

Parasitoids of butterflies: Diversity and host associations in Kolhapur district, Maharashtra, India

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ABSTRACT: This study describes the diversity of parasitoids associated with different life stages of the butterfly. During the study, 14 parasitic Hymenopteran and Dipteran species belong to seven families, viz. Braconidae (five species), Encyrtidae (two species), Scelionidae (two species), Ichneumonidae (two species), Pteromalidae (one species), Chalcididae (one species), and Tachinidae (one species) were recorded. Both, the braconid larval parasitoid *Distatrix papilionis* (Viereck) and the pupal parasitoid *Philomacroploea* sp. are gregarious, while other parasitoid species are solitary, except the egg parasitoid *Ooencyrtus* sp., from which three individuals emerged. Although parasitism on egg and pupal stages has been reported, most parasitic insects target the larval stages. Besides highlighting the ecological importance of parasitic insects, this study provides fundamental data useful for studies on butterfly ecology and conservation.
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KEY WORDS: Papilionoidea, Hymenoptera, Diptera, ecology, biocontrol

INTRODUCTION

Many biological factors, including parasitoids, control the populations of ecologically significant insects, the butterflies (Ehrlich and Raven, 1964). Parasitoids, which are primarily members of the orders Hymenoptera and Diptera, are powerful natural enemies of butterflies because they develop in or on a single host and eventually induce host mortality (Godfray, 1994). Eggs, larvae, and pupae are all attacked by butterfly parasitoids; reports of larval parasitoids are the most common. According to Stireman *et al.* (2006), important parasitoid families include Braconidae, Ichneumonidae, Chalcididae, Tachinidae, and Trichogrammatidae.

Despite their ecological importance, butterfly parasitoids remain poorly documented, particularly in biodiverse tropical regions. Therefore, research on parasitoid diversity and host associations is crucial for understanding butterfly population regulation and guiding conservation initiatives.

MATERIALS AND METHODS

Butterfly eggs, larvae, and pupae have been collected during regular field surveys in Kolhapur district, Maharashtra, from 2022 to 2024. The eggs, larvae, and pupae were hand-picked from host plants and brought to the laboratory in ventilated plastic containers. In the Department of Zoology

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at Shivaji University in Kolhapur, collected eggs, larvae, and pupae were reared under carefully regulated laboratory conditions ($25 \pm 2^\circ\text{C}$ and RH 60–70%). Every day, the caterpillars were provided with fresh host plant material. Daily signs of parasitism, parasitoid emergence, and pupation were observed with eggs, larvae, and pupae. Additionally, while studying the life cycles of various butterfly species in the laboratory, parasitoids that emerged at different stages of their life cycle were collected and included in this study. An aspirator was used to collect emerging parasitoids as soon as they appeared. For subsequent studies, adult parasitoids were either dry-mounted or kept in 70–95 per cent ethanol after being killed with ethyl acetate. The host species, host developmental stage, and emergence date were all noted on the labels of each specimen. Using reference collections and established taxonomic keys, *viz.* Boucek and Rasplus (1991); Rousse and Villemant (2012); Rousse and Gupta (2013); Gupta *et al.* (2015); Narendran and Achterberg (2016); Gupta and Mandal (2019); Oktaviani *et al.* (2021) and Chen *et al.* (2021), the parasitoid species associated with various stages of butterfly life cycle were identified to the lowest possible taxonomic level.

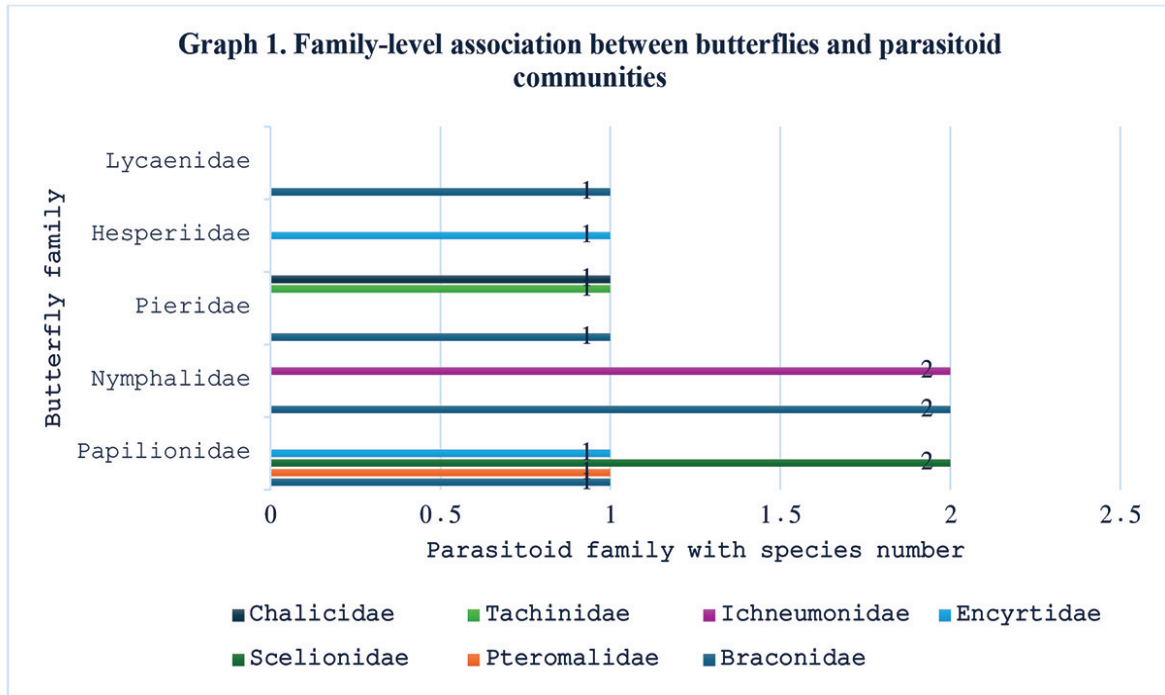
RESULTS AND DISCUSSION

During the study period, 14 parasitoid species from 10 genera and seven families of Hymenoptera and Diptera were recorded. Of these, most species (13 species) belonged to Hymenoptera and only one belonged to Diptera. Among the hymenopterans, the family Braconidae was represented by the maximum number of species (five species) while the families Encyrtidae, Scelionidae, and Ichneumonidae were represented by two species each, and Pteromalidae and Chalcidae by one species each. The family Tachinidae was represented by a single dipteran parasitoid species (Table 1).

The egg, larval, and pupal life stages of a total of 12 butterfly species were found to be parasitized by parasitoids. Specifically, the eggs of butterfly species *Erionota thrax* (Linnaeus), *Graphium agamemnon* (Linnaeus), *Papilio clytia* Linnaeus

and *Papilio polytes polytes* Linnaeus were recorded as being attacked by parasitoids *Ooencyrtus* sp. (Fig. 1A), *Ooencyrtus papilionis* Ashmead (Fig. 1B), *Telenomus* sp. (Fig. 1C) and *Telenomus* sp. (Fig. 1D), respectively. The larvae of butterfly species *Euploea core core* (Cramer), *Luthrodes pandava* (Horsfield), *Papilio demoleus* Linnaeus and *Eurema hecabe* (Linnaeus) were found to be attacked by Ichneumonidae parasitoids (Fig. 1E, F), *Parapanteles eros* Gupta (Fig. 1G), *Distatrix papilionis* (Viereck) (Fig. 1H) and *Cotesia* nr. *effrenus* (Fig. 1I), respectively. The pupae of butterfly species *E. core core* and *Danaus chrysippus* (Linnaeus) were parasitized by *Philomacroploea* sp. (Fig. 1J, K), while *Papilio agenor polymnestor* Cramer, and *Belenois aurota* (Fabricius) were recorded as being parasitized by *Pteromalus puparum* (Linnaeus) (Fig. 1L), and *Brachymeria* nr. *minuta* (Fig. 1M), respectively. Only one butterfly, *Catopsilia pomona* (Fabricius) pupa, was found to be parasitized by a Tachinid fly (Fig. 1N).

Overall, regarding the parasitoid population, it was observed that three individuals of *Ooencyrtus* sp. emerged from the eggs of *E. thrax* through three different holes, while only one wasp of *Telenomus* sp. emerged from the egg of *P. polytes polytes*. The highest number of wasp cocoons (72), of *D. papilionis* was recorded from the fifth instar of *P. demoleus*, which were previously attached to its body in the form of cocoons. A single individual of indeterminate Ichneumonidae was observed emerging by making a hole in the head of the *E. core core* larva, and one individual of *Cotesia* nr. *effrenus* was recorded emerging from the dorsolateral side of the abdominal end of the *E. hecabe* larva. In the laboratory, 63 wasps of *Philomacroploea* sp. were observed emerging from a single hole in the pupa of *E. core*, while 55 wasps of the same species were reared from the pupa of *D. chrysippus*. One individual of *B. nr. minuta* was reared from the pupa of *B. aurota*, and a single dipteran parasitoid, a tachinid fly species, was found in the form of a maggot in the pupa of *C. pomona pomona*, and it transformed into a pupa the next day. Among all the recorded parasitoid families, Braconidae was the most dominant,



attacking the larval and pupal stages of five butterfly species. The members of families Encyrtidae and Scelionidae parasitized the egg stage, while Ichneumonidae species parasitized only the larvae. Both, Pteromalidae and Chalcididae species were pupal parasitoids (Table 1).

In relation to the parasitic link between parasitoids and butterfly families (Graph 1), it was observed that the family Papilionidae is parasitized by species from four parasitoid families: Scelionidae (2 species), Encyrtidae (1 species), Braconidae (1 species), and Pteromalidae (1 species). Additionally, one species each from Encyrtidae and Braconidae was recorded as a parasitoid for the families Hesperidae and Lycaenidae, respectively. Among the remaining families, two species each from Ichneumonidae and Braconidae were recorded parasitizing Nymphalidae, while one species each from Braconidae, Chalcididae, and Tachinidae

(Diptera) was recorded parasitizing Pieridae. It was found that species of Braconidae parasitize various life stages of butterfly families other than Hesperidae (Table 1).

Considering the studies on Lepidoptera and their parasitoids, mainly the lepidoptera pests found on crops and their associated parasitoids have been studied. For example, Mahavar *et al.* (2017) studied the larval parasitoid *Compoletes chloridae* of *Helicoverpa armigera*, Bhosale (2020) studied the larval parasitoid *Diadegma argenteopilosa* of *Spodoptera litura*, and Sharmitha *et al.* (2020) studied the egg parasitoid of *Scirpophaga incertulus* in the rice ecosystem. Many such references can be given, which are mainly based on parasitoids of crop pests. However, the references on parasitoids of butterflies are relatively few. The current study highlights the significance of parasitoids in controlling butterfly populations.

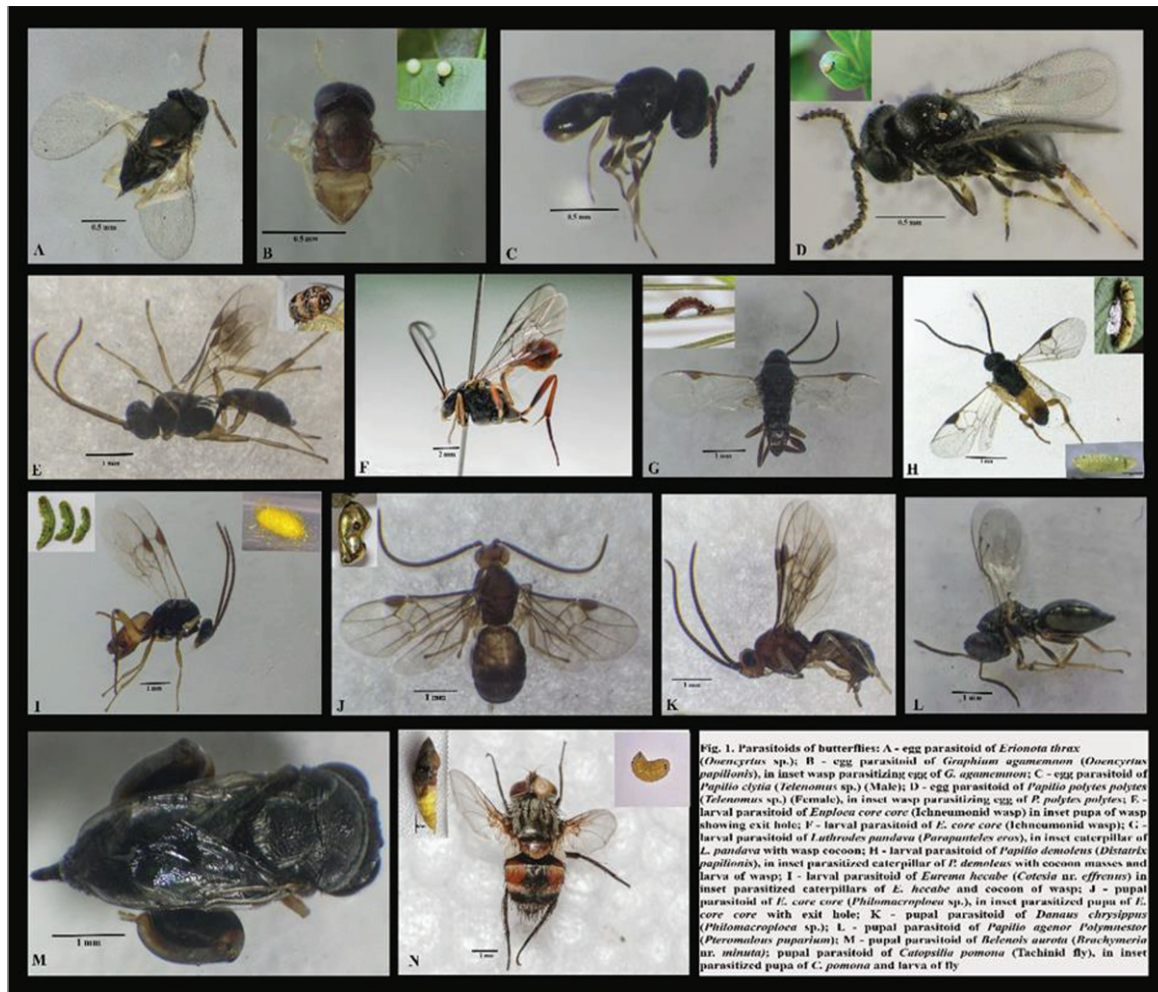


Fig. 1 A) *Ooencyrtus* sp.; B) *Ooencyrtus papilionis* Ashmead; C) *Telenomus* sp.; D) *Telenomus* sp.; E, F) Ichneumonidae parasitoids; G), *Parapanteles eros* Gupta; H) *Distatrix papilionis* (Viereck); I) *Cotesia* nr. *effrenus*; J, K) *Philomacroploea* sp.; L) *Pteromalus puparum* (Linnaeus); M) *Brachymeria* nr. *minuta*; N) Tachinid fly

Butterflies are subjected to severe biotic pressure from a variety of natural enemies throughout their life cycle. Our findings are consistent with previous work by Hawkins *et al.* (1997), which showed that mortality due to natural enemies, especially in the egg and larval stages, is often much higher than mortality due to abiotic factors. Hymenopterans (Braconidae, Ichneumonidae, Trichogrammatidae)

and dipterans (Tachinidae) have become highly specialized and efficient natural enemies of butterfly eggs, larvae and pupae. Like the previous study by Stearman *et al.* (2006), the parasitoid assemblage associated with butterflies in the present study was dominated by Hymenoptera and Diptera. Butterfly eggs, larvae, and pupae are frequently parasitized by hymenopteran families such as Braconidae,

Table 1. Parasitoids associated with different life stages of butterflies

Life stage	Host species/ Family	Parasitoid species/ Family	Solitary/ gregarious
Egg	1. <i>Erionota thrax</i> (Linnaeus, 1767) (Hesperiidae)	<i>Ooencyrtus</i> sp. (Encyrtidae)	Gregarious
	2. <i>Graphium agamemnon</i> (Linnaeus, 1758) (Papilionidae)	<i>O. papilionis</i> Ashmead, 1905 (Encyrtidae)	Gregarious
	3. <i>Papilio clytia</i> Linnaeus, 1758 (Papilionidae)	<i>Telenomus</i> sp. (Male) (Scelionidae)	Gregarious
	4. <i>P. polytes polytes</i> Linnaeus, 1758 (Papilionidae)	<i>Telenomus</i> sp. (Female) (Scelionidae)	Gregarious
Larva	5. <i>Euploea core core</i> (Cramer, [1780]) (Nymphalidae)	Indeterminate (Ichneumonidae)	Solitary
	6. <i>E. c. core</i> (Cramer, [1780]) (3 rd instar) (Nymphalidae)	Unidentified Ichneumonid wasp	Solitary
	7. <i>Luthrodes pandava</i> (Horsfield, [1829]) (5 th instar) (Lycaenidae)	<i>Parapanteles eros</i> Gupta, 2014 (Braconidae)	Solitary
	8. <i>P. demoleus</i> Linnaeus, 1758 (5 th instar) (Papilionidae)	<i>Distatrix papilionis</i> (Viereck) (Braconidae)	Gregarious
	9. <i>Eurema hecabe</i> (Linnaeus, 1758) (Pieridae)	<i>Cotesia</i> nr. <i>effrenus</i> (Braconidae)	Solitary
Pupa	10. <i>E. core core</i> (Cramer, [1780]) (Nymphalidae)	<i>Philomacroploea</i> sp. (Braconidae)	Gregarious
	11. <i>Danaus chrysippus</i> (Linnaeus, 1758) (Nymphalidae)	<i>Philomacroploea</i> sp. (Braconidae)	Gregarious
	12. <i>P. agenor polymnestor</i> Cramer, 1775 (Papilionidae)	<i>Pteromalus puparum</i> (Linnaeus, 1758) (Pteromalidae)	Gregarious
	13. <i>Catopsilia pomona</i> (Fabricius, 1775) (Pieridae)	Tachinid Fly (Tachinidae)	Solitary
	14. <i>Belenois aurota</i> (Fabricius, 1793) (Pieridae)	<i>Brachymeria</i> nr. <i>minuta</i> (Chalcididae)	Gregarious

Ichneumonidae, Chalcididae, and Trichogrammatidae, whereas dipteran parasitoids are primarily represented by Tachinidae, that attack larval and pupal stages (Scoble, 1995; Feener and Brown, 1997). Gupta *et al.* (2016) reported six species of wasps belonging to three families, viz. Braconidae, Chalcididae and Ichneumonidae parasitic on various life stages of seven butterfly species of three families: Hesperiidae, Lycaenidae and Papilionidae. In the present study, as mentioned by Scoble (1995), Feener and Brown (1997) and Gupta *et al.* (2016), members of the families

Braconidae, Ichneumonidae, and Chalcididae were found to parasitize the larvae and pupae of butterflies. Verza *et al.* (2024) recorded the first case of gregarious parasitism by *Brachymeria pandora* (Crawford, 1914) in the pupae of *Danaus eryppus* (Cramer, 1775). Patil and Gaikwad (2024) have also newly reported *Brachymeria euploae* (Westwood), a chalcid wasp, as a pupal parasitoid of the butterfly *Acarea terpsicore* (Linnaeus). Simoneli *et al.* (2025) reported that the Chalcididae pupal parasitoids, the undescribed gregarious *Conura* (*pygmaea* group) and *Brachymeria*

mnestor (Walker), are parasites of the butterflies *Dione vanilla* (Linnaeus) (Nymphalidae) and the *Melete lycimnia flippantha* (Fabricius) (Pieridae), respectively, and their parasitization rate is high. However, in the present study, instead of Trichogrammatidae, members of Encyrtidae and Scelionidae were recorded as egg parasitoids. Additionally, along with Tachinidae and Braconidae, members of Pteromalidae were also found to be parasitizing the pupa of a butterfly.

According to Gupta and Mandal (2019), *D. papilionis* is a gregarious endoparasitoid of *P. demoleus*, and 21-34 wasp cocoons are associated per caterpillar. Similarly, in the present study, the gregarious larval parasitoid *D. papilionis* was found to be associated with the fifth instar caterpillar of *P. demoleus*, with a record of 72 wasp cocoons. Moreover, another gregarious pupal parasitoid, *Philomacroploea* sp., is reported in association with the pupa of *E. core*, with an emerged individual number of 63.

Parasitic insects show a clear preference for specific stages of the butterfly's life cycle. Godfray (1994) states that, particularly, families Trichogrammatidae and Scelionidae often prevents the host's development at an early stage. Similarly, in the present study, a member of the Scelionidae family was found to parasitize the eggs of *P. polytes polytes* but not Tichogrammatidae. Polaszek *et al.* (2024) reported that the Scelionidae parasitic wasp *Telenomus niszwensis* Polaszek, is responsible for high levels of egg mortality in the pomegranate butterfly *Deodorix* (= *Virachola*) *livia* Klug. We have also found two species of genus *Telenomus* of the Scelionidae, parasitizing on the eggs of butterflies, *P. clytia* and *P. polytes polytes*. The parasitism on larvae was the most frequently recorded category, as they are more exposed with longer lifespan and are nutritionally more suitable for the development of parasites (Shaw, 1988). The present findings is in consistent with Shaw (1988), such as members of the Ichneumonidae and Braconidae families parasitizing the larvae of a total of five butterfly species. According to Hawkins (1994), pupal parasitoids, although less diverse,

make a significant contribution to controlling host populations. Feener and Brown (1997) reported that tachnid parasitoids (Diptera), play a significant role in regulating lepidopteran host populations. However, current studies showed that parasitoids from the three families Braconidae and Pteromalidae (Hymenoptera), and Tachinidae (Diptera) attack and control butterfly pupae. Overall, the present study indicated that parasitoids are a crucial part of butterfly natural enemy complexes, displaying a variety of host exploitation tactics and considerable potential for population regulation. Improved knowledge of these relationships will certainly benefit lepidopteran and parasitoid ecology.

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REFERENCES

- Bhosale A.M. (2020) Parasitism potential of *Diadegma argenteopilosa* (Cameron) (Hymenoptera, Ichneumonidae), an internal larval parasitoid of *Spodoptera litura* (Fab.) (Noctuidae, Lepidoptera). ENTOMON 45(2): 123–128. doi: 10.33307/entomon.v45i2.520.
- Boucek Z. and Rasplus J. (1991) Illustrated key to West-Palearctic genera of Pteromalidae (Hymenoptera: Chalcidoidea). Institut National de la Recherche Agronomique (INRA), Paris. 140pp.
- Chen H.Y., Lahey Z., Talamas E., Valerio A., Popovici O., Musetti L., Klompen H., Polaszek A., Masner L., Austin A.D. and Johnson N.F. (2021) An integrated phylogenetic reassessment of the parasitoid superfamily Platygastroidea (Hymenoptera: Proctotrupomorpha) results in a revised familial classification. Systematic

- Entomology 46: 1088–1113. doi: 10.1111/syen.12511.
- Ehrlich P. R. and Raven P.H. (1964) Butterflies and plants: A study in coevolution. *Evolution*, 18: 586–608. doi: 10.2307/2406212.
- Feener D.H.Jr and Brown B.V. (1997) Diptera as parasitoids. *Annual Review of Entomology* 42: 73–97. doi: 10.1146/annurev.ento.42.1.73.
- Godfray H.C.J. (1994) *Parasitoids: Behavioral and Evolutionary Ecology*. Princeton University Press, Princeton. 473pp.
- Gupta A., Gawas S.M. and Bhambure R. (2015) On the parasitoid complex of butterflies with descriptions of two new species of parasitic wasps (Hymenoptera: Eulophidae) from Goa, India. *Systematic parasitology* 92: 223–240. doi: 10.1007/s11230-015-9596-6.
- Gupta A. and Mandal M. (2019) Host range expansion of *Distatrix papilionis* (Viereck) (Hymenoptera: Braconidae), a gregarious endoparasitoid of lepidopterous pests, in India. *Journal of Entomology and Zoology Studies* 7: 1058–1059.
- Gupta A., Saji K. and Manoj P. (2016) Parasitoids of Butterflies: Reassignment of *Dolichogenidea hasorae* (Wilkinson, 1928) as a New Combination along with new host-parasitoid linkages and notes on host specificity from Kerala, India. *Journal of Biological Control* 30: 61–67. doi: 10.18311/jbc/30/2/14917.
- Hawkins B.A., Cornell H.V. and Hochberg M.E. (1997) Predators, parasitoids, and pathogens as mortality agents in phytophagous insect populations. *Ecology* 78: 2145–2152.
- Hawkins B.A. (1994) *Pattern and Process in Host-Parasitoid Interactions*. Cambridge University Press, New York. 190pp.
- Mahavar M.K., Chanu N.Y., Nagar R. and Swaminathan R. (2017) Comparative parasitisation of *Helicoverpa armigera* by *Campoletis chloridae* on chickpea varieties. *ENTOMON* 42(2): 95–104.
- Narendran T.C. and Van Achterberg C. (2016) Revision of the family Chalcididae (Hymenoptera, Chalcidoidea) from Vietnam, with the description of 13 new species. *ZooKeys* 576: 1–202. doi: 10.3897/zookeys.576.8177.
- Oktaviani, Maryana N. and Pudjianto. (2021) Biology and life tables of *Telenomus remus* (Hymenoptera: Scelionidae) as parasitoid of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae). *IOP Conference Series: Earth and Environmental Science*, 948: 012041. doi: 10.1088/1755-1315/948/1/012041.
- Patil A.N. and Gaikwad S.M. (2024) First Record of Parasitoid *Brachymeria euploae* Westwood on *Acareia terpsicore* L. *Indian Journal of Entomology* 86(4): 1331–1333. doi: 10.55446/IJE.2023.1108.
- Polaszek A., Al-Riyami A., Lahey Z., AlKhatri S.A., Al-Shidi R.H. and Hardy I.C.W. (2021) *Telenomus nizwaensis* (Hymenoptera: Scelionidae), an important egg parasitoid of the pomegranate butterfly *Deudorix livia* Klug (Lepidoptera: Lycaenidae) in Oman. *PLoS ONE* 16(5): e0250464. doi: 10.1371/journal.pone.0250464.
- Rousse P. and Gupta A. (2013) Microgastrinae (Hymenoptera: Braconidae) of Reunion Island: A catalogue of the local species, including 18 new taxa and a key to species. *Zootaxa* 3616: 501–547. doi: 10.11646/zootaxa.3616.6.1.
- Rousse P. and Villemant C. (2012) Ichneumonids in Reunion Island: A catalogue of the local Ichneumonidae (Hymenoptera) species, including 15 new taxa and a key to species. *Zootaxa* 3278: 1–57. doi: 10.11646/zootaxa.3278.1.1.
- Scoble M.J. (1995) *The Lepidoptera: Form, Function and Diversity*. Natural History Museum, London. 404pp.
- Sharmitha T., Justin C.G.L., Roseleen S.S.J. and Yasodha P. (2020) Natural parasitism of eggs of *Scirpophaga incertulas* (Lepidoptera, Crambidae) in rice ecosystem. *ENTOMON* 45(3): 181–188. doi: 10.33307/entomon.v45i3.549.
- Shaw M.R. (1988) Parasitoid communities of butterfly larvae. *Biological Journal of the Linnean Society* 35: 239–252.
- Simoneli B.C., Araújo B.C.de, Mol P.B. and Tavares M.T. (2025) Parasitoidism efficiency of two species of Chalcididae (Hymenoptera) attacking Lepidoptera in urban areas of Brazil. *Revista Chilena de Entomología* 51(3): 487–501. <https://www.biotaxa.org/rce/article/view/87745>.
- Stireman J.O.III., O'Hara J.E. and Wood D.M. (2006) Tachinidae: evolution, behavior, and ecology. *Annual Review of Entomology* 51: 525–555. doi: 10.1146/annurev.ento.51.110104.151133.

- Verza W., Tavares M.T. and Eriksson A. (2024) First record of parasitoidism in *Danaus erippus* (Cramer, 1775) pupae (Lepidoptera, Nymphalidae): A possible mediation by an exotic plant species. Entomological Communications 6: ec06021. doi: 10.37486/2675-1305.ec06021.

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