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Diversity of *Platygastroidea* Species in Coffee Ecosystem at Thadiyankudisai, Tamil Nadu

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Abstract

During a one-year study from January, 2018 to January, 2019 at the Horticultural Research Station, Thadiyankudisai, Tamil Nadu, a combined count of 550 individuals of *Platygastroidea* species were documented under two family platygastridae (1 species) and scelionidae (9 species). Among the species diversity comprised of *Telenomus* sp. (52.0%) followed by *Scelio* sp. (11.4%), *Calliscelio* sp. (9.1%), *Sparasion* sp. (6.9%), *Idris* sp. (5.8%) and *Baryconus* sp. (4.0%). The least population was recorded in *Tritelia* sp. (2.2%). Researches on seasonal abundance exposed that the winter season exhibited the highest species population at 32.55%, with the South West Monsoon (SWM) following closely at 30.36%, while the North East Monsoon (NEM) period recorded the lowest species count at 16.54%. The prevalence of insect pests poses a significant challenge to achieving optimal yields in horticultural crops. Consequently, the examination of *Platygastroidea* species diversity assumes a pivotal role in the success of biological control strategies.

Keywords: Coffee, Diversity indices, Platygastroidae, Scelionidae, Seasonal abundance

Introduction

Hymenoptera, acknowledged for their ability to parasitize insects, act as efficient biocontrol agents by managing the population of their hosts in a manner that depends on their density (LaSalle and Gauld, 1993; Shweta and Rajmohana, 2016). Occupying a significant trophic level, they demonstrate sensitivity to the environmental fluctuations (Tscharntke *et al.*, 1998; Siemann, 1998; Shweta and Rajmohana, 2016). The superfamily Platygastroidea, comprising 4 (four) families (McKellar and Engel, 2012) with 166 genera and approximately 2600 species, stands out as one of the most diverse taxa within the Hymenoptera order (Rajmohana *et al.*, 2017). Platygastridae, cited as the solitary family within Platygastroidea, represents the third most extensive superfamily among parasitic Hymenoptera (Austin *et al.*, 2005; Rajmohana *et al.*, 2017), featuring five subfamilies (Platygastrinae, Scelioninae, Sceliotrachelinae, Telenominae and Teleasinae) with the first 3 (three) exclusively acting as egg parasitoids (Austin *et al.*, 2005; Shweta and Rajmohana, 2016).

In spite of the excess food production, insects pose a significant hindrance to achieving elevated yields. Over 100 insect species have been documented as pests in the coffee industry (Le Pelley, 1968; Manikandan *et al.*, 2019). The indiscriminate use of pesticides leads to the depletion of biodiversity among beneficial organisms. Recently, there has been increasing recognition of the importance of biodiversity in agricultural landscapes, as it plays a pivotal role in the operation of agro-ecosystems (Dudley *et al.*, 2005; Daniel and Ramaraju, 2017). Platygastroidae from coffee ecosystem has been of least concern in the past creating a void in biological control of pests of the coffee. The area of coffee plantations in Thadiyankudisai is about 13,436 ha (CCRI, 2018). Insect pests present a substantial obstacle in attaining optimal coffee yields. The diversity of Platygastroidae is imperative for effective biological control. Therefore, the present study was initiated to address this issue.

Article History

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Materials and Methods

This study was conducted to examine the diversity of *Platygastroidea* species in the Coffee ecosystem at the Horticultural Research Station (HRS), Thadiyankudisai, spanning from January 2018 to January 2019.

Location, Constitution and Experimental Area

The selection of survey sites was based on their accessibility. Dindigul district is situated at a latitude of 10.29° N and a longitude of 77.71° E, with an average elevation of 1098 meters above mean sea level (MSL). The region's soil types primarily consist of red and peat, and the average annual rainfall amounts to 1400 mm. Thadiyankudisai area experiences distinct climatic seasons, including winter (December-February), summer (March-May), South West Monsoon (SWM) (June-August), and North East Monsoon (NEM) (September-November). This area is located within the Lower Pulney Hills, where coffee cultivation is interspersed with the crops such as avocado, banana, kalyana murungai, mandarin orange, macadamia nut, pepper, silk cotton and silver oak, *etc*. (Manikandan *et al.*, 2022).

Sampling and Identification of Hymenopterans

Sampling was carried out weekly using yellow pan traps at different elevation plots. Four such elevation plots were chosen at random with each plot size of 10 m × 10 m.

Yellow Pan Trap

The Yellow Pan Trap operates based on the principle that numerous insects are attracted towards the bright yellow colors (Daniel and Ramaraju, 2017). 20 such traps were placed in four elevation plots. The traps were randomly positioned around the coffee plantations, spaced approximately 1.0-1.5 m apart. In each trap, water was added along with a small quantity of detergent (soap oil) and a pinch of salt to disturb the surface tension and minimize evaporation. The samples were filtered with a fine mesh filter after 24 hr from the yellow pan trap. The relative abundance of the hymenopterans was recorded at weekly intervals.

Preservation and Identification of the Specimens

The collected hymenopteran specimens were preserved in 70% ethyl alcohol (Subhashree and Kanagarajan, 2021). Subsequently, the dried specimens were affixed to pointed triangular cards and examined using a Stereo zoom (Stemi-zeiss DV4) microscope (Subhashree and Kanagarajan, 2021). Additionally, they were photographed with a stereo zoom microscope (Leica M205C) and were identified using conventional taxonomic methods based on the keys provided by Narendran and van Achterberg (2016). The assistance to identify the parasitoids was taken from experts at Zoological Survey of India, Kolkata. The parasitoid collections were stored at the Insect Biosystematics Lab, housed within the Dept. of Agricultural Entomology at the Tamil Nadu Agricultural University in Coimbatore.

Diversity Calculation

The relative abundance of the Chalcid species was computed using the following formula,

$$\text{Relative Density (\%)} = \frac{\text{No. of individuals of one species}}{\text{No. of individuals of all species}} \times 100$$

The species or alpha diversity of the sites was evaluated using Simpson's Diversity Index (SDI) (Simpson, 1949) and the Shannon-Wiener Index (Shannon and Wiener, 1949). SDI serves as a measure of diversity that incorporates both the species present and the relative abundance of each species (Daniel and Ramaraju, 2017).

Simpson's Diversity Index (D) is calculated using the formula,

$$D = \sum \frac{n\,(n-1)}{N\,(n-1)}$$

Where, *n* symbolizes to the total number of organisms of a particular species and *N* denotes the total number of organisms of all species.

By subtracting the value of Simpson's index from 1, the resulting value represents Simpson's Index of Diversity (SID). This index varies from 0 to 1, where the higher value indicates the greater diversity within the sample (Daniel and Ramaraju, 2017).

The Shannon-Wiener Index (*H'*) is the another measure of diversity and expressed as follows,

$$H' = -\sum P_i \ln(P_i)$$

Where, $P_i = S/N$; represents the ratio of the number of individuals of one species (*S*), to the total number of all individuals in the sample (*N*). The term *ln* denotes the natural logarithm with its base *e*. Notably, the higher value of H' indicates the greater diversity within the sample.

Species richness for the 3 (three) sites were calculated using the Margalef Index (Margalef, 1958), and expressed as follows,

$$\alpha = \frac{(S-1)}{\ln(N)}$$

Where, *S* represents the total number of species and *N* denotes the total number of individuals in the sample.

Species evenness were determined using Pielou's Evenness Index (*EI*) (Pielou, 1966) and expressed as follows,

$$EI = \frac{H'}{\ln(S)}$$

Where, *H'* represents the Shannon-Wiener Diversity Index and *S* denoted the total number of species in the sample with biodiversity calculator.

Results and Discussion

A combined count of 550 number of individuals were recorded under two family of Platygastridae (1 genera) and Scelionidae (9 genera) in the coffee ecosystem at HRS, Thadiyankudisai, was studied. The composition of platygastroidea species diversity comprised of *Telenomus* sp. (52.0%) followed by *Scelio* sp. (12%), *Calliscelio* sp. (9%), *Sparasion* sp. (7%), *Idris* sp. (6%) and *Baryconus* sp. (4.0%). The least population was recorded in *Tritelia* sp. (2%) (Figure 1). Shweta and Rajmohana (2016) reported that a collective of 198 female individuals, representing 38 species with 21 genera, were observed in irrigated rice ecosystems across diverse elevational ranges in southern India (Daniel and Ramaraju, 2017).

The 2 (two) incorporated families, namely Platygastridae and Scelionidae, consist of diminutive species, predominantly functioning as egg parasitoids. Masner (1976) and

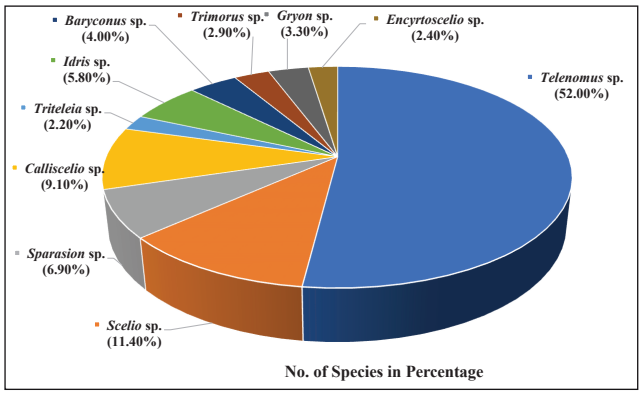

Figure 1: Percentage of *Platygastroidea* species composition in Coffee ecosystem at Thadiyankudisai

Masner and Huggert (1989) provided guidelines for identifying the genera within Scelionidae and a segment of Platygastridae. Additionally, Vlug (1995) compiled a catalog for Platygastridae. The Telenominae group within Scelionidae, known for its significant role in the biological control of economically vital pests, notably moths, represents a substantial taxonomic challenge (Huber, 2009).

The investigation into the seasonal abundance of *Platygastroidea* species revealed that the highest species population was observed during the winter season (32.55%), succeeded by the South West Monsoon (SWM) (30.36%), the summer season (20.55%) and finally, the North East Monsoon (NEM) (16.54%) as shown in table 1.

The analysis of indices of species richness during the four seasons revealed that the species richness (α) was the highest during NEM (1.99) followed by summer (1.90), SWM (1.75) and winter (1.73). The species diversity ranged from 0.65 to 0.73 with lesser variation as per SID and as well as by H' (range 2.27 to 2.55). The evenness was the maximum during winter (1.11) followed by summer (1.06) and SWM (0.99). Minimum evenness was observed during the NEM (0.98) (Table 2).

Table 1: Seasonal abundance of *Platygastroidea* species in Coffee ecosystem at Thadiyankudisai

Sl. No.	Genus/ Species	Seasons								Total	
		Winter		Summer		SWM		NEM			
		No	%	No	%	No	%	No	%	No	%
I	**Platygastridae**	85	47.4	58	51.3	92	55.0	51	56.0	268	52.0
1	*Telenomus* sp.	85	47.4	58	51.3	92	55.0	51	56.0	286	52.0
II	**Scelionidae**	94	52.6	55	48.7	75	45.0	40	44.0	264	48.0
1	*Scelio* sp.	21	11.7	11	9.7	20	12.0	11	12.1	63	11.4
2	*Sparasion* sp.	13	7.3	7	6.2	12	7.2	6	6.6	38	6.9
3	*Calliscelio* sp.	16	8.9	12	10.6	15	9.0	7	7.7	50	9.1
4	*Triteleia* sp.	3	1.7	4	3.5	3	1.8	2	2.2	12	2.2
5	*Idris* sp.	12	6.7	8	7.1	9	5.4	4	4.4	32	5.8
6	*Baryconus* sp.	12	6.7	3	2.7	4	2.4	3	3.3	22	4.0
7	*Trimorus* sp.	6	3.4	4	3.5	4	2.4	2	2.2	16	2.9
8	*Gryon* sp.	6	3.4	3	2.7	5	3.0	3	3.3	18	3.3
9	*Encyrtoscelio* sp.	5	2.8	3	2.7	3	1.8	2	2.2	13	2.4
Total		179	100	113	100	167	100	91	100	550	100

[Note that, % represents the relative abundance and No. signifies the total number of individual species. Additionally, SWM stands for South West Monsoon, while NEM refers to North East Monsoon]

Table 2: Diversity indices of *Platygastroidea* species from Coffee ecosystem at Thadiyankudisai

Season	Diversity Index			
	(α)	(SID)	(H')	(EI)
Winter	1.73	0.73	2.55	1.11
Summer	1.90	0.70	2.44	1.06
South West Monsoon	1.75	0.66	2.27	0.99
North East Monsoon	1.99	0.65	2.26	0.98

[Diversity index, α: Margalef index, SID: Simpson's Index of Diversity, H': Shannon-Wiener Index, EI: Pielou's Index of Evenness]

Conclusion

The diversity study unveiled that a total of 550 no's of individuals under two families (Platygastridae and Scelionidae) have recorded 10 species within the Coffee ecosystem of Thadiyankudisai. The application of pesticides in horticultural ecosystems disturbs the arthropod diversity which is considered to be the indicators of ecosystem health. The study implies the existence of a diverse array of natural enemies, highlighting their potential as valuable biological control agents. Consequently, significant emphasis should be placed on conserving and bolstering the abundant natural enemy fauna within the coffee ecosystem at Thadiyankudisai, Tamil Nadu.

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