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Review Article

SUPERIORITY OF THE SOLITARY PARASITOIDS OVER GREGARIOUS SPECIES IN THE BIOLOGICAL SUPPRESSION OF THE COCONUT CATERPILLAR, *OPISINA ARENOSELLA* WALKER[1]

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ABSTRACT

About 40 species of parasitoids are recorded in association with the coconut caterpillar, *Opisina arenosella* Wlk. in India and Sri Lanka. Excepting the dominant tachinid parasitoid, *Stomatomyia (Spoggosia) bezziana* Bar., all other species are prevalent in India. Among these, seven species of parasitoids such as *Bracon hebetor* Say, *B. brevicornis* Wesm. and *Goniozus nephantidis* (Mues.) (larval), *Elasmus nephantidis* Rohw. (prepupal) and *Tetrastichus israeli* M. & K. *Trichospilus pupivorus* Ferr. and *T. diatraeae* Cherian & Margabandhu are gregarious ones.

Generally, the gregarious parasitoids can be easily mass cultured in the laboratory. Fictitious hosts such as *Corcyra cephalonica* St. and other lepidopterous larvae/pupae can be used for mass multiplication of *B. hebetor, T. pupivorus* and *T. israeli*. In most cases, the female progeny dominates and the life cycle is shorter. As a result, the gregarious parasitoids were mass cultured and released in sizeable numbers for the biosuppression of *O. arenosella* for several years now. But. except in some localities, the intensity of parasitism by these in the field, is quite insignificant. *T. pupivorus* cannot breed in hot weather, which is incidentally the peak period of pest abundance in the field. However, this species is unable to compete with *Brachymeria* spp. In north Kerala tracts, it is a dominant species with 4.7% to 15.0% parasitism, whereas its intensity was only 2.15% in Alleppey district, Kerala. *T. israeli*, however, does not breed in the coconut ecosystem, even though there is a single record of its occurrence on *O. arenosella* from Tamil Nadu.

B. hebetor becomes adapted to *C. cephalonica* when it is continuously reared on it. When such parasitoid colonies are released to the field, they fail to parasitize the original host, *O. arenosella*. High intensity of parasitism by *B. hebetor* was reported in some localities. But, in general, the overall percentage of larval parasitism is quite negligible.

The parasitoid complex of *O. arenosella* itself is dominated by the solitary parasitoids. Among the solitary species, *Brachymeria nosatoi, B. nephantidis, Xanthopimpla punctata, X. nana nana* and the braconid *Apanteles taragamao* are important ones. *B. nosatoi* is the most dominant species of pupal parasitoid in southern tracts of Kerala, with an average natural parasitism of 30.1%, followed by *B. naphantidis* (15.7%). *Brachymeria* spp. can tolerate the high temperature and low humid conditions of the summer season.

Xanthopimpla spp. appear only in the latter half of the year, July to December, in

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certain selected locations, where the intensity of pest infestation is quite high and water sources are available nearby. In such locations, parasitism by *X. punctata* reached as high as 43.6%. Some species of solitary parasitoids survived to attack two to three or even more of pest generations.

The need for mass multiplication and release of temperature-tolerant species of parasitoids for the biosuppression of *O. arenosella* is also discussed.

INTRODUCTION

Attempts on biological suppression of the coconut leaf eating caterpillar, *Opisina arenosella* (Lepidoptera: Oecophoridae) were being made with different species of indigenous parasitoids, for several years now. For this, mainly the larval and pupal parasitoids were widely used. This pest supports a large number of paresitoids. Some of them are easy to rear, while others are not amenable to laboratory rearing or difficult to breed in sizeable numbers for field releases against the pest. Among them, there are gregarious ecto-larval parasitoids, gregarious endopupal parasitoids and solitary endo larval or pupal parasitoids. The only solitary species, which can develop externally on the fully grown caterpillar/prepupal pupa and also internally in the pupa is the Ichneumonid parasitoid *Brachycoryphus nursei* Cameron (Pillai and Nair, 1987). The gregarious parasitoids were mostly used in the biological control campaigns against *O. arenosella*. Therefore, it would be quite pertinent to discuss their merits and demerits along with those of the solitary species, so as to select better candidates for the biocontrol programme.

Parasitoids of Opisina arenosella:

There are about 40 species of parasitoids reported to be associated with *O. arenosella* in India and Sri Lanka. Excepting the dominant species of dipteran parasitoid *Stomatomyia (Spoggosia) bezziana* (Baranoff) all other species are prevalent in India. One species of egg parasitoid reported on *O. arenosella* is *Trichogramma chilonis* Ishii (*T. australicum*). However, the same has not been recorded as a natural parasitoid of *O. arenosella* from any of the major coconut growing tracts of the country. Twelve species are larval, two prepupal, and twenty-five are pupal parasitoids. A few of them are only casual visitors and some of them behave also as facultative hyper- parasitoids.

Gregarious species

Trichospilus pupivorus Ferr. and *Tetrastichus israeli* M K. are the two gregarious pupal endoparasitoids. *Trichospilus diatraeae* Cherian and Margabandhu, was reared by the authors from *O. arenosella* pupae collected from infested fields at Paravur, Kollam district, Kerala, during 1985.

Bracon hebetor Say, *B. brevicornis* Wesm. and *Goniozus nephantidis* Mues. are the ectophagous larval parasitoids, while *Elasmus nephantidis* Rohw. develops gregariously on the prepupal caterpillars. CAB International Institute of Entomology considers that *B. hebetor* and *B. brevicornis* are not distinct, but one and the same species. Similarly, Cock and Perera (1987) think that *Bracon serinopae* Ramakr. is a valid species. In South India, *B. brevicornis, T. pupivorus* and *T. israeli* were the three species of parasitoids which were mass cultured and released from the zonal parasite breeding laboratories. *G. nephantidis* and *E. nephantidis* were also cultured for field releases in some of the laboratories.

Merits of gregarious species of parasitoids:

1. They are easy to mass breed using simple methods.
2. They are generally high fecund species, except *E. nephantidis* which lays, on an average, 57 eggs (Pillai and Nair, 1982a).
3. Except *B. brevicornis/B. hebetor* others produce higher proportion of female progeny.

4. Fictitious hosts can also be used for rearing (except *E. nephantidis* which is highly host-and stage-specific). *Corcyra cephalonica* St. is an ideal host for rearing *Bracon*. Many lepidopterous pupae are suitable hosts for the multiplication of *T. pupivorus, T. diastraeae, T. israeli* etc.
5. Life cycle is generally shorter.

Demerits

1. Natural parasitism by the gregarious parasitoids is quite low in most of the localities.
2. The strains of *B. brevicornis* and *G. nephantidis* are not virulent.
3. Longevity is usually less than that of the solitary species.
4. Use of fictitious hosts continuously affects at least one species. *B. brevicornis*, when reared on *C. cephalonica* continuously, the parasitoid becomes adapted to *Corcyra* and the progeny produced fail to parasitise *O. arenosella*, when released in the field.
5. The host-suppressing capacity is less. For example, *T. pupivorus* lays all its eggs on 2-3 host pupae, *T. israeli* in 3-4 pupae and *E. nephantidie* on 1-5 (average-3) host caterpillars.

Parasitism by gregarious parasitoids

Lack of synchrony with the host population was observed in the case of *T. pupivorus*. During summer months, *O. arenosella* population builds up very fast, whereas the population of *T. pupivorus* undergoes aestivation (Pillai and Nair, 1982d). This provides the host an advantageous position over the parasitoid. High percentage of parasitism by *T. pupivorus* was reported by Rao *et al.* (1948) and this species was considered to be an efficient parasitoid. It requires high relative humidity and it fails to build up its population particularly in drier zones. *T. pupivorus* was not prevalent at all in Salem area during 1980. It dominated other species of parasitoids in North Kerala tracts (14%), where *B. nosatoi* population was scarce. But, in south Kerala, parasitism by it was only less than 1% (Joy and Joseph, 1977). The observations made by the present authors during 1979-1980 also revealed that *T. pupivorus* was not a significant species of parasitoid in South Kerala tracts, because *Brachymeria* spp. suppressed the population of *T. pupivorus* (Pillai and Nair, 1982 b) (Table 1).

The newly recorded species, *T. distraeae* was observed to be rare on *O. arenosella*. Its

Table I. ***Parasitism by*** *Trichospilus pupivorus*

Period	Locality	% Parasitism	Reference
1967-'70	Kayangulam	6.76	George *et al.* (1977)
	South Kerala	1.00	Joy and Joseph (1977)
	North Kerala	14.00	"
1979-'80	Kayangulam	1.60	Pillai and Nair (1981)
1980	Thottappally (Alappuzha Dist.)	2.15	"
1980	"	2.60	Pillai and Nair (1982b)
1971-'72	Trivandrum	3.03	Joy and Joseph (1978)
"	Kayangulam	0.28	"
"	Kottayam	Nill	"
"	Ernakulam	0.80	"
"	Calicut	14.73	"
"	Badagara	15.04	"
1981-1985	Malabar	0.57	Ghosh and Abdurahiman (1985)

egg to adult stages were completed in 15 to 19 days.

T. israeli is predominantly a parasitoid of *Sesamia inferens* Wlk. on rice. Several millions of this parasitoid were released in Opisina-infested coconut plantations in several tracts of the country, but it was never recovered indicating that it will not build up its population in the coconut ecosystem, although there is a single record of it from Tamil Nadu (Asaf Ali and Subramaniam, 1972).

B. hebetor also concentrates its population in certain pest-infested tracts, where high intensity of parasitism was observed. (Sathiamma *et al.*, 1986). But, in many other localities the parasitoid may not be present and its overall intensity of parasitism will be quite low.

The strain of *Goniozus nephantidis* occurring in Kerala appears, to be less efficient. George *et al.* (1977) recorded 8.5 per cent parasitism, out of a total 12.6 per cent larval parasitism as the contribution of *G. nephantidis*. Manjunath (1985) reported *G. nephantidis* as the principal parasitoid during an outbreak of *O. arenosella* in Andhra Pradesh accounting 28 per cent parasitism. Studies on the larval parasitism of *O. arenosella* carried out at the erstwhile CCRS, Kayangulam during the period from 1959 to 1964 at Arattupuzha and Neendakara, in the coastal and backwater tracts of Kerala, had revealed that the overall natural larval parasitism in those localities was quite negligible. The intensity of larval parasitism by the gregarious larval parasitoids is furnished in Table-II.

Solitary larval parasitoids

Stomatomyia (*Spoggosia*) *bezziana* was introduced during 1963 and 144 mated females were released in the pest-infested fields at Neendakara. (Anonymous, 1963). But, it did not establish. Further releases could not be made.

Occurrence of two biotypes of *Eriborus trochanteratus* (Morley) was reported by Pillai and Nair (1986). The Sri Lankan biotype, which is parasitic on *O. arenosella*, was introduced to India and it became established at Coimbatore, Tamil Nadu (Swamiappan and Balasubramanian, 1987) and at Thottappally, Alappuzha district, Kerala (Pillai and Nair, 1986).

Meteoridea hutsoni (Nixon) (Hymenoptera: Braconidae) and *Thelairodrino gracilis* Mesnil (Techinidae) are larval-pupal parasitoids, and *M. hutsoni* has limited distribution in Calicut district,

Table II. ***Parasitism by gregarious larval parasitoids***

Period	Locality	Per cent parasitism by			
		E. nephantidis	*B. brevicornis*	*G. nephantidis*	
1966 (Mar.-Dec.)	Kayangulam	0.0 to 2.49	0.0 - 0.12	0.21 - 3.19	Anonymous (1966)
1967 - 1970	"	3.25	0.80	8.54	George *et al.* (1977)
1976 - 1980	Gujarat	-	1.0 - 4.5	1.2 - 26.3	Yadav and Dhamalia (1986)
1985	Andhra-Pradesh	-	-	28.0	Manjunath (1985)
1985	Malabar (Kerala)	- -	4.08	0.15	Ghosh and Abdurahiman (1985)
1983	Madappally (Malabar)		1.33	0.06	Ghosh and Abdurahiman (1985)

Table III. ***Parasitism by*** *Apanteles taragamee* Wilkinson

Year	Locality	% Parasitism	Reference
1982	South Kerala	3.68	Mohamed *et. al.* (1982)
1982	North Kerala	2.68	Mohamed *et. al.* (1982)
1983	Malabar	3.43	Ghosh and Abdurahiman (1985)
1985	Malabar	8.04	Ghosh and Abdurahiman (1985)
1985	Andhra Pradesh	5.0	Manjunath (1985)

providing a parasitism of 10.4 per cent (Ghosh and Abdurahiman, 1985).

Among the solitary larval parasitoids *Apanteles taragamae* Wilkinson (Braconidse) parasitising early stage caterpillars is more important and it provides a maximum of 8.04% parasitism (Ghosh and Abdurahiman, 1985). Table III. This parasitoid is prevalent in all the coconut growing tracts of India.

Solitary pupal parasitoids

The solitary pupal parasitoids are most important. *Brachymeria nosatoi, B. nephantidis, Xanthopimpla punctata* and *X. nana nana* are the major species. At Thottappally, as high as 49.1 per cent of the pupal population of *O. arenosella* was observed to be suppressed by *Brachymeria* spp; which amounts to 92.3 per cent of the total pupal parasitism. The relative contribution of *B. nosatoi* was 30.1 per cent and that of *B. nephantidis* 15.7 per cent (Table 4). In Salem, Tamil Nadu, besides *B. nephantidis* (10.82%), *B. hime atteviae* Joseph also played a valuable role in suppressing an outbreak of the pest (Pillai and Nair, 1986).

Brachymeria spp. can tolerate high temperature and low relative humidity conditions of the summer season. *B. nosatoi* is capable of maintaining its population without any damage, even during prolonged drought conditions. In India, *B. nosatoi* population is confined to Kerala State, and it is more abundant especially in Southern Kerala. But *B. nephantidis* has a wider distribution throughout the country.

Xanthopimpla spp. appears in cocount gardens immediately after the initial rains. Their peak activity can be observed during September-November. Both the species breed in separate territories. The selected area will always have water sources nearby and a high intensity of pest incidence. Parasitism reaches as high as 43.6% (average) in the case of *X. punctata* and 31.9 per cent for *X. nana*

Table IV. ***Parasitism by*** *B. nosatoi* ***and*** *B. nephantidis*

Locality	Year	*B. nosatoi* (%)	*B. nephantidis* (%)	Reference
Kayangulam	1978-'80	29.6	13.9	Pillai and Nair (1981)
"	1985	27.4	21.7	(Data collected by the authors)
Thottappally (Alleppey Dist.)	1980	30.1	15.7	Pillai and Nair (1982a).
South Kerala	-	19.3	7.9	Joy and Joseph (1977)
North Kerala	-	2.2	4.1	"
Trivandrum	1971-'72	9.09	0.76	Joy and Joseph (1978)
Ernakulam	"	6.90	2.39	"
Calicut	"	2.90	9.15	"
Malabar	1981-'85	0.57	4.91	Ghosh and Abdurahiman (1985)
Salem	Sept. 1981	Absent	10.82	Pillai and Nair (1989)
Gujarat	1979-'80	-	10.5	Vyas and Butani (1986).

nana. (Table-V). Both the species are capable of suppressing *Brachymeria* spp. *X. punctata* was also found to dominate the parasitoid complex of *O. arenosella* in Salem (Table-V) area of Tamil Nadu.

Merits of solitary parasitoids

1. Solitary species are better killers of the host than the gregarious parasitoids.
2. Some of them are very sturdy and strong fliers. eg: *Brachymeria* spp, *Xanthopimpla punctata, X. nana nana* etc.
3. Some of them survive to parasitize 2 to 3 or even more of pest generations.
4. Can tolerate high temperature and low relative humidity of the summer season. eg. *B. nosatoi, B. nephantidis* etc.
5. *B. nosatoi* can tolerate even prolonged drought conditions.

Demerits

1. Large scale multiplication is difficult.
2. Rearing techniques are not very simple.
3. Trained persons are required to handle *Brachymeria* spp. and *Xanthopimpla* spp.
4. Some of them act as facultative hyperparasitoids.

DISCUSSION

One of the pertinent criticisms on the biological control campaigns on *O. arenosella* raised by Sudha Nagarkatti (1973) was that only the parasitoids which can be easily multiplied in the laboratory were included in the programme. They were mostly gregarious species, such as *B. brevicornis, G. nephantidis, T. pupivorus* and *T. israeli*, which provided only very low parasitism in the field. Due to continuous releases of these

Table V. ***Intensity of parasitism by ichneumonid parasitoids of*** *Opisina arenosella* Wlk.

Year and Locality	Total Percent Parasitism	Name of the Parasitoid	Percentage parasitism	Reference
1976 - 1980 Mahuva, Gujarat	11.5 - 62.8	*Xanthopimpla punctata*	5.2 to 20.0	Yadav and Dhamalia, 1986
1982 Sept.-Oct. Salem, Tamil Nadu	49.28 (173/151)	- do -	26.50 (93/351)	Pillai and Nair, 1989
1983 Sept. Ayiramthengu, Quilon	57.46 (204/355)	- do -	37.56 (133/355)	Pillai and Nair, 1989
1984 Sept. Ayiramthengu, Quilon	64.59 (363/562)	- do -	43.59 (245/562)	- do -
1980 Oct.-Dec. Quilon	57.50 (46/80)	*X. nana nana*	27.50 (22/80)	Pillai and Nair, 1983
1981 Jan. Quilon	72.22 (161/307)	- do -	9.26 (5/54)	- do -
		- do -		- do -
1984 Nov. Quilon	52.44 (161/307)	- do -	31.59 (97/307)	data collected by authors.
1984 Dec. Quilon	56.13 (87/155)	- do -	13.59	- do -
1984 - 85 Ayiramthengu	-	*Goryphus nursei*	1-6.0	Nirula *et al.* 1955
Sri Lanka Coimbatore	- -	*Eriborus trochanteratus*	12.79 to 31.42	Perera, 1977.

species, the level of parasitism did not rise to any appreciable extent. The absence of any efficient egg or larval parasitoid would provide considerable advantage to the pest for its population build up. Search for the egg parasitoids, if any, has to be intensified. Suitable techniques are to be developed for large scale multiplication of *Apanteles taragamae*, as this solitary parasitoid is capable of suppressing early instar caterpillars in the initial stage itself of the population build-up of the pest. Reintroduction of the tachinid parasitoid, *S. bezziana* from Sri Lanka for further trials should also receive top priority. Cock and Perera (1987) had suggested the introduction and trials with *Argyrophylax fumipennis* Townsend (Tachinidae) from East Java. This is a parasite of *Artona catoxantha* on coconut.

High temperatures of the summer season are conducive to the population build up of *O. arenosella*. But, the same condition adversely affects many of the parasitoids. To cope up with this situation, temperature tolerant species of parasitoids such as *B. nosatoi, B. nephantidis* etc. may be multiplied and released. Moreover, *B. nosatoi* is capable of building up its population in response to the increase in pest population even during drought periods.

In order to obtain best results in the biosuppression of insect pests, adequate knowledge on the bioecology and individual behaviour pattern of the promising species of parasitoids is an essential pre-requisite. *A. taragamae* prefers marshy and high humid areas. *X. punctata* and *X. nana nana* breed in the coconut ecosystem only from July to December. They do not disperse in all the pest-infested tracts, but concentrate in certain territories with high intensity of pest infestation and abundant water sources nearby. *X. punctata* and *X. nana nana* also suppress the population of *B. nosatoi* and *B. nephantidis* in such tracts. However, *Brachymeria* spp. are more valuable than *Xanthopimpla* spp. when the overall extent of pest suppression exerted by them is taken into account.

As techniques of rearing *Brachymeria* spp. and *Xanthopimpla* spp. are now available (Pillai and Nair, 1982c; 1983; 1989), further multiplication and release of less efficient species of parasitoids such as *B. brevicornis, T. israeli* etc. can be discontinued. However, releases of *T. pupivorus* in north Kerala tracts may still be rewarding.

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