Entomon 43(1): 33-44 (2018)
Article No. ent. 43105

A comparison of sweep net, yellow pan trap and malaise trap for sampling parasitic Hymenoptera in a backyard habitat in Kerala

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ABSTRACT: The trapping efficiency of three main parasitic hymenopteran sampling gadgets, the sweep net (SN), yellow pan traps (YPT) and malaise trap (MT) was assessed in two periods-December 2013 to May 2014 and from December 2014 to May 2015. The collections were made once a month and the traps were standardized as follows-SN-100 sweeps were taken from each site, YPT- 25 traps were set in each site for a period of 24 hours and one MT was employed at each site for a period of 1 week. SN and YPT were found to be suitable for quantitative estimation of parasitoids whereas MT was more suitable for qualitative estimates. Even though each trap seemed to indicate significant collection rate for certain genera, for a comprehensive collection, a combination of the three traps are recommended. Further comparison of traps in a combination of several types of habitats is advisable for an all-encompassing assessment. © 2018 Association for Advancement of Entomology

KEYWORDS: Sweep net, yellow pan trap, malaise trap, parasitic Hymenoptera

INTRODUCTION

The parasitic Hymenoptera are one of the most species rich and abundant components of terrestrial ecosystems and are estimated to comprise up to 20% of all insect species (LaSalle and Gauld, 1991). Despite this, they are a poorly studied group owing to their small size and available taxonomic expertise being limited. Increased efforts towards their study should be an integral component of future research programmes with the aim of assessing and conserving the world's biodiversity (LaSalle and Gauld, 1991). A major portion of the studies on parasitic Hymenoptera focuses on its taxonomy. Many new species are emerging in many of the families of parasitic Hymenoptera from around the world which clearly points to the fact that a lot of its diversity is still awaiting discovery. The common methods to collect parasitic Hymenoptera include sweep net, malaise trap, yellow pan trap (Narendran, 2001) and occasionally pit fall traps, flight intercept traps, beating tray and vacuum samplers (Shweta and Rajmohana, 2016). This study assessed the trapping efficiency of parasitic Hymenoptera identified upto genera from a backyard with mixed vegetation consisting of coconut trees, teak trees, a couple of mango trees and shrubs such as *Tridax procumbens*, *Mimosa pudica*, *Wedelia trilobata etc* in Kozhikode district, Kerala.

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When selecting an appropriate sampling method, one should closely consider the design of the respective sampling tools and their costs, as well as the ecological traits and habitat conditions of the target taxa (Gullan and Cranston, 2010). Sweep net (SN) is considered to be a simple and cost-effective method to collect parasitic Hymenoptera from vegetation (Narendran, 2001; Yi *et al.*, 2012). It is useful when comparing the species abundance and richness of small, vegetation-dwelling arthropods between different areas with similar vegetation types (Evans *et al.*, 1983; Siemann *et al.*, 1997). Yi *et al.* (2012) reported that it is a time-consuming method which is most suitable for open habitat types and is carried out at day time as it requires a good vision, thus causing some limitation to its wider applicability, e.g. for catching nocturnal taxa (Bartholomew and Prowell, 2005; Roulston *et al.*, 2007).

Yellow pan traps (YPT) work on the principle of yellow color being attractive to insects (Kennedy *et al.*, 1961; Hollingsworth *et al.*, 1970). The traps are filled three-fourth with a mild detergent solution to break the surface tension. Many insects get attracted to the yellow color and get collected in the soap solution. The contents are then filtered the same day and the parasitic hymenopterans are preserved in 70% ethyl alcohol.

Malaise traps (MT) make use of the negatively geotactic and positively phototactic behaviour of flying insects (Narendran, 2001). The insects in flight get intercepted by chance and move towards a collecting jar often filled with a killing agent (Campos *et al.*, 2000; Yi *et al.*, 2012). It is a passive method, as the trap is kept at fixed place and is expensive compared to SN and YPT.

The choice of appropriate approaches to collect different groups of insects has been in contention for much time. Noyes (1989) observed that even though sweep net was the most effective single method for sampling Hymenoptera, malaise trap was very effective in forest edges and yellow pan trap was effective in habitats with increased visibility of the traps. Idris *et al.* (2001) studied the effectiveness of malaise traps, yellow pan traps, flight-interception traps and sweep nets in sampling Ichneumonoidea in Malaysia and suggested to use all suitable sampling methods in order to get better collections. Wells and Decker (2006) compared yellow pan traps, malaise traps and flight interception traps to capture Hymenoptera on the island of Dominica and found yellow pan traps to be most effective followed by malaise traps and least by flight interception traps. Mazon and Bordera (2008) estimated the effectiveness of yellow pan traps and malaise traps to collect Ichneumonidae in a national park in Spain, and reported that since the relative abundance of the most common species differed in both the traps, a combination of both traps was ideal. Yi *et al.* (2012) provided a detailed review of sampling methods commonly used to collect insects along with their advantages and disadvantages. In a recent assessment of malaise traps over yellow pan traps to collect Velvet ants, Vieira *et al.* (2017) found the former to be more effective than the latter, even though yellow pan trap succeeded in collecting a few species that were rare in MT.

In India, very few works has been conducted in this regard. Pannure and Chandrashekara (2013) compared efficiency of sweep nets and pan traps to sample bee fauna in Karnataka and found sweep nets to capture more bee fauna compared to pan traps. Shweta and Rajmohana (2016) compared sweep net, yellow pan trap and malaise trap to capture Platygastridae in two urban habitats in Kerala concluding that to get a diverse collection of platygastrids, the use of MT was better over SN and YPT. Manoj *et al.* (2017) compared the pitfall trap and malaise trap to capture Platygastridae in forests of Western Ghats and found that malaise traps were ineffective to collect platygastrids in forests compared to pitfall traps. This is the first time in India that the trapping efficiency is being explored, taking into account the entire gamut of parasitic Hymenoptera. It is hoped that this work will pave the way for studies on trapping efficiencies in a wide range of habitats which will address the question whether habitat characteristics influence trapping efficiencies.

MATERIALS AND METHODS

The collections were made from a backyard habitat at Mayanad (11º16’57.42'' N 75º51’02.64''E; elevation 96 MASL; approximate distance from the Arabian sea 12 km; approximate area 1500m^2), Kozhikode district in the south Indian state of Kerala. Sampling was done for 12 months (once every month), from December 2013 to May 2014 andfrom December 2014 to May 2015 (non-monsoon months). The traps were standardized as follows-SN-100 sweeps were taken from each site. One to and fro motion of the SN was considered as one sweep. The SN measured 60 cm with a rounded bottom. The frame was made of aluminium and the sides measured 48 cm X 46 cm X 48 cm. The handle, also made of aluminium, measured up to 4 feet. The sweeps were made in the fore-noon when insect activity was prominent (9.30 am to 11.30 pm). YPT- 25 traps were set in each site, half-filled with water (approximately 20 ml) to which added 2 ml of commercially available detergent. Each rectangular trap measured 2.5cm deep with sides 14 X 8 cm. The spacing between each YPT was standardized to 1m distance. The traps were set for a period of 24 hours (Example: traps set at 10 am on one day were serviced at 10 am the following day). MT- measure approximately 6 feet wide, 3 feet and 6 inches high at one end and 6 feet and 6 inches high at the other end. One MT was employed at each site for a period of 1 week. The specimens were collected in the preservative-70% ethyl alcohol.

The alcohol containing the preserved sweep net, yellow pan trap and malaise trap collections, were transferred in small quantities into a watch glass under the microscope to ensure that even minute parasitoids (especially those belonging to Chalcidoidea) were included. They were then, preliminarily sorted into families, using keys in Narendran (2001), Goulet and Huber (1993), Gullan and Cranson (2010). The classification of Hymenoptera is as per Aguiar *et al.* (2013). The sorted collections were stored in labelled Tarson plastic vials. The taxa involved in the study were identified to their highest taxonomic resolutions possible, with the help of experts present in the home institute as well as from other institutes. The dried specimens were mounted on pointed triangular cards and studied under Olympus SZ 61 and Leica M 205-A stereomicroscopes; at a magnification of 60 to 160X.The specimens studied are deposited at the National Zoological Collection at Zoological Survey of India, Kozhikode.

The Shapiro-Wilk Normality test was applied to the data using R studio (R Core Team, 2016). As the data turned out to be not normal with P-value < 0.05, non-parametric tests were applied. The trap-wise capture rate for the three traps (SN, YPT, MT) was calculated. The mean for the genera was computed. The over-all capture of parasitic Hymenoptera for the traps was tested using Kruskal-Wallis H-test. When significant differences were found, a Mann-Whitney U-test was applied to determine which pairs of methods were different significantly (Weiss, 2007). The Kruskal-Wallis and Mann-Whitney U-test were done using MegaStat Version 10.0 (Orris, 2005).

RESULTS

A total of 1260 individuals belonging to 7 superfamilies, 19 families and 160 genera were studied. Out of the 441 parasitoids collected by SN, the most dominant superfamily was Chalcidoidea (55%) followed by Platygastroidea (23%). The superfamilies Ceraphronoidea, Ichneumonoidea, Cynipoidea and Diaprioidea were less dominant occupying 10%, 9%, 2% and 1% respectively. More than half of the parasitoids collected by SN, belong to superfamily Chalcidoidea, which included several families.

Out of the 446 parasitoids collected by YPT, the most dominant superfamily was Chalcidoidea (39%) followed by Diaprioidea (27%). The superfamilies Platygastroidea, Ceraphronoidea and Ichneumo-noidea occupied 20%, 9% and 5% of the collections respectively. It was observed that even though YPT was not effective in capturing diverse superfamilies, there was more evenness between the collected superfamilies from the YPT collections.

With respect to MT, a total of 373 parasitoids were collected, with the dominant superfamilies being Chalcidoidea (36%) followed by Platygastroidea (28%). The superfamilies Ichneumonoidea, Ceraphronoidea, Diaprioidea, Evanioidea and Cynipoidea occupied 21, 7, 4, 3 and 1% respectively. MT was found most effective in capturing a wide range of parasitoid superfamilies, especially the superfamily Evanioidea, in comparison to SN or YPT. The parasitoids collected belonged to the families Agaonidae, Aphelinidae, Chalcididae, Encyrtidae, Eucharitidae, Eulophidae, Eupelmidae, Eurytomidae, Mymaridae, Pteromalidae, Torymidae, Trichogrammatidae, Braconidae, Ichneumonidae, Ceraphronidae, Diapriidae, Evaniidae, Figitidae and Platygastridae (Fig. 1).

Many of the genera were represented by single individuals, which were not suitable for meaningful statistical comparison. A complete list of the genera collected is appended (Appendix 1).

The average capture rate of the traps was calculated by dividing the number of parasitic wasps collected by one trap with the total number of parasitic wasps collected by all the traps. The average capture rate for YPT and SN was 0.353 and 0.350 respectively (very similar values) and least for MT (0.296). Kruskal-Wallis H-test revealed significant differences among the different methods of collection, based on the overall average capture rate for each genus (H = 18.532, df = 2, P-value = 0.001).

Applied Kruskal-Wallis H-test for testing for a significant difference between the capture rate of the traps for the collected genera. The post-hoc Mann Whitney U-test was applied further, for the genera that showed significant Kruskal-Wallis H-test values (Mean number of parasitoids captured per month presented in Table 1 and Appendix 1).

MT appeared to be significantly good at collecting the braconid genus *Neoclarkinella* Rema and Narendran and the platygastrid genus *Ceratobaeus* Ashmead.

YPT had significantly high collection rate for the parasitoids belonging to the diapriid genera *Basalys* Westwood and *Trichopria* Ashmead. MT seemed to be better over SN to collect the genus *Basalys* Westwood. YPT infact appeared to be highly suitable to collect *Basalys* Westwood with a very low P-value (1.02×10^{-5} and mean = 9.25). The mymarid genus *Acmopolynema* Ogloblin and the pteromalid genus *Dipara* Walker were significantly highly collected by YPT. The genera *Anagyrus* Howard (Encyrtidae) and *Aprostocetus* Westwood (Eulophidae) were significantly better collected by SN (Table 1).

DISCUSSION

Different sampling methods are used for collecting different insect taxa, with appropriate sampling techniques being the key for effective monitoring and biodiversity research (Yi *et al.*, 2012). Often, the sampling method to be adopted is greatly influenced by the nature of the habitat in which the study is conducted. A home-garden or backyard is defined as the traditional land use system around a homestead, where several species of plants are grown and maintained by the household members and their products are primarily intended for the family consumption (Thirumarpan and Weeraheva, 2014). The backyard in this study at Mayanad had a heterogeneous plant composition. In a previous study, Shweta and Rajmohana (2016) made a comparison of traps to capture parasitic Hymenoptera belonging to family Platygastrirdae from a backyard and found that MT was suitable to capture a wide range of genera, followed by SN and YPT. But, since the study focussed only on parasitoids belonging to family Platygastridae, the results could not be extended to represent the entire range of parasitic Hymenoptera commonly collected from backyards.

Among the three traps compared, SN and YPT were more efficient for exhaustive quantitative data whereas MT was more efficient for qualitative data in the backyard habitat.

It was interesting to note that in the study by Shweta and Rajmohana (2016) from urban habitats, the genus *Ceratobaeus* Ashmead was best collected using malaise traps, an observation that is supported

Table 1. Kruskal-Wallis and Mann-Whitney tests on the variations in the collection for parasitic Hymenoptera

Sl no	Genus	Mean no. of parasitoids			Trapping method	Mann-Whitney	Kruskal-Wallis	
		SN	YPT	MT		P-value	H	P-value
1	*Neoclarkinella* Rema and Narendran	0	0	0.75	SN/YPT YPT/MT SN/MT	+ **0.0366** **0.0366**	4.557	0.0328
2	*Basalys* Westwood	0	9.25	0.83	SN/YPT YPT/MT SN/MT	**1.02 X 10^{-5}** **0.0002** **0.0363**	26.760	1.55 X 10^{-6}
3	*Trichopria* Ashmead	0.5	1.33	0.25	SN/YPT YPT/MT SN/MT	**0.0227** **0.0070** 0.9390	9.340	0.0094
4	*Anagyrus* Howard	2.42	0.33	0.25	SN/YPT YPT/MT SN/MT	**0.0268** 0.6837 **0.0128**	8.617	0.0135
5	*Aprostocetus* Westwood	2.92	0.33	0.5	SN/YPT YPT/MT SN/MT	**0.0055** 0.4236 **0.02**	10.137	0.0063
6	*Acmopolynema* Ogloblin	0	0.67	0.08	SN/YPT YPT/MT SN/MT	**0.0068** **0.0273** 0.3593	10.876	0.0043
7	*Ceratobaeus* Ashmead	0	0	0.42	SN/YPT YPT/MT SN/MT	+ **0.0156** **0.0156**	6.053	0.0139
8	*Dipara* Walker	0.25	1.92	0	SN/YPT YPT/MT SN/MT	**0.0628** **0.0164** 0.3593	8.345	0.0154

Note: + Statistical interpretation impossible; Significant Mann-Whitney P-value indicated in bold

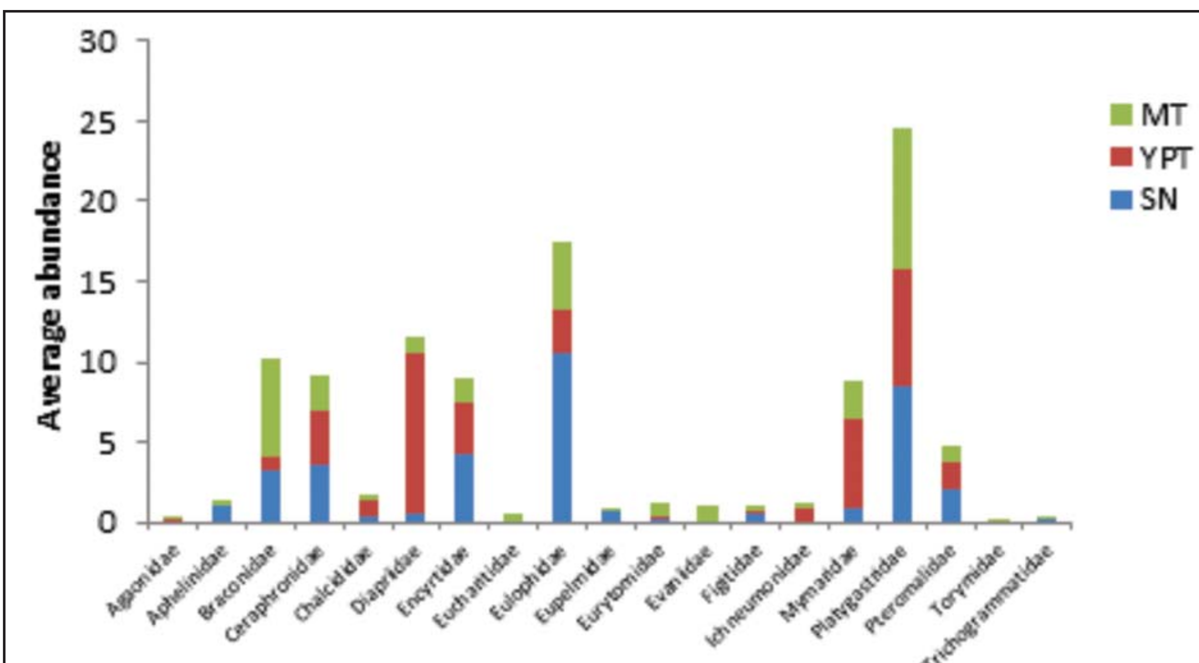

Figure 1. Relative abundance of parasitic hymenopteran families from SN, YPT and MT

by the present study. This shows that despite change in habitat characteristics, some traps tend to be highly efficient to capture certain genera. *Ceratobaeus* Ashmead is an egg parasitoid of spiders, but a more detailed investigation into the bioecology of *Ceratobaeus* Ashmead will be required to successfully explain the reason for the significant ability of MT to capture *Ceratobaeus* Ashmead over SN and YPT.

Compared to MT or SN, YPT was found to be more suitable to collect the diapriid genera- *Basalys* Westwood and *Trichopria* Ashmead. Masner (1976), Jervis and Kidd (1986) and Noyes (1989) mention that yellow pan traps are particularly efficient in sampling Diapriidae. This can be because the dipteran larvae/pupae, on which the diapriids attack are seen in soil. Rajmohana *et al.*(2013) also mentions that *Basalys* Westwood is particularly common in yellow pan trap collections. Even though it was not possible to observe a significant bias in YPT for all the diapriid genera, two of the most abundantly collected genera (*Basalys* and *Trichopria*) were clearly better collected by YPTs.

Noyes (1982) and Rameshkumar *et al.* (2015) states that due to their minute size, only yellow pan traps and malaise traps yield sufficiently good field collections of mymarids. In this study, YPT appeared to capture a sizable number of parasitoids belonging to genus *Acmopolynema* Ogloblin more significantly than MT and SN respectively. Cooper and Whitmore (1990) added that SN is more biased towards heavier and larger sized insects. Since mymarids are very small, they were not very abundant in SN collections. Callahan *et al.* (1966) found that invertebrates may be damaged by sweep-nets during collection and suggested the use of vacuum sampling to sweep-netting. It is possible that the active to-and-fro sweeping nature adopted for employing the sweep net may accidently damage the minute and fragile bodies of mymarids.

The genus *Dipara* Walker was also best collected by YPT over MT and SN. In a previous taxonomic study on species of *Dipara* Walker (Sureshan and Narendran, 2005), the collections were made exclusively from yellow pan traps possibly pointing to the propensity for YPT to collect *Dipara* Walker more than SN or MT. The species of *Dipara gastra* collected as part of this study was a brachypterous form (female) (Sureshan, 2013). We presume a better possibility for brachypterous parasitoids (like *D. gastra*) to easily get attracted to yellow pan traps placed directly on the ground and to gain access into it by crawling. It is possible that the host of this species could also be seen in close association with soil. According to Boucek (1988) and Noyes (2017) larvae of beetles could be its possible host.

The genera *Anagyrus* Howard (Encyrtidae) and *Aprostocetus* Westwood (Eulophidae), were better collected by SN in the present study. The genus *Anagyrus* Howard is almost entirely parasitic on Pseudococcidae (Hemiptera) whereas *Aprostocetus* Westwood has wide host range, and are known to parasitize Diptera (Cecidomyiidae), Hymenoptera, Cynipoidea, Coleoptera, Coccoidea and eriophyid mites. Several species are gall formers (Noyes, 2017). Evans *et al.* (1983) and Siemann *et al.* (1997) mention the effectiveness of SN to compare the species abundance and richness of vegetation dwelling small arthropods. Buffington and Redak (1998) observed that SN is biased towards foliar insects near the tips of vegetation. Overall, the SN seemed to represent an assemblage of hymenopterans that are parasitoids on hosts that are foliage dwelling and tend to be not exclusively soil-inhabiting.

The relative abundance of the parasitoids was different in the trapping methods. Where SN and YPT seem to be very suitable for quantitative estimation, MT was ideal for a wider qualitative estimation. A combination of different methods is highly recommended for a comprehensive sampling of groups like parasitic Hymenoptera where different genera vary in behaviour, ecological niche and their choice of hosts.

ACKNOWLEDGEMENTS

The authors are grateful to Director, ZSI, Kolkata and Officer-in-Charge, ZSI, Kozhikode for support.

Appendix 1. List of the identified genera with their mean (*-12 taxa identified only up to subfamily)

Superfamily	Family	Genus	Mean		
			SN	YPT	M T
Ceraphronoidea	Ceraphronidae	*Aphanogmus* Thomson	2.17	0.92	1.33
Ceraphronoidea	Ceraphronidae	*Ceraphron* Jurine	1.42	2.08	0.92
Ceraphronoidea	Ceraphronidae	*Cyoceraphron* Dessart	0.00	0.33	0.00
Chalcidoidea	Aphelinidae	*Aphelinus* Dalman	0.08	0.00	0.00
Chalcidoidea	Aphelinidae	*Coccophagus* Westwood	0.25	0.00	0.08
Chalcidoidea	Aphelinidae	*Encarsia* Forster	0.58	0.00	0.08
Chalcidoidea	Aphelinidae	*Coccobius* Ratzeburg	0.00	0.08	0.00
Chalcidoidea	Aphelinidae	*Pteroptrix* Westwood	0.08	0.00	0.08
Chalcidoidea	Chalcididae	*Antrocephalus* Kirby	0.08	0.25	0.00
Chalcidoidea	Chalcididae	*Hockeria* Walker	0.17	0.67	0.17
Chalcidoidea	Chalcididae	*Dirhinus* Dalman	0.08	0.00	0.00
Chalcidoidea	Chalcididae	*Neochalcis* Kirby	0.00	0.00	0.17
Chalcidoidea	Encyrtidae	*Anagyrus* Howard	2.42	0.33	0.25
Chalcidoidea	Encyrtidae	*Leptomastix* Forster	0.25	0.08	0.00
Chalcidoidea	Encyrtidae	*Copidosoma* Ratzeburg	0.67	0.83	0.42
Chalcidoidea	Encyrtidae	*Metaphaenodiscus* Mercet	0.08	0.08	0.00
Chalcidoidea	Encyrtidae	*Cheiloneurus* Westwood	0.00	0.00	0.17
Chalcidoidea	Encyrtidae	*Ooencyrtus* Ashmead	0.25	0.25	0.08
Chalcidoidea	Encyrtidae	*Adelencyrtus* Ashmead	0.08	0.00	0.08
Chalcidoidea	Encyrtidae	*Rhopus* Foerster	0.00	0.00	0.17
Chalcidoidea	Encyrtidae	*Anomalicornia* Mercet	0.00	0.08	0.00
Chalcidoidea	Encyrtidae	*Callipteroma* Motschusky	0.17	0.00	0.00
Chalcidoidea	Encyrtidae	*Leptomastidea* Mercet	0.00	0.00	0.08
Chalcidoidea	Encyrtidae	*Adektitopus* Noyes & Hayat	0.00	0.33	0.00
Chalcidoidea	Encyrtidae	*Neodusmetia* Kerrich	0.00	0.75	0.08
Chalcidoidea	Encyrtidae	*Metaphycus* Mercet	0.00	0.89	0.00
Chalcidoidea	Encyrtidae	*Paraclausenia* Hayat	0.08	0.00	0.00
Chalcidoidea	Encyrtidae	*Acerophagus* Smith	0.00	0.00	0.08
Chalcidoidea	Encyrtidae	*Aenasius* Walker	0.08	0.08	0.00
Chalcidoidea	Encyrtidae	*Trechnites* Thomson	0.00	0.08	0.00
Chalcidoidea	Encyrtidae	*Blepyrus* Howard	0.08	0.00	0.00
Chalcidoidea	Encyrtidae	*Proleurocerus* Silvestri	0.08	0.00	0.08
Chalcidoidea	Eucharitidae	*Schizaspidia* Westwood	0.08	0.00	0.08
Chalcidoidea	Eucharitidae	*Neolosbanus* Heraty	0.00	0.00	0.33
Chalcidoidea	Eulophidae	*Aceratoneuromyia* Girault	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Anaprostocetus* Graham	0.75	0.00	0.00
Chalcidoidea	Eulophidae	*Aprostocetus* Wstwood	2.92	0.33	0.50
Chalcidoidea	Eulophidae	*Dutereulophus* Schulz	0.08	0.00	0.00
Chalcidoidea	Eulophidae	*Elachertus* Spinola	0.33	0.58	0.25
Chalcidoidea	Eulophidae	*Elasmus* Westwood	0.50	0.00	0.58
Chalcidoidea	Eulophidae	*Euplectrus* Westwood	0.67	0.33	0.17
Chalcidoidea	Eulophidae	*Hyssopus* Girault	0.00	0.08	0.08

Superfamily	Family	Genus	Mean		
			SN	YPT	M T
Chalcidoidea	Eulophidae	*Leptocybe* Fisher & LaSalle	0.08	0.00	0.25
Chalcidoidea	Eulophidae	*Nesolynx* Ashmead	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Parahorismenus* Girault	0.00	0.00	0.17
Chalcidoidea	Eulophidae	*Pediobius* Walker	0.08	0.00	0.00
Chalcidoidea	Eulophidae	*Quadrastichus* Girault	0.42	0.00	0.17
Chalcidoidea	Eulophidae	*Sigmophora* Rondani	0.08	0.00	0.00
Chalcidoidea	Eulophidae	*Stenomesius* Westwood	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Sympiesis* Forster	0.29	0.00	0.29
Chalcidoidea	Eulophidae	*Tetrastichus* Haliday	3.75	1.00	0.42
Chalcidoidea	Eulophidae	*Metaplectrus* Ferriere	0.00	0.08	0.17
Chalcidoidea	Eulophidae	*Euplectrophelinus* Girault	0.00	0.00	0.17
Chalcidoidea	Eulophidae	*Trichospilus* Ferriere	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Kostjurixia* Narendran	0.08	0.00	0.00
Chalcidoidea	Eulophidae	*Tamarixia* Mercet	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Mestocharella* Girault	0.08	0.00	0.00
Chalcidoidea	Eulophidae	*Perthiola* Boucek	0.08	0.00	0.00
Chalcidoidea	Eulophidae	*Pleurotroppopsis* Girault	0.08	0.00	0.08
Chalcidoidea	Eulophidae	*Pseudosecodes* Girault & Dodd	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Rhynchentedon* Girault	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Oomyzus* Rondani	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Platyplecrus* Ferriere	0.33	0.00	0.08
Chalcidoidea	Eulophidae	*Aulogymnus* Forster	0.00	0.00	0.08
Chalcidoidea	Eulophidae	*Euplecromorpha* Girault	0.00	0.08	0.08
Chalcidoidea	Eulophidae	*Piekna* Boucek	0.08	0.00	0.00
Chalcidoidea	Eupelmidae	*Anastatus* Motschulsky	0.00	0.00	0.08
Chalcidoidea	Eupelmidae	*Calosota* Curtis	0.08	0.00	0.08
Chalcidoidea	Eupelmidae	*Neanastatus* Girault	0.58	0.00	0.17
Chalcidoidea	Eupelmidae	*Zaischnopsis* Ashmead	0.00	0.00	0.08
Chalcidoidea	Eurytomidae	*Eurytoma* Illiger	0.17	0.17	0.83
Chalcidoidea	Mymaridae	*Anagrus* Haliday	0.00	1.00	0.00
Chalcidoidea	Mymaridae	*Gonatocerus* Nees	0.75	2.17	1.00
Chalcidoidea	Mymaridae	*Camtoptera* Forster	0.00	0.00	0.08
Chalcidoidea	Mymaridae	*Mymar* Curtis	0.08	0.2	0.58
Chalcidoidea	Mymaridae	*Polynema* Haliday	0.00	0.33	0.33
Chalcidoidea	Mymaridae	*Achmopolynema* Oglobin	0.00	0.67	0.08
Chalcidoidea	Mymaridae	*Ooctonus* Haliday	0.00	0.00	0.08
Chalcidoidea	Mymaridae	*Anaphes* Haliday	0.08	0.17	0.17
Chalcidoidea	Mymaridae	*Ptilomymar* Annecke and Doutt	0.00	0.00	0.00
Chalcidoidea	Platygastridae	*Alaptus* Westwood	0.00	0.00	0.08
Chalcidoidea	Pteromalidae	*Dipara* Walker	0.25	1.92	0.00
Chalcidoidea	Pteromalidae	*Dinarmus* Thompson	0.08	0.00	0.00
Chalcidoidea	Pteromalidae	*Systasis* Walker	0.08	0.00	0.00
Chalcidoidea	Pteromalidae	*Spalangia* Latreille	0.08	0.00	0.00

Superfamily	Family	Genus	Mean		
			SN	YPT	M T
Chalcidoidea	Pteromalidae	*Propicroscytus* Szelenyi	0.75	0.08	0.67
Chalcidoidea	Pteromalidae	Eunotinae Ashmead*	0.08	0.00	0.08
Chalcidoidea	Pteromalidae	*Pteromalus* Swederus	0.58	0.00	0.25
Chalcidoidea	Pteromalidae	*Netomocera* Boucek	0.00	0.08	0.00
Chalcidoidea	Trichogrammatidae	*Trichogramma* Westwood	0.17	0.00	0.08
Chalcidoidea	Torymidae	*Podagrion* Spinola	0.00	0.00	0.08
Chalcidoidea	Agaonidae	*Ceratosolen* Mayr	0.00	0.17	0.08
Cynipoidea	Figitidae	*Kleidotoma* Westwood	0.08	0.00	0.08
Cynipoidea	Figitidae	*Leptopilina* Forster	0.42	0.08	0.00
Cynipoidea	Figitidae	*Endecameris* Yoshimoto	0.00	0.00	0.17
Cynipoidea	Figitidae	*Hexacola* Forster	0.08	0.00	0.00
Cynipoidea	Figitidae	*Rhoptomeris* Forster	0.00	0.00	0.08
Cynipoidea	Figitidae	*Micruroides* Yoshimoto	0.00	0.00	0.08
Diaprioidea	Diapriidae	*Basalys* Westwood	0.00	9.25	0.83
Diaprioidea	Diapriidae	*Trichopria* Ashmead	0.50	1.33	0.25
Diaprioidea	Diapriidae	*Entomacis* Forster	0.00	0.08	0.00
Evanioidea	Evanidae	*Parevania* Kieffer	0.08	0.00	0.83
Evanioidea	Evanidae	*Evania* Fabricius	0.00	0.00	0.08
Ichneumonoidea	Braconidae	Alysiinae Leach*	0.00	0.00	0.17
Ichneumonoidea	Braconidae	*Apanteles* Forster	0.33	0.33	0.92
Ichneumonoidea	Braconidae	Opiinae Blanchard*	0.25	0.08	0.33
Ichneumonoidea	Braconidae	*Bracon* Fabricius	0.17	0.08	0.17
Ichneumonoidea	Braconidae	*Orgilonia* van Achterberg	0.00	0.00	0.08
Ichneumonoidea	Braconidae	*Phaenodus* Forster	0.08	0.00	0.50
Ichneumonoidea	Braconidae	*Choeras* Mason	0.08	0.08	0.25
Ichneumonoidea	Braconidae	*Gnamptodon* Haliday	0.42	0.00	0.33
Ichneumonoidea	Braconidae	*Cardiochiles* Nees	0.00	0.08	0.17
Ichneumonoidea	Braconidae	*Parahormius* Nixon	0.00	0.00	0.25
Ichneumonoidea	Braconidae	*Glyptapanteles*Ashmead	0.08	0.00	0.25
Ichneumonoidea	Braconidae	Lysiterminae Tobias*	0.00	0.00	0.08
Ichneumonoidea	Braconidae	*Spathius* Nees	0.33	0.00	0.08
Ichneumonoidea	Braconidae	*Rhaconotus* Ruthe	0.33	0.00	0.00
Ichneumonoidea	Braconidae	Doryctinae Forster*	0.08	0.08	0.25
Ichneumonoidea	Braconidae	*Aspidobracon* van Achterberg	0.33	0.00	0.08
Ichneumonoidea	Braconidae	*Phanerotoma* Wesmael	0.17	0.00	0.08
Ichneumonoidea	Braconidae	*Neoclarkinella* Rema & Narendran	0.00	0.00	0.75
Ichneumonoidea	Braconidae	*Testudobracon* Quicke	0.25	0.00	0.00
Ichneumonoidea	Braconidae	*Diolocogaster* Ashmead	0.00	0.00	0.08
Ichneumonoidea	Braconidae	*Acanthormius* Ashmead	0.17	0.00	0.42
Ichneumonoidea	Braconidae	Rhyssalinae Forster*	0.08	0.08	0.17
Ichneumonoidea	Braconidae	*Canalirogas* van Achterberg & Chen	0.00	0.00	0.17
Ichneumonoidea	Braconidae	Pambolinae Marshall*	0.08	0.00	0.00
Ichneumonoidea	Braconidae	Ophioninae Shuckard*	0.00	0.00	0.08

Superfamily	Family	Genus	Mean		
			SN	YPT	M T
Ichneumonoidea	Braconidae	*Heterospilus* Haliday	0.08	0.00	0.08
Ichneumonoidea	Braconidae	*Adesha* Cameroon	0.00	0.00	0.08
Ichneumonoidea	Braconidae	Euphorinae Forster*	0.00	0.00	0.17
Ichneumonoidea	Braconidae	*Euagathis* Szepligeti	0.00	0.29	0.00
Ichneumonoidea	Ichneumonidae	*Acromia* Townes	0.00	0.08	0.00
Ichneumonoidea	Ichneumonidae	*Lepotobatopsis* Ashmead	0.00	0.08	0.00
Ichneumonoidea	Ichneumonidae	Cryptinae Kirby*	0.08	0.08	0.08
Ichneumonoidea	Ichneumonidae	Orthocentrinae Forster*	0.00	0.08	0.00
Ichneumonoidea	Ichneumonidae	*Isotima* Foerster	0.00	0.33	0.17
Ichneumonoidea	Ichneumonidae	*Menaforia* Seyrig	0.00	0.08	0.00
Ichneumonoidea	Ichneumonidae	*Scenocharops* Uchida	0.00	0.08	0.00
Ichneumonoidea	Ichneumonidae	*Metopius* Panzer	0.00	0.00	0.08
Ichneumonoidea	Ichneumonidae	Ichneumoninae Latreille*	0.00	0.08	0.00
Platygastroidea	Platygastridae	*Baryconus* Forster	0.08	0.00	0.25
Platygastroidea	Platygastridae	*Calliscelio* Ashmead	0.17	0.17	0.25
Platygastroidea	Platygastridae	*Chakra* Rajmohana & Veenakumari	0.17	0.25	0.83
Platygastroidea	Platygastridae	*Ceratobaeus* Ashmead	0.00	0.00	0.42
Platygastroidea	Platygastridae	*Cremastobaeus* Ashmead	0.00	0.00	0.08
Platygastroidea	Platygastridae	*Dicroscelio* Kieffer	0.25	0.08	0.42
Platygastroidea	Platygastridae	*Duta* Nixon	0.25	0.17	0.17
Platygastroidea	Platygastridae	*Encyrtoscelio* Dodd	0.08	0.08	0.00
Platygastroidea	Platygastridae	*Gryon* Haliday	1.25	1.42	0.92
Platygastroidea	Platygastridae	*Idris* Forster	0.42	0.67	0.92
Platygastroidea	Platygastridae	*Leptacis* Forster	0.67	0.25	0.33
Platygastroidea	Platygastridae	*Macroteleia* Westwood	0.17	0.00	0.00
Platygastroidea	Platygastridae	*Narendraniola* Rajmohana	0.00	0.00	0.08
Platygastroidea	Platygastridae	*Microthoron* Masner	0.00	0.00	0.08
Platygastroidea	Platygastridae	*Odontocolus* Kieffer	0.00	0.17	0.50
Platygastroidea	Platygastridae	*Palpoteleia* Forster	0.00	0.00	0.08
Platygastroidea	Platygastridae	*Paratelenomus* Dodd	0.08	0.42	0.17
Platygastroidea	Platygastridae	*Platygaster* Latrielle	0.67	0.08	0.25
Platygastroidea	Platygastridae	*Platyscelio* Kieffer	0.00	0.08	0.00
Platygastroidea	Platygastridae	*Scelio* Latreille	0.67	0.58	0.33
Platygastroidea	Platygastridae	*Synopeas* Forster	1.17	0.58	0.25
Platygastroidea	Platygastridae	*Telenomus* Haliday	2.25	2.00	1.58
Platygastroidea	Platygastridae	*Titta* Mineo O' Connor & Ashe	0.00	0.58	0.00
Platygastroidea	Platygastridae	*Trimorus* Ashmead	0.00	0.08	0.00
Platygastroidea	Platygastridae	*Trissolcus* Ashmead	0.08	0.08	0.00
Platygastroidea	Platygastridae	*Paridris* Kieffer	0.00	0.00	0.17
Platygastroidea	Platygastridae	*Leptoteleia* Forster	0.00	0.17	0.00
Platygastroidea	Platygastridae	*Isolia* Forster	0.08	0.00	0.08
Platygastroidea	Platygastridae	*Allotropa* Forster	0.00	0.00	0.17
Platygastroidea	Platygastridae	*Iphetrachelis* Haliday	0.00	0.00	0.17
Platygastroidea	Platygastridae	*Heptascelio* Forster	0.00	0.00	0.08

The first author thanks Kerala State Council for Science, Technology and Environment for financial assistance.

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(Received 27 September 2017; revised ms accepted 28 January 2018; published 12 March 2018)