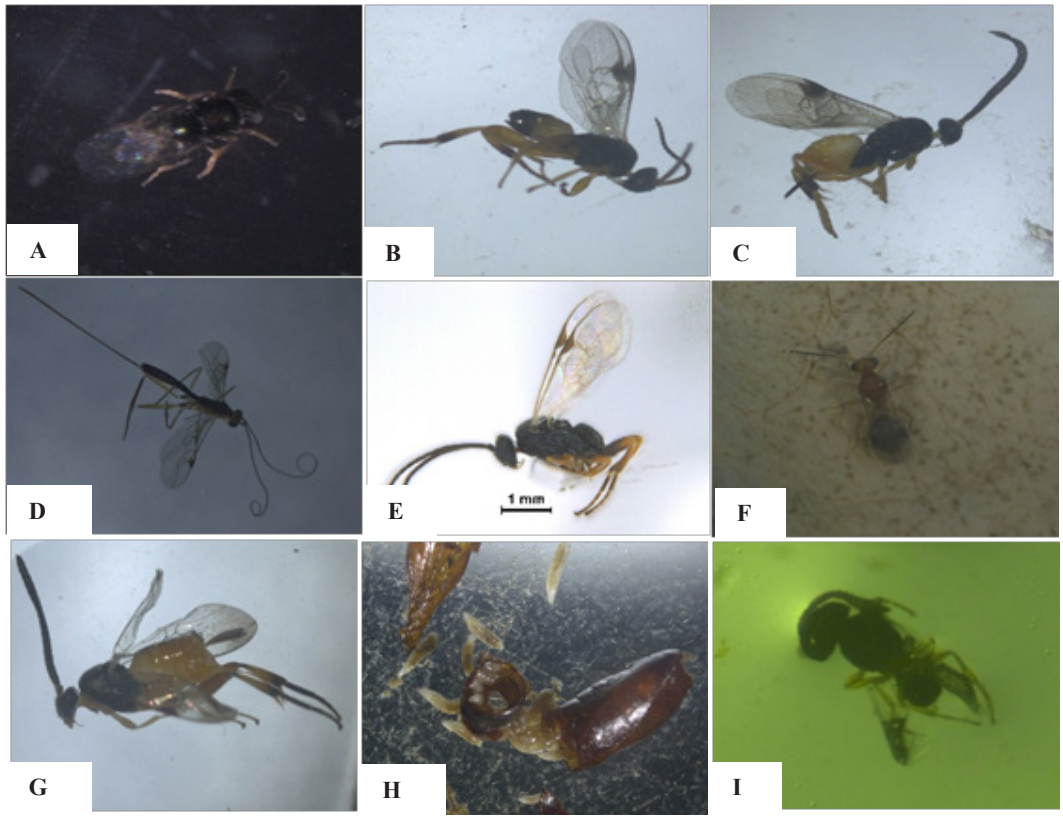

Figure 2. Parasitoids observed in the medicinal plants ecosystem of northern parts of West Bengal: A) *Copidosoma* sp. B) *Glyptapanteles* sp. C) *Dolichogenidea* sp. D) *Aleiodes* sp. E) *Parapanteles* sp. F) Indeterminate braconid G) *Diolcogaster* sp. H) Tachinid fly parasitoid I) *Telenomus* sp.

larval or prepupal stage. The mature parasitoid larva wriggled out by making a wound on the host larva, then underwent pupation inside a membranous cocoon. The maximum natural parasitism was documented as 14% during the period of study.

Parasitoid complex of defoliator, *Selepa discigera* Walker on dhataki, *Woodfordia fruticosa* Kurz

The defoliator *S. discigera* laid small, conical-shaped, sculptured eggs in groups on leaves. These eggs were parasitized by the egg parasitoid, *Telenomus* sp. (Fig. 2I) (Scelionidae; Hymenoptera). Although, 90 % (per cent parasitism) of the host eggs were parasitized, but the percentage of adult parasitoid emergence from such eggs was only 20% (per cent emergence of adult parasitoids).

The information on the relative faunal diversity and abundance of parasitoids in any medicinal plant ecosystem is very scanty. However, relative abundance studies of parasitoids amongst various families have been studied in some other crop ecosystems. Arakaki and Kinjo (1998) studied the parasitoid fauna of the serpentine leafminer *Liriomyza trifolii* (Burgess) in southern Japan. Through the surveys, they found that nearly 12 species of parasitoids were associated with *L. trifolii*. The most dominant parasitoid family was Eulophidae (8 species) followed by Pteromalidae (2 species), one species each from Braconidae and Eucoilidae families. Among all parasitoids, *Neochrysocharis formosa* (Eulophidae) was the most dominant species in the field. Similarly, dominance of hymenopteran parasitoids as compared to dipteran parasitoids has also been reported by Bhattacharya *et al.* (2006) who studied the diversity and abundance of parasitoids and predators associated with various insect pests of rice in three different fields from Jorhat district of Assam by collecting parasitoid samples at weekly intervals with the help of sweeping nets. They found nearly 29 parasitoid species belonging to 10 families of Hymenoptera *viz.,* Braconidae, Ichneumonidae, Scelionidae, Trichogrammatidae, Bethylidae, Eulophidae, Chalcididae, Pteromelidae, Ceraphronidae and Vespidae and only one dipteran parasitoid species from the family Tachinidae. Kaya *et al.* (2016) studied natural enemies of gelechiid moth *Helcystogramma triannulella* infesting sweet potato in Turkey. They observed parasitoids, *Apanteles* sp., *Chelonus* sp. and *Compsilura concinnata* in the laboratory from larvae of *H. triannulella*. Borkakati *et al.* (2018) studied the natural enemy fauna of paddy, sugarcane and horticultural ecosystems of upper Assam and found *Cotesia angustibasis* and *Trichogramma japonicum* more abundant in the rice ecosystem. The parasitoids like *Sturmiopsis inferens* and *Cotesia flavipes* on *Chilo infuscatellus;* and *Cotesia flavipes* on *C. tumidicostalis* commonly occurred in sugarcane ecosystem. In the horticultural ecosystem, the braconid *Cotesia vestalis* on cabbage butterfly was observed as predominant species. Manikandan (2019) studied the diversity of chalcid parasitoids in a horticultural ecosystem in Tamil Nadu and recorded about 10 species belonging to 9 genera from 4 families *viz.,* Encyrtidae, Mymaridae, Chalcididae and Pteromalidae. Their results showed that *Copidosoma floridamum* was the dominant species followed by *Dipara* sp., *Brachymeria jambolana*, *Agarwalencyrtus citri*, *Gonatocerus* sp. and *Lymaenon delhiensis, Epitranus* sp. and the least population was recorded in *Haltichella* sp.

Gupta and Mandal (2019) observed parasitization by the braconid wasp *Distatrix papilionis* on larvae of *Graphium nomius* (Papilonidae) found to feed on forest tree, *Miliusa tomentosa* which is used in Chinese traditional medicine for their antibacterial and analgestic properties. They reported that the parasitoid, *D. papilionis* was noticed for the first time on *G. nomius* showing its expansion of host range for better adaptability and survival and more affinity towards papilionid hosts. Saravanan *et al.* (2020) studied the parasitoid complex associated with a defoliator, *Acria meyricki* in oilpalm ecosystem. They found three parasitoid species *viz., Dolichogenidea (=Apanteles) hyposidrae, Elasmus brevicornis* and *Brachymeria albotibialis* belonging to families Braconidae, Eulophidae and Chalcididae, respectively. The highest mean parasitism was recorded by *B. albotibialis,* i.e., 73.39% followed by *D. hyposidrae* 61.71% and least parasitism was recorded by *E. brevicornis* 14.58% respectively. Shivakumara *et al*. (2021) observed the infestation of Bihar hairy caterpillar *Spilarctia obliqua* on sweet basil crop and collected the larvae from field and reared under laboratory by providing sweet basil leaves as food. While rearing they noticed two parasitoids viz., *Glyptapanteles obliquae* and *Carcelia* sp. parasitizing the *S. obliqua* larvae. They also worked out the per cent of parasitism by *G. obliquae* and *Carcelia* sp. As 11 and 17 per cent, respectively.

CONCLUSION

Medicinal plants are highly valued for their phytochemicals from which drugs are manufactured or direct use of plant parts in traditional herbal medicine systems in India. Therefore, the production of healthy plant material is essential for maintaining quality. However, several insect pests particularly defoliators are major problems in medicinal plants as well as in forest ecosystems as many medicinal plants are grown naturally in the wild. Furthermore, chemical control is not feasible in medicinal plants because of the toxic residues remaining on the plant surfaces which can be hazardous to human health. Hence, the present study revealed the existing potential parasitoid fauna that can check the harmful pest populations. Out of ten parasitoid genera

identified, *Copidosoma* sp. on *H. hibisci* was found very promising with per cent parasitism levels up to 38% and can further be employed as biocontrol agent in the management of this pest.

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