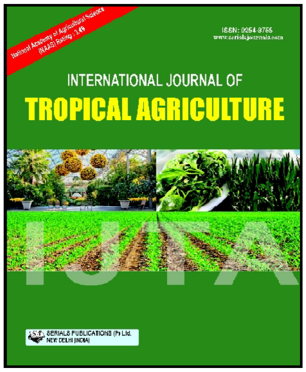

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Collection Methods of Pimplini (Pimplinae: Ichneumonide: Hymenoptera) Parasitoids and their Species Composition in Selected Districts of Tamil Nadu, India

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Abstract: In the present study, a survey was conducted to determine the species composition of Pimplini parasitoids in selected districts of Tamil Nadu state, India using three different methods of collections viz., sweep net, Malaise trap and host rearing. The species composition of Pimplini recorded from different sites and the collection methods were compared. Of the collection methods employed, use of sweep net yielded highest species composition of Pimplini whereas Malaise traps were effective in collecting ichneumonids other than Pimplini. Among the districts surveyed, Cuddalore recorded more Pimplini and other ichneumonids than other eight districts. In the tribe Pimplini, the genera *Xanthopimpla* and Pimpla were recorded from the study area. In the genus *Xanthopimpla*, eight species; *X. flavolineata, X. punctata, X. stemmator, X. exigua, X. konowi, X. tricapus, X. pedator* and *X. nigritarsis* were recorded. *Xanthopimpla flavolineata* was the predominant species while in the genus *Pimpla*, only a single species *P. duplicauda* was recorded.

Key Words: Species composition, Host rearing, Malaise trap, Net sweep, Pimplini Parasitoids.

INTRODUCTION

With over 1, 00,000 described species, the order Hymenoptera is ranked fourth in the Class Insecta. In the order Hymenoptera, the superfamily Ichneumonoidea contains the two largest families, Ichneumonidae and Braconidae (Wahl, 1993). Gauld (1997) divided the family Ichneumonidae into 37 subfamilies, and this number varied greatly over the past few decades according to different authors and is still debated. Among them, Pimplinae is one of the vital subfamilies that include parasitoids of agricultural importance. The Pimplinae is the most biologically diverse and moderately large group with several big, strikingly coloured common parasitoid species (Gauld, 1991). They are diverse, ecologically significant and economically important. It is often numerically the best represented subfamily in general collections of Ichneumonidae (Fitton *et al.,* 1988). The classification of Pimplinae has undergone many changes by different authors and presently the subfamily is divided into four tribes; Ephialtini, Pimplini, Delomeristini and Perithoini (Gauld *et al.,* 2002). All species of Pimplini are generalist parasitoids (rather than specialists) that have more than one species of host. The most primitive pimplines are idiobionts (kill or paralyze their host) of the endopterygote insects. Typically the hosts of these parasitic wasps are concealed within plant tissues (Salt, 1941 and Fitton *et al.,* 1988).

Studies on the biosystematics of these important parasitoids would provide information required for undertaking biological control or integrated pest management programmes. Application of biocontrol agents against insect pests has had a major resurgence in the recent years. Parasitic Hymenoptera including pimplines are among the most important agents for biological control and are abundant in most tropical terrestrial habitats. Numerous instances where outbreaks of a pest have been suppressed by Ichneumonidae suggested the use of these parasitic insects in the management of pests (Narendran, 2001). The species composition of Pimpline ichneumonids was seldom studied. It was done in Costa Rica with Malaise trap collections by Kavin and Gauld (1993). Despite their species composition, taxonomy of the group remain poorly known and their identification is still difficult and debatable (Huber, 1993). This leads to undue delays in documenting the fauna of a locality. Many species may become extinct before they are brought to light. Further, lack of knowledge in the parasitoid fauna, their taxonomy and distributions in particular area will result in bio-control failures. Keeping this in view, the objective of the study was to document the agriculturally important parasitoid species of the tribe, Pimplini in select districts of Tamil Nadu state, India as well as to compare three methods of collection used in the study.

MATERIALS AND METHODS

Study Area

The present survey was carried out for a period of three years in three districts each representing a different habitat, a coastal belt (Cuddalore, Nagapattinam and Villupuram), a central tropical region in Tamil Nadu (Namakkal (Kolli hills 1200 ft above MSL), Karur and Salem (Yercaud hills 4970 ft above MSL) and one each representing rice monocropping (Thanjavur) and multicropping (rice, pulses, flowers, vegetables, *etc.,*) (Coimbatore) practiced districts (Figure 1).

Collection Methods

The Pimplini parasitiod wasps were collected using three methods; net sweeping, Malaise trapping and through host rearing at different sites of the above mentioned districts. The sweep net collected specimens were removed using an aspirator. Sweeping was done in different sites of the entire study area covering 2000 sq km once a week including barren field. Malaise traps made according to Townes (1972) were used. Two Malaise traps each were set up in Cuddalore, Nagapattinam, Namakkal and Salem representing agro and forest ecosystems in Tamil Nadu. Catches were emptied once a week for three years and specimens were diagnosed up to genus/ species level using the keys of Townes and Chiu (1970) and Fitton *et al.* (1988) during the study period.

One of the host insects of Pimplini is the rice pink stem borer, *Sesamia inferens* Walker. Its pupae were collected from rice fields of Annamalai University farm premises of Cuddalore district and held either individually or in clusters in Petri dishes

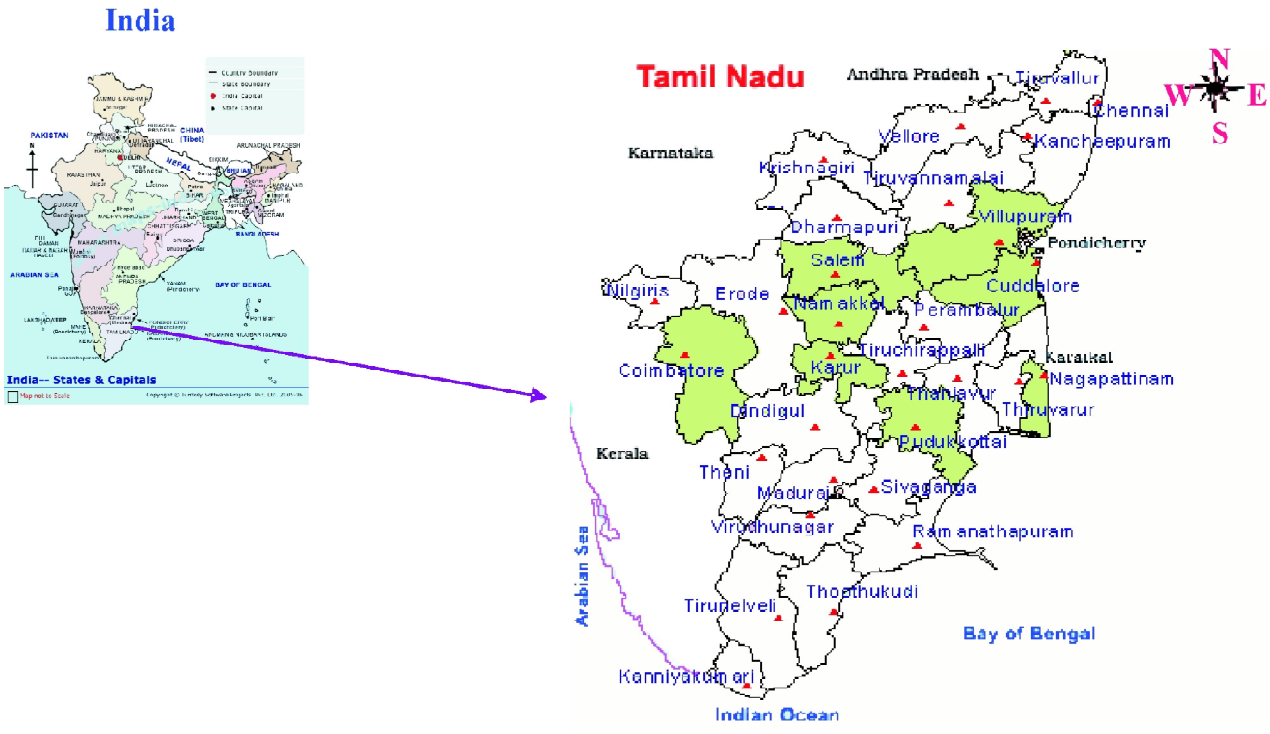

Figure 1: Sampling areas of Pimplini parasitoids in Tamil nadu, India

lined with cotton roll. The pupae were collected during an outbreak of *S. inferens* in Annamalai University farm premises during the *Navarai* rice season (February to April). They were maintained under laboratory conditions at 27±2°C and 65±5% RH) for continuous observations for emergence of Pimplini parasitoids.

RESULTS AND DISCUSSION

Sweep Net Collection

The Pimplini parasitoids collected by sweep netting in the select districts of Tamil Nadu are presented in Table 1. A total of 9,486 other ichneumonids and 3,029 Pimplini parasitoids were collected. Among the Pimplini, the two genera *Xanthopimpla* Saussure and *Pimpla* Fabricius were recorded from the study area. Of them, *Xanthopimpla* was the predominant genus 97.5 % occurring in almost all the habitats that were surveyed in selected districts while the genus *Pimpla* was represented by only 2.5% of Pimplini. In the genus *Xanthopimpla,* eight species were identified. They are *X. flavolineata* Cameron*, X. punctata* Fabricius*, X. stemmator* Thunberg*, X. exigua* Krieger, *X. konowi* Krieger*, X. tricapus* Townes*, X. pedator* Cameron and *X. nigritarsis* Cameron. From the genus *Pimpla*, only a single species *P. duplicauda* Heinrich was identified. From the number collected (1886), it was evident that *X. flavolineata* is the dominant species followed by *X. punctata* (697) and *X. stemmator* (248). *Xanthopimpla pedator* and *X. nigritarsis* were recorded only from Coimbatore district numbering 30 and 54 respectively, whereas *X. konowi* (19)*, X. tricapus* (12) and *X. exigua* (8) were recovered only from Namakkal, Karur and Salem districts respectively. In the genus *Xanthopimpla,* the predominant species *X. flavolineata* was represented by 62.3% of the total Pimplini collected. *Xanthopimpla punctata* was represented by 23.0%**.** The findings are in accordance with those findings of Menakadevi (2006) and Mahendran (2007) who also reported that the predominant and potential species is *X.*

flavolineata. The districts surveyed using sweep net revealed that maximum number of Pimplini in Cuddalore (654) followed by Nagapattinam (472) and Thanjavur (464). Karur district recorded the least number (129) of Pimplini. This is likely due to the multicropping system practiced in the district. Low number of Pimplini and other ichneumonids recorded from Karur, Villupuram, Salem and Namakkal districts may be due to the unavailability of host insects coupled with the dry climate of the districts. Absence of certain groups of Ichneumonidae in the tropics has been explained by the absence of their host groups (Gauld, 1987). The number of specimens representing *X. pedator, X. nigritarsis, X. konowi* and *X. exigua* was low because of their narrow host range and host unavailability in the study area as reported by Townes and Chiu (1970). The number of *P. duplicauda* reported from Cuddalore was 14 and from Namakkal was 59 and two specimens of *Pimpla* from Salem. This may be due to the preference of this parasitoid for forests dense vegetation as reported by Fitton *et al.* (1988).

Malaise Trap Collection

The numbers of Pimplini parasitoids collected from Malaise trap in the four districts of Tamil Nadu are given in Table 1. A total of 1,461 Pimplini and 6,702 other ichneumonids were collected. A total of 615, 332, 292 and 222 of Pimplini were collected from Cuddalore, Namakkal, Nagapattinam and Salem respectively. In the genus *Xanthopimpla*, *X. flavolineata, X. punctata and X. stemmator* were recorded from all the four districts whereas *X. exigua, X. tricapus and X. konowi* were recorded only from Salem, Nagapattinam and Namakkal districts respectively. *Xanthopimpla pedator* and *X. nigritarsis* were not recorded from Malaise trap collections. The genus *Pimpla* was represented by *P. duplicauda* (33) in Cuddalore and Namakkal districts only. Malaise traps were found to be more suitable for the collection of other ichneumonids than Pimplini because the predominant species *X. flavolineata, X. stemmator* and *X. punctata* are mainly associated with agro ecosystems. Hence, Pimplini collection through Malaise traps proved less effective than that of sweeping. Moreover, Malaise trap is suitable for the collection of insects of forest and orchard ecosystems where sweeping is comparatively difficult and labour intensive. Findings of the study in agreement with Bartlett (2000) who compared Malaise trap collections and host rearing. Namakkal and Salem districts recorded higher number of other ichneumonids over other two districts *viz.*, Cuddalore and Nagapattinam. The other two districts recorded maximum numbers of Pimplini. The former districts represented forest habitats and the latter districts represented rice based habitats. Of the two genera collected, *Xanthopimpla* (97.7 %) outnumbered *Pimpla* (Table1). The results are in accordance with the report that Malaise traps are generally considered to be better for collecting ichneumonids in tropical areas (Mathews and Mathews, 1970) in forest ecosystem (Gauld, 1991).

Host Rearing for Parasitoid Collections

The natural parasitism levels of *Xanthopimpla* species on *S. inferens* pupae in rice fields is presented in Table 2. Significantly high (28.9%) emergence was recorded from pupae collected in March followed by May, April, January and February with levels of 21.8, 21.6, 21.4 and 19.1 % respectively. The highest parasitoid emergence was recorded in pupae collected in March. This may be due to the availability of the active tillering and flowering stage of the rice crop when the pre-pupae and pupal stages of *S. inferens* was present in plenty. The population build up of the host is less during the early stages of the crop and it increased during and after tillering and to decline again at the end of the season coinciding with steady increase in temperature upto harvest in May. This is evident from the number of host pupae collected and the emergence of the parasitoids.

Table 1
Pimplini parasitoids collected by net sweeps and Malaise traps from selected districts of Tamilnadu

Districts / *Pimplini*	*Cuddalore **		*Nagapattinam**		*Salem**		*Namakkal**		*Thanjavur**		*Villupuram**		*Coimbatore**		*Karur**		*Cumulative total*	
Methods	*NS*	*MT*	*NS*	*MT*	*NS*	*MT*	*NS*	*MT*	*NS*	*MT*	*NS*	*MT*	*NS*	*MT*	*NS*	*MT*	*NS*	*MT*
X. flavolineata	391	314	303	164	215	156	176	213	280	Not Erected	162	Not Erected	250	Not Erected	109	Not Erected	1886	847
X. stemmator	85	93	61	49	12	30	17	26	40		9		21		3		248	198
X. punctata	164	202	108	64	56	14	77	61	144		97		46		5		697	341
X. pedator	0	0	0	0	0	0	0	0	0		0		30		0		30	0
X. nigritarsis	0	0	0	0	0	0	0	0	0		0		54		0		54	0
X. konowi	0	0	0	0	0	0	19	5	0		0		0		0		19	5
X. exigua	0	0	0	0	8	22	0	0	0		0		0		0		8	22
X. tricapus	0	0	0	15	0	0	0	0	0		0		0		12		12	15
P. duplicauda	14	6	0	0	0	0	59	27	0		0		0		0		73	33
Pimpla sp.	0	0	0	0	2	0	0	0	0		0		0		0		2	0
Total Pimplini	654	615	472	292	293	222	348	332	464		268		401		129		3029	1461
Other ichneumonids	1816	1467	1315	1578	1495	1762	1263	1895	1386		941		961		309		9486	6702
Total	2470	2082	1787	1870	1828	2022	1611	2227	1850		1209		1362		438		12515	8163

NS – Net sweep
* Total number of parasitoids collected in 3 years
* Sweeps made once a week for 3 years
MT – Malaise trap
* Total number of parasitoids collected in 3 years
* Collections emptied and counted once a week for 3 years

Table 2

Natural parasitism by Pimplini Parasitoids on *Sesamia inferens* in rice (Host rearing method)

Month	*Total number of host pupae collected*	*Parasitoid emergence %*						*Pimplini group emerged**	*Other parasitoids emerged**	*Adult S. inferens emerged**	*Host pupae dead**
		X. flavolineata+		*X. stemmator+*		*X. punctata+*					
		♂	♀	♂	♀	♂	♀				
January	149	3.8	11.2	0.7	1.8	1.2	2.7	21.4 (27.56)^{b}	19.2 (25.98)^{b}	48.7 (44.26)^{ab}	10.7 (25.98)^{b}
February	101	4.0	8.4	1.2	2.1	1.5	1.9	19.1 (25.91)^{b}	18.2 (25.25)^{bc}	49.6 (44.77)^{a}	13.1 (21.21)^{c}
March	202	6.2	11.5	2.0	3.5	2.0	3.7	28.9 (32.52)^{a}	17.3 (24.58)^{c}	41.5 (40.11)^{c}	12.3 (25.53)^{cd}
April	283	6.3	10.3	0.3	1.5	0.9	2.3	21.6 (27.69)^{b}	18.7 (25.60)^{bc}	45.5 (42.42)^{b}	15.2 (22.95)^{b}
May	125	5.0	10.0	1.1	1.7	1.2	2.8	21.8 (27.83)^{b}	21.6 (27.69)^{a}	38.5 (38.35)^{c}	18.1 (25.18)^{a}
	SE.d							1.73	0.67	0.92	0.78
	CD (p =0.05)							3.52	1.33	1.98	1.61

* Values in parentheses are arc sine transformed and analyzed using CRD

* Mean values followed by a common letter are not significantly different at 5% level by LSD

+ Percent values worked out from emergence of *Xanthopimpla* species per month collected pupae

With regard to the other groups of parasitoids, 21.6% emergence was found from host pupae collected in May followed by January (19.2%), April (18.7%), February (18.2%) and March (17.3%), while the % emergence of *S. inferens* was found to be high in February (49.6) followed by January (48.7) and April (45.50). The other parasitoids that emerged were mainly, *Brachymeria lasus* and *Tetrastichus* sp. The unemerged host pupae were 18.1 % in May followed by 15.2 in April. Among the Pimplini parasitoids, emergence of *X. flavolineata* was more in all months. The results are in accordance with the findings of Kanagarajan (2008). Wherever, there was no emergence of either the host moth or the parasitoids from pupae, many dead immature stages of parasitoids were found on dissection. This may be due to competition among developing parasitoids (some times belonging to different species). Similar levels of emergence of *X. nana nana* during the peak incidence of its host *Opisina arenosella* in October to December was reported by Pillai and Nair (1983).

Comparison of Collection Methods

Among the methods employed to recover Pimplini parasitoids from Cuddalore district, net sweep was found better than Malaise trap and host rearing. It was easy to make sweeping with net in the crop canopy as well as in adjoining weeds. Generally, the flight activity of Pimplini is associated with crop canopy and also the parasitoids rest on the surface of leaves whereas in Malaise trapping, the parasitoids have to be trapped while on flight. The third method *viz.,* host rearing is laborious, though this would be useful to determine host - parasitoid association. The collection of pupae of host insect *S. inferens* is also laborious as it is hidden within the stem. The findings are in accordance with Mahendran (2007) who adopted similar methods for the collection of ichneumonids. In addition, Bartlett (2000) and Prabhu (2006) also reported that sweep net is practicable and easier and host rearing is an effective method for host specific parasitoids. Malaise trap showed its supremacy in places where sweeps could not be made. Noyes (1989) also compared net sweeping, Malaise trapping and other collection methods and found both the methods are efficient in the collection of Ichneumonidae.

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CONCLUSION

From the study, it is evident that the net sweeping method is more effective than Malaise trapping and host rearing in collecting Pimplini group of parasitoids, while Malaise trapping is better for collecting ichneumonids other than Pimplini. Regarding the species composition of Pimplini parasitoids, Cuddalore yielded more Pimplini because of the habitats representing multiple cropping system.

The tribe Pimplini is represented by two genera *viz.*, X*anthopimpla* and *Pimpla* in the study area, with the genus X*anthopimpla* represented by eight species and the genus *Pimpla* by only one species.

REFERENCES

Bartlett, R. (2000). Efficiency of collection methods and flight activity of Ichneumonidae (Hymenoptera) in three sites in Guanacaste, Costa Rica. M.Sc. Thesis, The University of Georgia, Athens, Georgia.

Fitton, M.G., Shaw, M.R. and Gauld, I.D. (1988). Pimpline – Ichneumon flies. Hymenoptera, Ichneumonidae (Pimplinae). Handbook for the Identification of British Insects. 7 (1), 110 p.

Gauld, I.D. (1987). Some factors affecting the composition of tropical ichneumonid fauna. *Biol. J. Linn. Soc.*, 30: 299-312.

Gauld, I.D. (1991). The Ichneumonidae of Costa Rica, 1. *Mem. Amer. Entomol. Inst.*, 47: 1- 589.

Gauld, I.D. (1997). The Ichneumonidae of Costa Rica, 2. Mem. *Amer. Entomol. Inst.*, 57: 1- 485.

Gauld, I.D., Wahl, D.B. and Broad, G. R. (2002). The suprageneric groups of the Pimplinae (Hymenoptera : Ichneumonidae): a cladistic re-evaluation and evolutionary biological study. *Zool. J. Linn. Soc.*, 136: 421-485.

Huber, J.T. (1993). Introduction to Hymenoptera. pp. 1-3. In: Goulet, H. and Hubner, T.J. (Eds.), Hymenoptera of the World: An Identification Guide to Families. Agriculture Canada Publication, Ottawa, Canada. 595 p.

Kanagarajan, R. (2008). Chalcid fauna of rice ecosystem in the cauvery delta region and their utilization in IPM. Ph.D. Thesis, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India.

Kavin, J. Gaston and Ian D. Gauld. (1993). How many species of Pimplines are there in Costa Rica. *J. Trop. Ecol.,* 9: 491- 499.

Mahendran, M. (2007). Studies on taxonomy of selected Ichneumonidae (Insecta : Hymenoptera). M.Sc. (Ag.) Thesis, Faculty of Agriculture, Annamalai University, Tamil Nadu, India.

Mathews, R.W. and Mathews, J.R. (1970). Malaise trap studies of flying insects in a New York mesic forest. I. Ordinal composition and seasonal abundance. *J. New York Entomol. Soc.,* 78: 52-59.

Menakadevi, C. (2006). Ichneumonid parasitoids of rice insect pests. M.Sc.(Ag.) Thesis, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India.

Narendran, T.C. (2001). Parasitic Hymenoptera and Biological Control. Palani paramount publications, Palani, India, pp.16-20.

Noyes, J.S. (1989). A study of five methods of sampling Hymenoptera (Insecta) in a tropical rain forest with special reference to the Parasitica. *J. Nat. Hist.,* 23: 285-298.

Pillai, G.B. and Nair, R.K. (1983). *Xanthopimpla nana nana* Schulz. (Hymenoptera : Ichneumonidae), a new pupal parasitoid of *Opisina arenosella* Wlk. on coconut. *J. Plant. Crops,* 11 (1): 65-69.

Prabhu, A. (2006). Species abundance, biology and behaviour of hymenopteran parasitoids of rice brown planthopper, *Nilaparvata lugens* (Stal.) Ph. D. Thesis, Faculty of Agriculture, Annamalai University, Annamalainagar.

Salt, G. (1941). The effects of hosts on their insect parasites. *Biol. Rev.,* 16: 96-119.

Townes, H. (1972). A light weight Malaise trap. Entomol. News. 83: 239-247.

Townes, H. and Chiu, S.C. (1970). The Indo-Australian species of *Xanthopimpla* (Ichneumonidae). *Mem. Amer. Entomol. Inst.*. 14: 1-367.

Wahl, D.B. (1993). Family : Ichneumonidae. pp. 433-434. In : Goulet, H. and Huber, T.J. (Eds.). Hymenoptera of the World: An Identification Guide to Families. Centre for Land and Biological Resource Research, Ottawa, Canada. 595 p.