

Seasonal incidence and extent of parasitization of fruit piercing moths of the genus *Othreis* (Lepidoptera: Noctuidae)

B. S. BHUMANNAVAR and C. A. VIRAKTAMATH¹

Project Directorate of Biological Control (ICAR)

P. B. No. 2491, H. A. Farm Post, Bellary Road

Hebbal, Bangalore 560 024, Karnataka, India

E-mail: bhumannavar@rediffmail.com

ABSTRACT: Four egg and three larval parasitoids were recorded on *Othreis* spp. Mean per cent parasitization of eggs of *Othreis* by *Trichogramma chilonis* Ishii and *Telenomus* sp. during 1998 was 21.45 ± 27.45 (range 0-80 %) and 6.57 ± 11.56 (range 0-50 %) and during 1999 was 50.40 ± 34.08 (range 0-100 %) and 4.93 ± 8.99 (range 0-31.9 %), respectively. Parasitisation by egg parasitoids, *Ooencyrtus papilionis* Ashmead and *Anastatus* sp., was negligible. In nature, *Euplectrus indicus* Ferriere parasitised the fifth instar larvae of *O. materna* whereas *E. maternus* Bhatnagar parasitised first to third instars of *O. materna*, *O. fullonia* and *O. homaena*. Mean per cent parasitization of *O. materna*, *O. fullonia* and *O. homaena* larvae by *E. maternus* was 20.7 ± 10.9 (range 0-30 per cent), 19.46 ± 18.71 (range 0-50 per cent) and 1.66 ± 3.33 (range 0-8.33 per cent), respectively, in the field. In the laboratory, *E. indicus* parasitized fourth or fifth instar caterpillars of *Othreis* and laid 38-97 eggs on the dorsum in between posterior eye spots on the third abdominal segment of the host. The parasitoid paralysed the host before oviposition. Total development from egg to adult emergence took 15 -17 days. The tachinid, *Winthemia* sp. parasitized only the fifth instar of *O. materna*. Eggs were laid on the lateral side of prothorax. On hatching, the maggots directly entered the host body by cutting the skin just below the egg attachment. The maggot development continued until the host caterpillar pupated. Full grown larvae came out from the host pupa through a hole and pupated either in soil or in leaf debris. Both *E. maternus* and *Winthemia* sp. have the potential for the suppression of population of species of *Othreis*.

KEY WORDS: *Euplectrus indicus*, Fruit piercing moth, *Othreis*, *Telenomus* sp. *Trichogramma chilonis*, *Winthemia*

Fruit-piercing moths, *Othreis fullonia* (Clerck), *O. materna* (Linnaeus), *O. homaena* Hübner and *O. cajeta* (Cramer) are known to occur in India and cause widespread damage on orange and pomegranate (Susainathan, 1924a, b; Ayyar, 1944; Srivastava and Bogawat, 1968; Lolage and

Khaire, 1998). In New Caledonia, 95 per cent of citrus and 100 per cent of tomato crop were destroyed by *O. fullonia* (Cochereau, 1977). Even though these moths cause serious damage to tropical and subtropical fruits, very little progress has been made in suppressing their damage. The

Part of the Ph. D. thesis submitted to University of Agricultural Sciences, Bangalore by the first author.

¹ Professor, Department of Entomology, University of Agricultural Sciences, GKVK, Bangalore 560 065.

available control methods like catching the adult moths by hand net, smoking of the orchard in the evening, spraying the fruits with insecticides, baiting with arsenic compounds, bagging of the fruits, deterring the moths by light source and destruction of the larval host plants are only partially effective in reducing the fruit piercing moth damage (Baptist, 1944). Very little research has been done in India especially on the natural enemies of the primary fruit piercers, except a few sporadic reports by Susainathan (1924a,b) and Ayyar (1944). Waterhouse and Norris (1987) provided an overview of the natural enemies of *O. fullonia* and shortlisted *Ooencyrtus* sp. and *Trichogramma ostriniae* occurring in Hawaii for introduction elsewhere.

Sands (1996) considered that *Euplectrus maternus* Bhatnagar from India might be a valuable candidate for introduction into countries where species of *Othreis* were pests, since this parasitoid had only been recorded from larvae of *O. materna* and *O. fullonia*. Studies were made on the natural enemies of species of *Othreis* from 1997 to 1999 at Department of Entomology, University of Agricultural Sciences, Bangalore, and the results are presented hereunder.

MATERIALS AND METHODS

The larvae of species of *Othreis* are known to feed only on species of Menispermaceae. Different species of Menispermaceae, namely, *Tinospora cordifolia* Miers, *Cocculus hirsutus* Diels, *Anamirta cocculus* W. & A., *Stephania japonica* Miers, *Stephania wightii* Dunn., *Cyclia peltata* Diels and *Diploclisia glaucescens* Diels grown in and around University of Agricultural Sciences, GKVK Campus, Bangalore (12°58' N, 77°35' E) were surveyed at fortnightly interval from September, 1997 to December, 1999. All the eggs, larvae and pupae of species of *Othreis* found on these vines were collected and reared in the laboratory to record the natural enemies. The Menispermaceae found around Raichur (16° 15' N, 77° 20' E), Bijapur (16° 47' N, 75° 48' E) (Karnataka), Pune (18° 34' N, 73° 68' E) (Maharashtra), Tirupati (13° 39' N, 79° 25' E)

(Andhra Pradesh) were also surveyed two times during October, 1998 and 1999 when the eggs, larvae and adults of the fruit-piercing moths were abundant. The eggs of different species of *Othreis* collected from the field were enclosed separately in glass vials (50 x 5mm) and parasitoids emerging from them were recorded. The larvae collected from the field were reared in plastic containers (100ml capacity) on their respective host plants till the emergence of parasitoid or adult of the moth. A circular hole (30mm diam) was made on the lids of these containers and replaced with copper mesh for aeration.

RESULTS AND DISCUSSION

Four egg and three larval parasitoids were recorded on species of *Othreis* during the present investigation (Table 1). An unidentified fungus also killed the eggs of *O. materna* in the field.

Egg parasitoids

1. *Anastatus* sp. (Hymenoptera: Eupelmidae)

This is a solitary parasitoid of eggs of *O. materna* laid on *T. cordifolia* and was found only once during September, 1999 at UAS Campus. Only one egg of *O. materna* was found parasitised by *Anastatus* sp. Species of *Anastatus* are egg parasitoids of Lepidoptera, Homoptera, Dictyoptera and *Apanteles* sp. (Hayat, 1975). This species is not a significant egg parasitoid for the suppression of eggs of *Othreis* as it was found only once, that too on single egg.

2. *Ooencyrtus papilionis* Ashmead (Hymenoptera: Encyrtidae)

Only two eggs of *O. materna* were found parasitised by this species during November, 1998 at UAS Campus. Three and four parasitoids emerged from the parasitised eggs indicating it is a gregarious parasitoid.

Ooencyrtus papilionis recorded on eggs of *O. materna* is a general parasitoid on the eggs of lepidopterans belonging to the families Papilionidae, Nymphalidae, Danaidae, Pyralidae, Noctuidae, Lymantriidae and Sphingidae (Huang

Table 1. Natural enemies of species of *Othreis* recorded during 1997-1999

Scientific name	Family: Order	Year/host	Per cent parasitisation Mean±SD	Range
Egg parasitoids				
<i>Anastatus</i> sp.*	Eupelmidae: Hymenoptera	---	Negligible	
<i>Ooencyrtus papilionis</i> Ashmead*	Encyrtidae: Hymenoptera	---	Negligible	
<i>Telenomus</i> sp. #	Scelionidae: Hymenoptera	1998	6.57±11.56	0-50
		1999	4.93±8.99	0-31.9
<i>Trichogramma chilonis</i> Ishii #	Trichogrammatidae: Hymenoptera	1998	21.45±27.45	0-80
		1999	50.40±34.08	0-100
Larval parasitoids				
<i>Euplectrus indicus</i> Ferriere*	Eulophidae : Hymenoptera	---	Negligible	
<i>Euplectrus maternus</i> Bhatnagar+	Eulophidae : Hymenoptera	<i>O. materna</i>	20.70±10.90	0-30
		<i>O. fullonia</i>	19.46±18.71	0-50
		<i>O. homaena</i>	1.66±3.33	0-8.33
<i>Winthemia</i> sp.*	Tachinidae : Diptera	---	51.50±24.07	0-77.77

* Collected only on *O. materna*# Collected on *O. materna* and *O. fullonia*+ Collected on *O. materna*, *O. fullonia* and *O. homaena*

and Noyes, 1994). According to Huang and Noyes (1994), Indian records of *O. papilionis* parasitising eggs of *Pyrrilla perpusilla* Walker were erroneous and referred to *O. manii*. None of the previous workers mentioned parasitization by *O. papilionis* on any of the hosts they studied.

3. *Telenomus* sp. (Hymenoptera: Scelionidae)

It is a solitary egg parasitoid of species of *Othreis*. The parasitoid was widely distributed. It was collected from Bangalore, Raichur, Tirupati and Pune. Mean per cent parasitisation of eggs of *Othreis* by *Telenomus* sp. during 1998 and 1999 was 6.57 ± 11.56 (range 0-50 %) and 4.93 ± 8.99 (range 0-31.9%), respectively. In the field the parasitoid was observed during July in 1999 and August in 1998 (Fig. 1 and 2). Parasitised eggs could be easily recognized as the developing parasitoid embryo could be seen through the chorion. Parasitised eggs remain white but a few reddish spots appear at a later stage. The mean

width of emergence hole was 0.355 ± 0.006 mm (n=10), circular with a smooth edge. Denton *et al.* (1989) also recorded 47.6 per cent parasitisation of eggs of *O. fullonia* by *Telenomus* sp.

4. *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae)

This is a gregarious parasitoid of eggs of *O. materna* laid on *T. cordifolia* at UAS Campus, Bangalore. It parasitised eggs laid both on dorsal and ventral sides of the leaf. Mean per cent parasitisation of eggs of *Othreis* by *Trichogramma chilonis* during 1998 and 1999 was 21.45 ± 27.45 (range 0-80%) and 50.40 ± 34.08 (range 0-100%), respectively. The parasitoid appeared along with the first batch of eggs of *O. materna* in May, 1998 and in April, 1999 (Fig. 1 and 2). This parasitoid was found only in the UAS Campus, Bangalore. Seven to 19 adult parasitoids emerged from a single parasitised egg. Parasitised eggs turned grey or

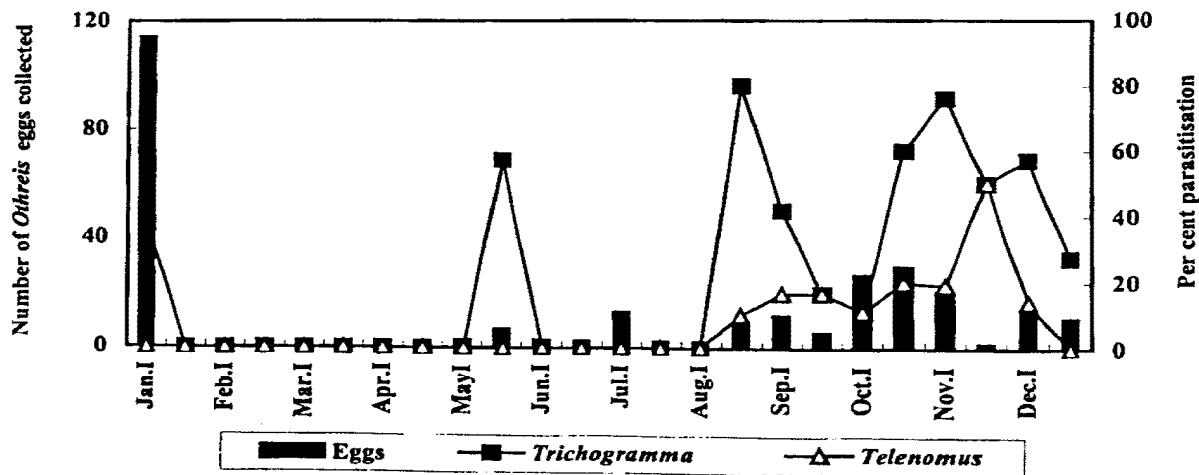


Fig.1. Incidence of egg parasitoids of *Othreis materna* (Linnaeus) during 1998

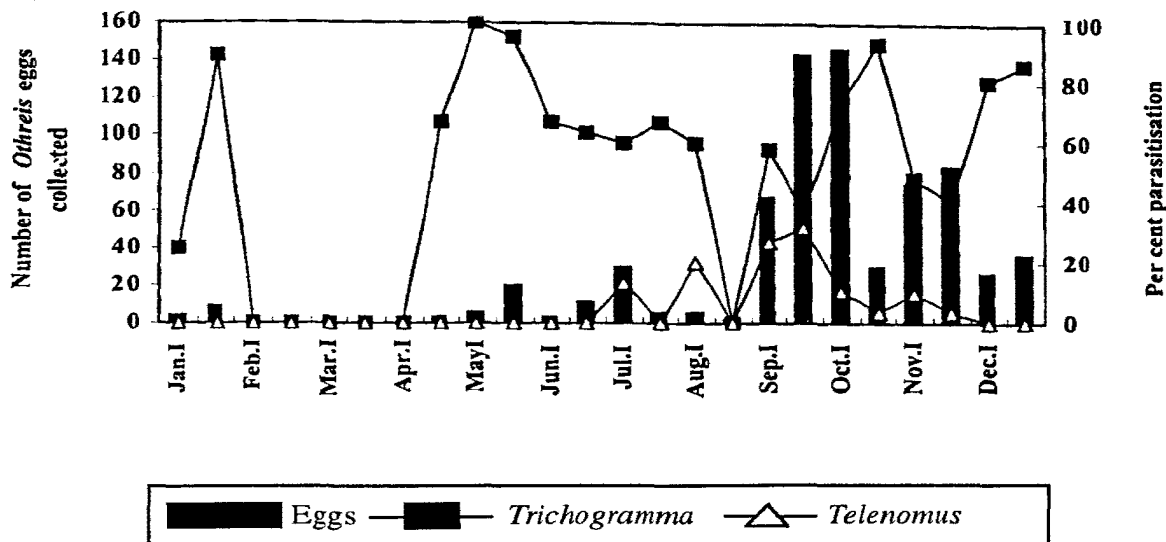


Fig.2. Incidence of egg parasitoids of *Othreis materna* (Linnaeus) during 1999

black in colour. The mean width of parasitoid emergence hole was 0.205 ± 0.006 mm ($n=10$) with finely ragged-edge.

Throughout India, *T. chilonis* is mass multiplied and released for the biological suppression of several species of lepidopterosus pests. Inundative releases of *T. chilonis* can definitely destroy sizeable egg population of species of *Othreis*. *Telenomus* sp. is also widely distributed. *Telenomus* sp. and *T. chilonis* together can parasitise a large number of eggs of *Othreis* in India. *T. chilonis* was earlier recorded to parasitise 14 per cent of eggs of *O. fullonia* in New Caledonia (Cochereau, 1977) and only 0.6 per cent eggs in Guam (Denton *et al.*, 1989).

Larval parasitoids

1. *Euplectrus indicus* Ferriere (Hymenoptera: Eulophidae)

This is a gregarious ectoparasitoid on fourth instar caterpillar of *O. materna*, which was recorded during October, 1997 at Hebbal (Three km from UAS Campus), Bangalore. The eggs were laid in a group on the dorsum of the third abdominal segment between the posterior eye spots. The parasitoid egg measured 0.23 ± 0.01 mm in length and 0.11 ± 0.01 mm in width ($n=10$). The incubation period was 2 ± 0.89 days ($n=67$). After hatching, the parasitoid larvae attached to the host skin at the site of oviposition and started feeding

immediately and grew in size. The larval duration was 7 ± 1.03 days. As the size of the larvae increased, a few larvae (nine) became detached from the host larva, fell to the substratum and died. On the fourth day after hatching the posterior ends of the parasitoid larvae became telescopic and moved in all directions. On the fifth day, the grown up parasitoid larvae started moving away from their original place of attachment and the host larva died immediately. The larvae got distributed over dead carcass and spun loose, dull yellow silken cocoons out of gummy liquid, which oozed out from their anal tip. On the sixth day the process of spinning cocoons was completed and on the eighth day they all pupated. Before pupation a black thread like excreta was voided outside the loose cocoon and this came from the protruding 'tail' end through the space between the loose dried threads of the cocoon. The freshly formed pupa was yellowish brown and later turned to shining brown. The silken threads dried and turned to golden colour. Adult parasitoids emerged six days after pupation. The total developmental time from egg to adult emergence was 15-17 days.

Laboratory multiplication of *Euplectrus indicus*

An attempt was made to rear the parasitoids by exposing fourth and fifth instars of all the three species of *Othreis* in a cage (0.3 x 0.3 x 0.3 m). The female parasitoids laid eggs on the dorsum in between posterior eyespots. The female parasitoid did not discriminate between different *Othreis* species and laid eggs on the larvae of both *O. materna* and *O. homaena* that were provided. The female parasitoid inserted ovipositor into the host integument two to three times without laying an egg. These ovipositor pricks probably meant to inject venom to paralyze the host larva. The number of eggs per host larva varied from 38 to 97 depending on the size of the larva with a mean of 58.4 ± 16.57 eggs ($n=15$). There was an average of 35.27 per cent mortality in the parasitoid larvae that might be due to

insufficient space between the growing larvae. The host larva continued to feed for 2-3 days, thereafter food consumption was reduced and finally they stopped feeding on the fourth day after parasitisation. The parasitised host larva did not moult. Only male parasitoids emerged from the pupae. In the absence of female adults, the parasitoid could not be reared further.

Larvae of *Euplectrus* Westwood (Eulophidae, Hymenoptera) are gregarious ectoparasitoids on the larvae of Lepidoptera (Gerling and Limon, 1976), mainly Noctuidae (Prinsloo, 1980). *E. indicus* was earlier recorded on an unidentified geometrid larva feeding on *Brassica* sp. (mustard), on a cocoon found on leaf of *Tectona grandis* Linn. f. and on *Apanteles obliqua* var. *niger* Walker, all collected at Dehra Dun (Ferriere, 1941). Nothing is known about the biology of *E. indicus* either from India or from any other country. *E. indicus* preferred to parasitise fourth and fifth instar caterpillars of *O. materna*, *O. fullonia* and *O. homaena* in the laboratory. The biology and behaviour of *E. indicus* was similar to that of *Euplectrus laphygmae* Ferriere (Gerling and Limon, 1976). *E. indicus* induced paralysis prior to oviposition, quite similar to *E. laphygmae*. Depending on the host size, the number of eggs laid per host caterpillar varied from 38 to 97. Similar observations were also made on *E. laphygmae* (Gerling and Linmon, 1976) and *Euplectrus melanocephalus* Girault (Jones and Sands, 1999). *E. indicus* parasitised host larvae consumed less amount of food compared to healthy larvae and similar observations were also made by Rajeshwari and Chacko (1992) on *Penicillaria jocosatrix* (Guenée) larvae parasitised by *Euplectrus* sp. nr. *parvalus* Ferriere.

E. indicus was collected only once during the three year study period. This indicated that *Othreis* larvae were not the main hosts of this parasitoid. Most of the *Euplectrus* species were reported from one host only; however, *E. platyhypenae* was recorded from 13 noctuid hosts belonging to 10 different genera, and *E. laphygmae*

was reared from 5 noctuid species belonging to 3 genera (Gerling and Limon, 1976).

2. *Euplectrus maternus* Bhatnagar (Hymenoptera: Eulophidae)

It is a gregarious larval ectoparasitoid of the first three instars of *Othreis* spp. In the field the parasitoid was observed from August to November. It was collected from Raichur, Bijapur, Pune (Maharashtra) and Tirupati (Andhra Pradesh) in addition to Bangalore. Mean per cent parasitisation of *O. materna*, *O. fullonia* and *O. homaena* first and second instar larvae by *E. maternus* was 20.7 ± 10.9 (range 0-30 %), 19.46 ± 18.71 (range 0-50 %) and 1.66 ± 3.33 (range 0-8.33 %), respectively, in the field. Bhumannavar and Viraktamath (2000) have reported on the biology and behaviour of this parasitoid.

3. *Winthemia* sp. (Diptera: Tachinidae)

This is a gregarious endoparasitoid. It was found active during August, 1988 - November, 1999. The female parasitoid laid five to seven eggs on the sides of thoracic segments. The eggs were oval, bright white with a flat bottom and were glued to the host skin. On hatching, the maggots directly entered the host body cutting through the skin just below the egg attachment. The parasitised caterpillar continued to feed and pupated normally. Fully grown maggots came out of the host pupae through the inter-segmental region or by making a hole and pupated in the soil (under field condition) or pupated on leaf debris in the cage. The egg-larval duration was 14-18 days (4-6 days in the host larva and 10-12 days in the host pupa). The pupal duration was 8-15 days.

This tachinid parasitised the fifth instar caterpillar of *O. materna*. None of the field collected larvae of *O. fullonia* and *O. homaena* was parasitised by this tachinid. The parasitoid was found from August to November and approximately 51.5 ± 24.07 per cent (range 0 to 77.77%) of the larvae of *O. materna* were parasitised. Seven to 14 maggots emerged from each host pupa. The parasitoid was collected from Bangalore and Raichur.

W. caledoniae Mesnil, another tachinid, was introduced from New Caledonia into Fiji in 1983 for the control of *O. fullonia*, however there are no reports of its establishment (Kumar and Lal, 1983). Cochereau (1977) reported that *W. caledoniae* was the single most important natural enemy of *Othreis* in New Caledonia where 100 per cent *Othreis* larvae were parasitised. Since *Winthemia* sp. did not parasitise other species of *Othreis* (except *O. materna*) in the field, its use as a biocontrol agent could be exploited where *O. materna* forms a major species among the fruit piercers.

ACKNOWLEDGEMENTS

The authors thank Dr. M. E. Schauff, Research Entomologist, Systematic Entomology Laboratory, Beltsville, Dr. M. Hayat, Department of Zoology, Aligarh Muslim University, Dr. T. C. Narendran, Department of Zoology, University of Calicut, and Dr. H. Nagaraja, General Manager, Biotech International, Bangalore, for identifying various egg and larval parasitoids. We also thank Dr. R. Muniappan, Agricultural Experiment Station, University of Guam, who was instrumental in infusing interest in fruit piercing moths and their natural enemies. The study leave granted to the first author by the Project Director, Project Directorate of Biological Control (ICAR), Hebbal, Bangalore, is gratefully acknowledged.

REFERENCES

- Ayyar, T. V. R. 1944. Notes on some fruit-sucking moths of the Deccan. *Indian Journal of Entomology*, 5(1 & II): 29-33.
- Baptist, B. A. 1944. The fruit-piercing moth (*Othreis fullonica* L.) with special reference to its economic importance. *Indian Journal of Entomology*, 6: 1-13.
- Bhumannavar, B. S. and Viraktamath, C. A. 2000. Biology and behaviour of *Euplectrus maternus* Bhatnagar (Eulophidae: Hymenoptera), an ectoparasitoid of *Othreis* spp. (Noctuidae: Lepidoptera) from southern India. *Pest*

- Management in Horticultural Ecosystems*, 6(1): 1-14.
- Cochereau, P. 1977. Biology and ecology of populations in New Caledonia of a fruit piercing moth: *Othreis fullonia* (Clerck) (Lepidoptera, Noctuidae, Catocalinae). [Biologie et ecologie des populations en Nouvelle-Calédonie d'un papillon piqueur de fruits: *Othreis fullonia* (Clerck) (Lepidoptera, Noctuidae, Catocalinae).] *Travaux et Documents de ORSTOM.*, No. 71: 322 pp.
- Denton, G. R. W., Muniappan, R., Marutani, M., McConnell, J. and Lali, T. S. 1989. Biology and natural enemies of the fruit-piercing moth, *Othreis fullonia* (Lepidoptera: Noctuidae) from Guam. pp. 150-154, In: Johnson M. J., Ullman, D. E. and Vargo, A. (Eds), ADAP Crop Protection Conference Proceedings, Honolulu, Hawaii, U. S. A.
- Ferriere, C. 1941. New species of Euplectrini (Hym. Chalcidoidea) from Europe, Africa and Asia. *Bulletin of Entomological Research*, 32: 17-48.
- Gerling, D. and Limon, S. 1976. A biological review of the genus *Euplectrus* (Hym: Eulophidae) with special emphasis on *E. laphygmae* as a parasite of *Spodoptera littoralis* (Lep: Noctuidae). *Entomophaga*, 21(2): 179-187.
- Hayat, M. 1975. Some Indian species of *Anastatus* (Hymenoptera: Chalcidoidea, Eupelmidae). *Oriental Insects*, 9(3): 261-271.
- Huang, D. W. and Noyes, J. S. 1994. A revision of the Indo-Pacific species of *Ooencyrtus* (Hymenoptera: Encyrtidae), parasitoids of immature stages of economically important insect species (mainly Hemiptera and Lepidoptera). *Bulletin of Natural History Museum, London*. (Entomology), 63: 1-136.
- Jones, P. and Sands, D. P. A. 1999. *Euplectrus melanocephalus* Girault (Hymenoptera: Eulophidae), an ectoparasitoid of larvae of fruit piercing moths (Lepidoptera: Noctuidae; Catocalinae) from northern Queensland. *Australian Journal of Entomology*, 38: 377-381.
- Kumar, K. and Lal, S. N. 1983. Studies on the biology, seasonal abundance and host-parasite relationship of fruit sucking moth *Othreis fullonia* (Clerck) in Fiji. *Fiji Agricultural Journal*, 45: 71-77.
- Lolage, G. R. and Khaire, V. M. 1998. Studies on biology of fruit sucking moth, *Othreis materna*. *National seminar on "Entomology in 21st century"* Rajasthan College of Agriculture, Udaipur.
- Mani, M. S. 1989. The Fauna of India and Adjacent Countries. Chalcidoidea, part II: Zoological Survey of India, Calcutta, pp. 1069-1631.
- Prinsloo, G. L. 1980. An illustrated guide to the families of African Chalcidoidea (Insecta: Hymenoptera). *Science Bulletin Department of Agriculture For. Vn. South Africa*, 345: 1-66.
- Rajeshwari, S. K. and Chacko, M. J. 1992. Parasitoids of the mango shoot caterpillar *Penicillaria jocosatrix* Guen. (Lepidoptera, Noctuidae) in southern India. *Entomon*, 17(1 & 2): 41-47.
- Sands, D. 1996. Natural enemies and prospects for biological control of fruit piercing moth. In: *Proceedings of the 4th National Lychee Seminar Including Longans* (eds. A. Welsh & J. Ferguson) pp. 110-117. Australian Lychee Growers Association, Yeppoon, Queensland.
- Srivastava, R. P. and Bogawat, J. K. 1968. Descriptions of the immature stages of a fruit-sucking moth, *Othreis materna* (L.) (Lepidoptera: Noctuidae), with notes on its bionomics. *Bulletin of Entomological Research*, 59: 275-280.
- Susainathan, P. 1924a. Fruit-sucking moths of South India. *Proceedings of 5th Entomological Meeting, Pusa*, pp. 23-27.
- Susainathan, P. 1924b. The fruit moth problem in the Northern Circars. *Agricultural Journal of India*, 19: 402-404.
- Waterhouse, D. F. and Norris, K. R. 1987. *Biological Control-Pacific Prospects*. pp. 240-249. Inkata Press, Melbourne, 454pp.