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Effectiveness of sweep net, yellow pan trap and malaise trap for sampling parasitic hymenoptera on tidal swamp rice

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ABSTRACT

The presence of the parasitic Hymenoptera plays a vital role in pest management for sustainable agriculture. So, it is crucial to know the parasitoid species that exist in an agroecosystem. Sweep Net, Yellow Pan Trap, and Malaise Trap are often used to study the diversity of Hymenoptera parasitic in agroecosystems. This study aims to see the effectiveness of Sweep Net, Yellow Pan Trap, and Malaise Trap in trapping Parasitic Hymenoptera. The study was carried out at four sub-districts, namely are Batang Tuaka, Keritang, Reteh, and Tembilahan Hulu sub-district. The research was carried out by sampling with the transect line method. Sweep net, Yellow pan trap, and Malaise trap have trapped 5,732 individuals of Parasitic Hymenoptera on tidal swamp rice in Indragiri Hilir Regency. The Parasitic Hymenoptera consists of 10 superfamilies, 30 families, and 320 morphospecies. Malaise traps are the best for trapping parasitic Hymenoptera on tidal swamp rice. Malaise traps have been able to trap up to 62% of morphospecies and 81% of the abundance of individual Parasitic Hymenoptera on tidal swamp rice. Yellow pan traps trap 28% of morphospecies and 15% of the abundance of individual Parasitic Hymenoptera. The sweep net can trap 10% of morphospecies and 4% of the abundance of individual Parasitic Hymenoptera.

Introduction

The use of natural enemies is necessary to support sustainable agriculture. Sustainable agriculture approaches take advantage of natural enemies such as predators, parasitic insects, and pathogens to manage pests in agroecosystems. Parasitic wasps, an extensive evolutionary group of Hymenoptera insects, are well-known as biological control agents for arthropod pests in agricultural ecosystems.

Hymenoptera consists of 2 suborders, 27 superfamilies, 132 families, 8423 extant genera, and 153088 extant species have been described (Aguiar *et al.*, 2013). Then, Hymenoptera has many important roles in ecosystems, namely as a pollinator, bioindicator, predator, and parasitoid (Triplehorn and Johnson, 2004; Anderson *et al.*, 2011).

About 80% of the Hymenoptera group is dominated by parasitoid species (Quicke, 1997; Saputra *et al.*, 2017). For example, some species of the Braconidae Family are used as parasitoids to control various pests in plants (Lv *et al.*, 2011; Tomanović *et al.*, 2013), some species of the Family Ichneumonidae as parasitoids in larvae and pupae of Lepidoptera pests (Mason, 2013; Nelly *et al.*, 2005), some species of Encyrtidae family as a parasitoid pest infestation on the agroecosystem (Smith *et al.*, 1988), several species of the Scelionidae family as parasitoids on rice and oil palm plantations (Maulina *et al.*, 2020; Pebrianti *et al.*, 2016), and several species of the Trichogrammatidae family as a parasitoid to control pests in the agroecosystem (Hidrayani *et al.*, 2013; Sangha *et al.*, 2018). Parasitic Hymenoptera is a natural control agent for insects, mainly in the agroecosystem. So, it is crucial to know the parasitoid species that exist in an agroecosystem.

In the study of parasitic Hymenoptera, there are several trap devices used. The standard methods to collect parasitic Hymenoptera are sweep net, yellow

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pan trap, malaise trap (Narendran, 2001), occasionally using pitfall traps, flight intercept traps, beating trays, and vacuum samplers (Mukundan and Rajmohana, 2016). When selecting an appropriate sampling method, one should carefully consider the design of the respective sampling tools and their costs and the ecological traits and habitat conditions of the target taxa (Gulland and Cranston, 2000).

The best trap tool for collecting various insects has been frequently debated, including for the Hymenoptera parasitoid collection. A sweep net is the most effective trap tool for Hymenoptera sampling, malaise traps are very effective at the edge of the forest, and yellow pan traps are effective in habitats that have high visibility (Noyes, 1989). Sweep net and yellow pan trap were found to be suitable for quantitative estimation of Hymenoptera parasitoids whereas MT was more suitable for qualitative estimates in Kerala. It is recommended to use all appropriate sampling methods to obtain more collections (Idris *et al.*, 2001). The most effective yellow pan traps and followed by malaise traps. Flight interception traps have the lowest trapping effectiveness (Wells and Decker, 2006). The former to be more effective than the latter, even though the yellow pan trap succeeded in collecting a few species that were rare in the malaise trap (Vieira *et al.*, 2017).

This study uses three types of traps most widely used to trap Parasitic Hymenoptera, namely sweep net, yellow pan trap, and malaise trap. There is no report yet on the ability of the parasitic Hymenoptera trapping tool on tidal swamp rice. This research will show the effectiveness of each trapping tool to trap Hymenoptera parasitc on tidal swamp rice.

Materials and Methods

Site and time

This study was conducted in four districts of rice production centers in Indragiri Hilir Regency in January 2018 to December 2019. The districts were Batang Tuaka (0°20'19 "S, 103°2'53" E), Reteh (0°40'04 "S, 103°08 ' 06 "E), Tembilahan Hulu (0°24'05" S, 103°04'06 "E), Keritang (0°42'29" S, 103°0'28 "E). Each research location has an area of ±150 hectares. The insects obtained were then sorted and identified at the Insect Bioecology Laboratory of Andalas University.

Data collection

Data Sampling in each district was carried out three times per planting period, namely before planting, during the vegetative and generative periods. The Hymenoptera collection was carried out in two planting periods at each study location so that the number of samples taken at each study location was six times. At each study site, two transect lines were made in the middle of field with ± 1000 m lengths. The transect line is made along the rice field with a distance between 300 - 400 m transect. Along the transect line, sampling points within ± 100 m are determined so that each transect contains 10 sample plots. So, there are 20 sample plots at each study location. In each sample plot, Hymenoptera trapping was carried out using a sweep net and yellow pan trap. The installation of malaise traps is used one unit per sampling at each study location.

The sweep net is made of gauze, cone-shaped, and the mouth of the net is made of coiled wire (± 30 cm in diameter). The sweep net is used for insect collection in the plant canopy. Insect collection was carried out on each sample plot. The collection is done by swinging the net left and right back and forth for ten double swings while walking forward in the direction of the transect line.

The Yellow Pan Trap is made of a plastic container shaped like a bowl with ± 150 ml of detergent solution. Yellow pan trap is placed in an open place like in a rice field dike to be easily seen by insects. Two yellow pan traps were placed on the ground level 2 pieces in each sample plot. Yellow pan trap is installed for 10 hours, from 08.00-16.00 o'clock

The malaise trap is shaped like a tent, consisting of four vertical nets stretched on the same axis and each forming an angle of 90° to each other. The upper part is covered by a rectangular cloth that is adjusted so that it leads to a collecting tube which is placed at the top of the mast on the main axis. The collecting tube is given a liquid killer in the form of alcohol 96%. The design of the collection tube is made in such a way that insects can enter but not get out of the tube. The installation of malaise traps is based on the direction of the compass, which is facing north or south. Malaise traps are installed one piece per study site in a place that is relatively safe from animal disturbance. Hymenoptera collection using malaise traps is done by setting traps for a week per sampling.

Hymenoptera identification is carried out using a binocular microscope. All insects obtained are separated by order. Hymenoptera insects are identified further up to the level of the family and morphospecies. Hymenoptera identification to family level and functional grouping of Hymenoptera are identified using the book Goulet and Huber (1993) and related articles (Goulet and Huber, 1993). The identification data is tabulated in a pivot table in

Microsoft Excel software to become a database. Data processing and analysis are also calculated using Microsoft Excel.

Results

Sweep net (SN), yellow pan trap (YPT), and malaise trap (MT) have trapped 5,732 individuals of Parasitic Hymenoptera on tidal swamp rice in Indragiri Hilir Regency. The parasitic Hymenoptera consists of 10 superfamilies, 30 families, and 320 morphospecies (Table 1). Table 1 shows the average number of species and the number of individuals trapped parasitic Hymenoptera family in each trap. Sweep net, malaise traps, and yellow pan trap have the ability to trap Parasitic Hymenoptera, but each tool has a different percentage of trapping results. Malaise traps have been able to collect up to 62% of morphospecies and 81% of the abundance of individual Parasitic Hymenoptera on tidal swamp rice. Yellow pan trap trapped 28% of morphospecies and 15% of the abundance of individual Parasitic Hymenoptera. The sweep net caught 10% of morphospecies and 4% of the abundance of individual parasitic Hymenoptera (Figure 1).

Sweep net, yellow pan trap, and malaise trap successfully captured 6, 28, and 48 Family Scelionidae morphospecies. Furthermore, Sweep net, yellow pan trap, and malaise trap succeeded in capturing 9, 19, and 44 morphospecies of Family Ichneumonidae, respectively. From the captured of parasitic Hymenoptera, Family Braconidae has the highest number of morphospecies (54 morphospecies), then followed by Scelionidae (51 morphospecies) and Ichneumonidae (51 morphospecies) (Figure 2).

Family Scelionidae has the highest abundance of individuals (1,596 individuals), followed by Family Braconidae (709 individuals), and Family Diapriidae (677 individuals). Sweep net, Yellow pan trap, and Malaise trap succeeded in capturing 23, 255, and 1,318 Family Scelionidae. Sweep net, Yellow pan trap, and Malaise trap managed to capture 72, 81, and 556 Family Braconidae individuals. Furthermore, Sweep net, Yellow pan trap, and Malaise Trap managed to capture 2, 138, and 537 individuals of Family Diapriidae, respectively (Figure 3).

Table 1. List of the parasitic Hymenoptera with their mean in each trap in Indragiri Hilir Regency.

Superfamily	Family	Mean per collect					
		Sweep net		Yellow pan trap		Malaise trap	
		Species	Individual	Species	Individual	Species	Individual
Ceraphronoidea	Ceraphronidae	0.00	0.00	0.67	3.17	1.67	22.83
	Megaspilidae	0.00	0.00	0.00	0.00	0.17	1.00
Chalcidoidea	Aphelinidae	0.00	0.00	0.17	0.17	1.17	4.00
	Chalcididae	1.17	4.33	1.17	3.83	1.67	13.00
	Elasmidae	0.00	0.00	0.17	0.17	0.67	9.83
	Encyrtidae	0.00	0.00	0.67	5.33	1.50	20.83
	Eulophidae	0.67	1.50	1.67	4.83	4.50	80.17
	Eupelmidae	0.00	0.00	0.17	0.17	0.67	3.67
	Eurytomidae	0.00	0.00	0.17	0.33	0.33	1.00
	Leucospidae	0.00	0.00	0.00	0.00	0.17	0.17
	Mymaridae	0.17	0.50	0.50	1.33	1.83	24.50
	Pteromalidae	0.17	0.33	0.83	3.17	2.17	13.83
	Tetracampidae	0.00	0.00	0.17	1.50	0.50	3.50
	Torymidae	0.00	0.00	0.17	0.33	0.17	2.00
	Trichogrammatidae	0.00	0.00	0.33	0.33	0.33	6.00
Chrysidoidea	Bethylidae	0.00	0.00	0.33	2.83	1.17	6.67
	Chrysididae	0.00	0.00	0.00	0.00	0.33	0.50
	Drynidae	0.00	0.00	0.00	0.00	0.17	0.67
	Embolemidae	0.00	0.00	0.00	0.00	0.17	0.50
Cynipoidea	Eucoilidae	0.17	1.00	0.33	3.00	0.67	16.17
	Figitidae	0.00	0.00	0.00	0.00	0.17	1.00
Diaprioidea	Diapriidae	0.33	0.33	2.83	23.00	3.17	89.50
Evanioidea	Evaniidae	0.33	6.00	0.33	17.33	0.33	34.17
Ichneumonoidea	Braconidae	**2.17**	**12.00**	2.67	13.50	**8.17**	92.67
	Ichneumonidae	1.50	7.00	3.17	13.17	7.33	71.17
Mymarommatoidea	Mymarommatidae	0.00	0.00	0.33	0.67	0.33	8.50
Platygastroidea	Platygastridae	0.00	0.00	0.33	1.17	0.83	20.33
	Scelionidae	1.00	3.83	**4.67**	**42.50**	8.00	**219.67**
Vespoidea	Scoliidae	0.00	0.00	0.17	0.17	0.50	5.83
	Tiphiidae	0.00	0.00	0.33	1.33	0.50	1.50

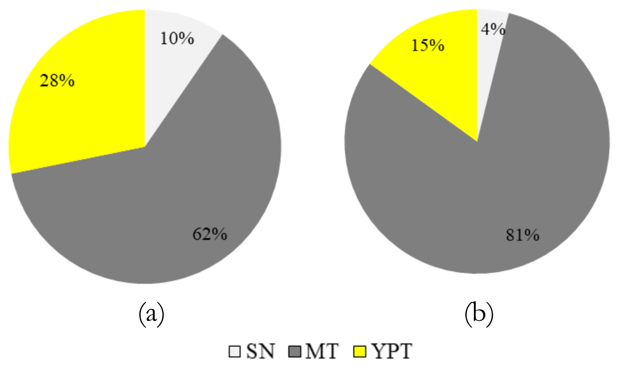

Figure 1. Percentage of Parasitic Hymenoptera in each trap. a) Percentage of morphospecies, b) Percentage of individual abundance.

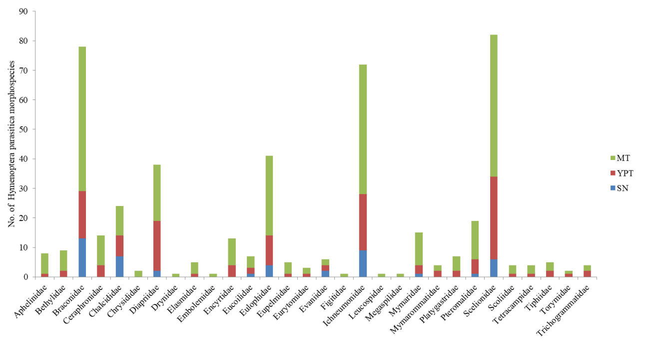

Figure 2. Total of morphospecies of Hymenoptera parasitoid at each trap in Indragiri Hilir District, Riau Province, Indonesia

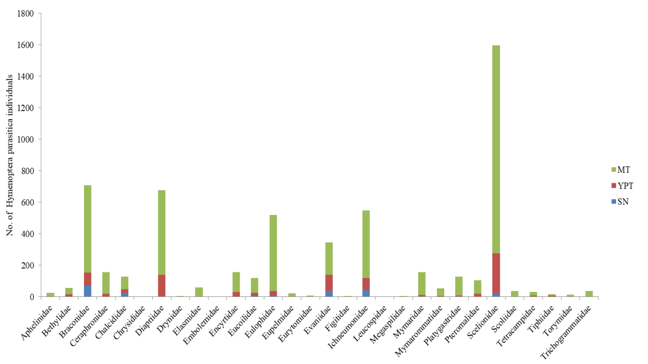

Figure 3. Total of individual of Hymenoptera parasitoid at each trap in Indragiri Hilir District, Riau Province, Indonesia.

Discussion

Out of 5,732 Parasitic Hymenoptera found, Platygastroidea is the most dominant superfamily on tidal swamp rice (30%), then followed by superfamily Chalcidoidea (22%) and Ichneumonoidea (22%). Superfamily Platygastroidea consists of 2 families, namely the Scelionidae Family and the Platygastridae Family. The Scelionidae Family paralyzes the eggs of Orthoptera, Lepidoptera, Diptera, Mantodea, Hemiptera, Neuroptera, and Coleoptera. Platygastridae paralyzes the eggs of Coleoptera, Hemiptera, and Diptera (Gnanakumar *et al.*, 2012; Goulet and Huber, 1993). Species of Platygastroidea are importance in biodiversity assessment studies due to their abundance in different habitats.

From the captured of parasitic Hymenoptera, Family Braconidae has the highest number of morphospecies (54 morphospecies), then followed by Scelionidae (51 morphospecies) and Ichneumonidae (51 morphospecies). Braconidae is an important group of parasitic Hymenoptera in biodiversity studies. It is the second most diverse family of Hymenoptera. They are worldwide in distribution, with about 19,205 species (Aguiar *et al.*, 2013).

Family Scelionidae has the highest abundance of individuals (1,596 individuals), followed by Family Braconidae (709 individuals), and Family Diapriidae (677 individuals). Sweep net, Yellow pan trap, and Malaise trap succeeded in capturing 23, 255, and 1,318 Family Scelionidae. Sweep net, Yellow pan trap, and Malaise trap managed to capture 72, 81, and 556 Family Braconidae individuals. Furthermore, Sweep net, Yellow pan trap, and Malaise Trap managed to capture 2, 138, and 537 individuals of Family Diapriidae, respectively (Figure 3).

Family Scelionidae has a significant potential to be utilized as a biological control on tidal swamp rice. In other research, Family Scelionidae and Braconidae were parasitoid Hymenoptera families with the highest number of individuals on tidal swamp rice in Indragiri Hilir regency. This is because there were abundant food sources from various plants in the agricultural ecosystem, which support their living system (Ikhsan *et al.*, 2020).

Scelionidae is exclusively Parasitic Hymenoptera, with a broad host array, with host-dependent morphological specialization. They show high specificity in host partitioning at a tribal level (Galloway and Austin, 1984). There are 3,308 valid species of Scelionidae (Samin and Asgari, 2012). Even, very many parasitoid species have been found from scelionidae found until now. Eight new xanthic species of Telenominae Thomson, 1860. Six new species of *Phanuromyia* Dodd, 1914, and two new species of *Telenomus* Haliday, 1833 are described from India. The new species are *P. flaviabdominalis* n. sp., *P. levigatus* n. sp., *P. reticulata* n. sp., *P. rufocoxalis* n. sp., *P. shashikalae* n. sp., *P. tamaris* n. sp., *T. ekadanta* n. sp. and *T. elegans* n. sp. (Veenakumari and Prashanth, 2019). The Scelionidae has been successful as a biological control against agricultural pests.

Malaise traps are the best for trapping parasitic Hymenoptera on tidal swamp rice. Malaise trap often used to capture Hymenoptera parasitoid. Malaise traps were also handy in every habitat. In our research, the malaise trap succeeded in trapping 4,651 individual Parasitic Hymenoptera consisting of 296 morphospecies. Family Braconidae had the highest average morphospecies trapping (8.17), and Family Scelionidae had the highest average number of individual trapping (219.67). Malaise trap is a passive trap, as the trap is kept at a fixed place and is more expensive than a sweep net and yellow pan trap. Malaise trap makes use of the negatively geotactic and positively phototactic behavior of flying insects. The insects in flight get intercepted by chance and move towards a collecting jar often filled with a killing agent (Zou *et al*., 2012). The effectiveness of traps to capture insects from six different locations in Brussels and generalized that the Malaise trap was the most effective in capturing various orders of insects (Devigne and Biseau, 2014).

Malaise trap is an extraordinary trap to collect parasitic Hymenoptera. Table 1 shows that malaise trap can trap all the existing species of parasitic Hymenoptera on tidal swamp rice. Therefore, I think Malaise trap is a compulsory trap for parasitoid Hymenoptera diversity research. Besides that, ertain groups of insects that are least attracted to the light (Hymenoptera, etc.), Malaise trap could be very handy for the collection of such insects (Sheikh *et al*., 2016).

In this study, yellow pan trap trapped 860 individual Parasitic Hymenoptera consisting of 134 morphospecies. Family Scelionidae has the highest average morphospecies capture (4.67) and the highest average number of individuals (42.50). Pan traps are generally caught more pollinators than Malaise traps. Because of their low cost and simplicity, using several colors of pan traps is an effective way to sample relative abundance and species richness of flower-visiting insects (Campbell and Hanula, 2007). Yellow pan trap works on the principle of yellow color to be attractive to insects (Darnaedi and Noerdjito, 2007). Compared to 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 (Wells and Decker, 2006). Yellow pan trap is particularly efficient in sampling Family Diapriidae because the dipteran larvae/pupae on which the diapriids attack are seen in the soil. Basalys Westwood is particularly common in yellow pan trap collections (Mukundan and Rajmohana, 2016; Noyes, 1989). Also, yellow pan trap was perfect for some groups, e.g., Proctotrupoidea, Ceraphronoidea, Chalcidoidea, and Aculeata. This may have been related to altitude or the increased visibility of the traps in certain vegetation types (Noyes, 1989).

Yellow pan trap has the effectiveness of trapping species of parasitoid Hymenoptera number two, after the malaise trap. Yellow pan trap use is the right choice to complement the trapping results parasitic Hymenoptera by malaise trap. Sweep net has the lowest effectiveness of parasitic Hymenoptera trapping compared to malaise trap and yellow pan trap. This can be caused by parasitic Hymenoptera is an active fly insect, making it difficult to reach by sweep net.

Table 1 shows the average number of species and the number of individuals trapped parasitic Hymenoptera family in each trap. Thus, the effectiveness of the parasitic Hymenoptera trapping by Sweep net, yellow pan trap, and malaise trap can be compared more easily. It is clear that the difference in effectiveness of parasitic Hymenoptera trapping in the number of species and the number of individuals collected by each trap in tidal swamp rice.

Based on our study on tidal swamp rice, Sweep net managed to trap 221 individual Parasitic Hymenoptera consisting of 46 morphospecies. Family Braconidae had the highest average morphospecies trapping (2.17) and the highest average number of individual trapping (12.00) (Table 1). Sweep net is considered to be the simplest and good method to collect parasitic hymenopterans as well as other groups of insects. A sweep net is a cheap and easy tool to use as an insect collector. This tool is effective for capturing insects that actively fly in the canopy of plants. That it is a time-consuming method that is most suitable for open habitat types and is carried out at day time as it requires a good vision (Zou *et al*., 2012), causing some limitation to its wider applicability, e.g., for catching nocturnal taxa (Roulston and Smith, 2007).

Each trap shows different levels of parasitic Hymenoptera collection. For a comprehensive collection of parasitic Hymenoptera, a combination of these three traps is needed. For an extensive collection, a combination of the three traps is recommended (Mukundan and Rajmohana, 2018).

Sweep net, yellow pan trap, and malaise trap managed to capture 13, 16, and 49 morphospecies of the Family Braconidae. Malaise trap is the trap that traps most species of braconidae. Therefore, there are many observations on Braconidae diversity using malaise trap. One of them, using six malaise trap in different parts of the reserve, A total of 377 wasps were captured, 17 subfamilies, and 56 genera identified. Braconinae, Microgastrinae, Doryctinae, and Rogadinae subfamilies were very abundant, and also the genera Aleiodes, Bracon, Capitonius, Compsobracon, Heterospilus, Hymenochaonia, Opius, Pedinotus, Rogas and Stantonia (Velho *et al*., 2012). Malaise trap also used in the diversity and abundance of braconidae in three highlands of peninsular Malaysia research. A total of 57 individuals of Braconidae were successfully collected, comprising 12 subfamilies and 36 species (Norliyana and Idris, 2011).

Sweep net, yellow pan trap, and malaise trap successfully captured 6, 28, and 48 Family Scelionidae morphospecies. Furthermore, Sweep net, yellow pan trap, and malaise trap succeeded in capturing 9, 19, and 44 morphospecies of Family Ichneumonidae, respectively (Figure 2).

In other research, Ceraphronoidea and Scelionidae are represented better in pan traps (five of eight comparisons) than Malaise trap) Pan traps were an important component of efficient Malaise traps. Especially for Aculeata and microhymenoptera. The coarse mesh was more effective in collecting Aculeata. Coarse and fine mesh were both effective in collecting Ichneumonoidea. The fine mesh was more effective in collecting microhymenoptera. There was an interaction effect between the type of trap used and groups collected, and it was not possible to maximize simultaneously the collection of all groups of Hymenoptera. The use of various mesh types and a trap design that incorporates pan traps were recommended (Darling, 1988).

Conclusions

Sweep net, yellow pan trap, and malaise trap have trapped 5,732 individuals of Parasitic Hymenoptera on tidal swamp rice in Indragiri Hilir Regency. The parasitic Hymenoptera consists of 10 superfamilies, 30 families, and 320 morphospecies.

Malaise traps are the best for trapping parasitic Hymenoptera on tidal swamp rice. Malaise traps have been able to collect up to 62% of morphospecies and 81% of the abundance of individual Parasitic Hymenoptera on tidal swamp rice. Yellow pan trap trapped 28% of morphospecies and 15% of the abundance of individual Parasitic Hymenoptera. The sweep net caught 10% of morphospecies and 4% of the abundance of individual parasitic Hymenoptera.

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References

Aguiar, A.P., A.R. Deans, M.S. Engel, M. Forshage, J.T. Huber, J.T. Jennings, N.F. Johnson, A.S. Lelej, J.T. Longino, V. Lohrmann, I. Mikó, M. Ohl., C. Rasmussen, A. Taeger, D.S.K. Yu. 2013. Order Hymenoptera. Zootaxa, 3703(1): 51-62.

Anderson, A., S. Mccormack, A. Helden, H. Sheridan, A. Kinsella, G. Purvis. 2011. The potential of parasitoid Hymenoptera as bioindicators of arthropod diversity in agricultural grasslands. Journal of Applied Ecology, 48: 382-390.

Borror, D.J., C.A. Triplehorn, N.F. Johnson. 1996. Pengenalan pelajaran serangga (S. Partosoedjono & M. D. Brotowidjoyo (eds.); 6th ed.). Gadjah Mada University Press, Yogyakarta.

Campbell, J.W., J.L. Hanula. 2007. Efficiency of Malaise traps and colored pan traps for collecting flower visiting insects from three forested ecosystems. Journal Insect Conservation, 11: 399-408.

Darling, C. 1988. Effectiveness of Malaise traps in collecting Hymenoptera: The influence of trap design, mesh size, and location. The Canadian Entomologist, 120: 787-796.

Darnaedi, D., W.A. Noerdjito. 2007. Understanding Indonesian natural diversity: insect-collecting methods taught to parataxonomists during DIWPA-IBOY training courses. Proceedings of International Symposium, pp. 245-250.

Devigne, C., J.D. Biseau. 2014. Urban ecology: comparison of the effectiveness of five traps commonly used to study the biodiversity of flying insects. Biodiversity Journal, 5(2): 165-174.

Galloway, I.D., A.D. Austin. 1984. Revision of the Scelioninae (Hymenoptera: Scelionidae) in Australia. Australian Journal of Zoology, 99: 1-138.

Gnanakumar, M., K. Rajmohana, C. Bijoy, D. Balan, R. Nishi. 2012. Diversity of hymenopteran egg parasitoids in organic and conventional paddy ecosystems. Tropical Agricultural Research, 23(4): 300-308.

Goulet, H., J.T. Huber. 1993. Hymenoptera of the world: an identification guide to families, Canada Communication Group, Canada.

Gulland, Cranston. 2000. The insect - an outline of entomology (2nd ed.). Blackwell Science Ltd, Oxford.

Hidrayani, R. Rusli, Y.S. Lubis. 2013. Keanekaragaman spesies parasitoid telur hama Lepidoptera dan Parasitisasinya pada beberapa tanaman di Kabupaten Solok , Sumatera Barat. Jurnal Natur Indonesia, 15(1): 9-14.

Idris, A., N.N. Zaneedarwaty, A.D. Gonzaga, M.I Zaidi, S. Azman, Y. Salmah. 2001. A study on four methods of sampling ichneumonidae and braconidae at two different habitats of Fraser's Hill, Malaysia. Pakistan Journal of Biological Sciences, 4(21): 1515-1517.

Ikhsan, Z., Hidrayani, Yaherwandi, H. Hamid. 2020. The diversity and abundance of Hymenoptera insects on tidal swamp rice field in Indragiri Hilir District, Indonesia. Biodiversitas, 21(3): 1020-1026.

Lv, J., L.T. Wilson, J.M. Beuzelin, W.H. White, T.E. Reagan. 2011. Impact of *Cotesia flavipes* (Hymenoptera: Braconidae) as an augmentative biocontrol agent for the sugarcane borer (Lepidoptera: Crambidae) on rice. Biological Conservation, 56(1): 159-169

Mason, P.G. 2013. Biological control in ontario 1952-2012: a summary of publications in the "journal of the entomological society of ontario." J. Entomological Society of Ontario, 144(1): 27-111.

Maulina, F., N. Nelly, Hidrayani, H. Hamid. 2020. The species of rice bug (*Leptocorisa oratorius* Fabricius) egg parasitoids in rice field in West Sumatra, Indonesia. Journal of Applied Agricultural Science and Technology, 4(1): 76-85.

Mukundan, S., K. Rajmohana. 2016. A Comparison of efficiencies of sweep net, yellow pan trap and malaise trap in sampling platygastridae (Hymenoptera: Insecta). Journal of Experimental Zoology India, 19(1): 393-396.

Mukundan, S., K. Rajmohana. 2018. A comparison of sweep net, yellow pan trap and malaise trap for sampling parasitic Hymenoptera in a backyard habitat in Kerala. Entomon, 43: 33-44.

Narendran, T.C. 2001. Parasitic Hymenoptera and biological control. Palani Paramount Pubilcations, Kerala.

Nelly, N., T. Habazar, R. Syahni, B. Sahari, D. Buchori. 2005. Tanggap fungsional parasitoid *Eriborus argenteopilosus* (Cameron) terhadap *Crocidolomia pavonana* (Fabricius) pada Suhu yang Berbeda. Hayati Journal of Biosciences, 12(1): 17-22.

Norliyana, H.A., A.B. Idris. 2011. A comparison of the diversity and abundance of braconidae (Hymenoptera: Ichneumonoidea) in three highlands of peninsular Malaysia. Malaysian Journal of Science, 30(3): 177-181.
Noyes, J.S. 1989. A study of five methods of sampling Hymenoptera (Insecta) in a tropical rainforest, with special reference to the parasitica. Journal of Natural History, 23(2): 285-298.
Pebrianti, H.D., N. Maryana, I.W. Winasa. 2016. Keanekaragaman parasitoid dan artropoda predator pada pertanaman kelapa sawit dan padi sawah di Cindali, Kabupaten Bogor. J. HPT Tropika, 16(2): 138-146.
Quicke, D.L. 1997. Parasitic Wasps (1st ed.). Springer, Ascot.
Roulston, T.H., S.A. Smith. 2007. A Comparison of pan trap and intensive net sampling techniques for documenting a bee (Hymenoptera: Apiformes) Fauna. Journal of the Kansas Entomological Society, 80(2): 179-181.
Samin, N., S. Asgari. 2012. A Study on the fauna of scelionid wasps (Hymenoptera: Platygastroidea: Scelionidae) in The Isfahan Province, Iran. Archive of Biological Science Belgrade, 64(3): 1073-1077.
Sangha, K.S., P.S. Shera, S. Sharma, R. Kaur. 2018. On-farm impact of egg parasitoid, *Trichogramma* spp. against lepidopteran pests in organic basmati rice. Journal of Biological Control, 32(2): 116-120.
Saputra, H.M., N. Maryana, Pudjianto. 2017. Keanekaragaman hymenoptera parasitika pada tipe ekosistem berbeda di Bangka Tengah, Kepulauan Bangka Belitung. J. HPT Tropika, 17(1): 37-44.
Sheikh, A.H., M. Thomas, R. Bhandari, H. Meshram. 2016. Malaise trap and insect sampling: Mini Review. Bio Bulletin, 2(2): 35-40.
Smith, D., D.F. Papacek, D.A.H. Murray. 1988. The use of *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae) to control *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) in Queensland citrus orchards. Queensland J Agric Animal Sci., 45(2): 157-164.
Tomanović, Ž., P. Starý, N.G Kavallieratos, V. Gagić, M. Plećas, M. Janković, E. Rakhshani, A. Ćetković, A. Petrović. 2013. Aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) in wetland habitats in western Palaearctic: key and associated aphid parasitoid guilds. International Journal of Entomology, 48(1): 189-198.
Veenakumari, K., M. Prashanth. 2019. Eight new species of xanthic Telenominae Thomson, 1860 (Platygastroidea, Scelionidae) from India. Zoosystema, 41(18): 341-358.
Velho, M.D.P., S.D.S. Gadelha, A.M. Penteado-dias, A.D. Almeida. 2012. Diversity of Braconidae (Insecta, Hymenoptera) of the Parque Natural Municipal de Porto Velho, Rondonia, Brazil. Revista Brasileira de Entomologia, 56(4): 468-472.
Vieira, C.R., C. Waichert, K.A. Williams, J.P. Pitts. 2017. Evaluation of Malaise and yellow pan trap performance to assess velvet ant (Hymenoptera: Mutillidae) Diversity in a Neotropical Savanna. Environmental Entomology, 46(2): 353-361.
Wells, W., T. Decker. 2006. A comparison of three types of insect traps for collecting non-Formicidae Hymenoptera on the Island of Dominica. Southwestern Entomologist, 31(1): 59-68.
Zou, Y., W. Sang, J.C. Axmacher. 2012. A Comparison of terrestrial arthropod sampling methods. Journal of Resources and Ecology, 3(2): 174-182.