



## Research Article

# Diversity of chalcidids (Hymenoptera: Chalcididae) from different agro-climatic zones of Chhattisgarh, India

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**ABSTRACT:** The present study was conducted from July 2019 to February 2020 to evaluate the diversity of chalcidoids in different natural and manmade agroecosystems from three agro-climatic zones (Chhattisgarh Plains, Bastar Plateau and Northern Hills) in the state Chhattisgarh, India. The survey resulted in the collection of 386 specimens belonging to eight families Chalcididae-256 specimens (66.32%), Encyrtidae-13 (3.37%), Eulophidae-77 (19.94%), Eurytomidae-06 (1.56%), Mymaridae-02 (0.52%), Ormyridae-01 (0.26%), Pteromalidae-16 (4.14%), and Torymidae-15 (3.89%), respectively from 17 collection sites. The highest diversity of chalcidoids was observed in the natural vegetation of Chhattisgarh Plains with Chalcididae as the most predominant family. Altogether, five predominant genera were collected using sweep net and yellow pan traps and were identified as *Antrocephalus* Kirby - 48 specimens (18.75%), *Brachymeria* Westwood - 71 (27.73%), *Dirhinus* Dalman -78 (30.47%), *Epitranus* Walker - 02 (0.78%), and *Hockeria* Walker - 57 (22.27%). The Chalcididae genera collected from different natural vegetation in descending order of their dominance were: *Brachymeria*- 53 specimens (32.31%) > *Dirhinus*- 42 (25.61%) > *Antrocephalus*- 34 (20.73%) > *Hockeria*- 33 (20.13%) > *Epitranus*-02 (1.22%). However in the manmade agroecosystems, *Dirhinus* was the most dominant genus and the descending order of dominance of genera observed were: *Dirhinus*- 36 specimens (39.13%) > *Hockeria*- 24 (26.09%) > *Brachymeria*- 18 (19.57%) > *Antrocephalus*- 14 (15.21%) with absence of the genus *Epitranus*. Comparing all the survey sites, Achanakmar Tiger Reserve, Mungeli was found most abundant in chalcid diversity under natural ecosystem and College of Agriculture, Raipur under agroecosystem with maximum diversity in vegetable fields of spine gourd, bottle gourd and sponge gourd altogether.

**KEY WORDS:** Agricultural ecosystem and natural ecosystem, agro-climatic zones, Chalcididae, Chhattisgarh, diversity, Hymenoptera

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## INTRODUCTION

The order Hymenoptera Linnaeus comprise of 27 superfamilies, nine of which are under suborder Symphyta and 18 superfamilies are included under Apocrita (Aguiar *et al.*, 2013) with presently 116,861 described species worldwide (Stork, 2018). The family Chalcididae Latreille, 1817 is known to be the fourth largest family within Chalcidoidea (Aguiar *et al.*, 2013). Wijesekara (1997) confirmed the monophyly of Chalcididae excluding Leucospidae based on unambiguous characters. Chalcidids are predominantly primary solitary endoparasitoids, seldom gregarious or hyperparasitoids, of host species belonging to Lepidoptera, Diptera, Coleoptera and Hymenoptera, with few reports being parasitic on Neuroptera, Orthoptera, and Strepsiptera (Narendran and van Achterberg, 2016). Minimal information is known of the superfamily Chalcidoidea, which accommodate key parasitoids of agroecosystems, associated

with different agro-climatic zones of Chhattisgarh. Hence this study endeavored to advance the data related to chalcidoids associated with different agro climatic zones and also to highlight the biodiversity rich spots.

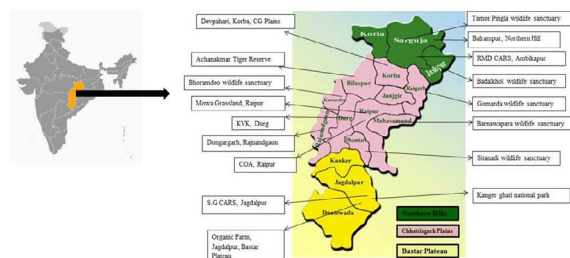
In the present study an attempt was made to document the abundance and diversity of Chalcididae from different agro-climatic zones of Chhattisgarh State to find out the diversity rich regions/ecosystems and genera.

## MATERIALS AND METHODS

### Description of the study area

The survey area selected was Chhattisgarh state which is located in the centre-east of the country with an area of 135,191 km<sup>2</sup> (census, 2011). The latitude of Chhattisgarh, India is 21.295132, and the longitude is 81.828232 with the GPS coordinates of 21° 17' 42.4752" N and 81° 49' 41.6352"

E. All the three agro-climatic zones, Bastar Plateau Zone, Chhattisgarh Plain Zone and Northern Hills Zone were surveyed in the present study (Fig. 1). The survey sites selected for the present study are listed in the Table 1.



**Fig. 1. Collection sites of the present study in different agro-climatic zones (Green, pink and yellow colour represents each study area limitation)**

**Table 1. List of survey sites selected for the present study**

SITES	ECOSYSTEM	LATITUDE	LONGITUDE	ALTITUDE
Tamor Pingla WLS, Surajpur	Natural	23°45'31.09"N	82°54'23.57"E	623 m above MSL
Badalkhol WLS, Jashpur	Natural	22°89'60"N	83°91'58"E	256 m-400 m above MSL
Achanakmar Tiger Reserve, Mungeli	Natural	22°26'04.4"N	81°42'11.0"E	200 m-1000 m above MSL
Barnawapara WLS, Mahasamund	Natural	21°29'04.9"N	82°31'31.0"E	265 m-400 m above MSL
Bhoramdeo WLS, Kawardha	Natural	22°10'22.1"N	81°03'04.9"E	900 m above MSL
Kangerghati National Park, Jagdalpur	Natural	18°57'14.3"N	82°14'11.7"E	338 m-781 m above MSL
Balampur, Northern Hills	Natural	23°36'46.3"N	83°36'36.3"E	464 m above MSL
Gomarda WLS, Raigarh	Natural	21°40'84"N	83°18'66"E	1500 m – 1800 m above MSL
Sitanadi WLS, Dhamtari	Natural	20°20'56"N	81°57'39"E	327 m-736 m above MSL
Devpahari, Korba, CG. Plains	Natural	22°38'12"N	82°48'41"E	293 m above MSL
Mowa grassland, Raipur	Natural	21°16'14.3"N	81°40'15.2"E	297 m above MSL
Dongargarh grassland, Rajnandgaon	Natural	21°13'20"N	80°43'07"E	490 m above MSL
RMD CARS, Ambikapur	Man made Agroecosystems	23°08'58.3"N	83°08'58.6"E	623 m above MSL
COA, Raipur	Man made Agroecosystems	21°14'02.2"N	81°42'42.5"E	298.15 m above MSL
S.G. CARS, Jagdalpur	Man made Agroecosystems	19°05'33.9"N	81°57'38.7"E	557 m above MSL
Organic Farm, Jagdalpur, Bastar Plateau	Man made Agroecosystems	19°09'26"N	81°49'34"E	560 m above MSL
KVK, Durg, Anjora	Man made Agroecosystems	21°10'06"N	81°14'10"E	289 m above MSL

MSL: Mean sea level

### Specimen collection

For the present study, fifty yellow pan traps were placed uniformly for a period of 48 hours in and around different ecosystems across three agro-climatic zones of Chhattisgarh. The collected specimens were preserved in 70% ethyl alcohol and later were examined in the ICAR-National Bureau of Agricultural Insect Resources (NBAIR). All the chalcidoids were sorted based on their key morphological characters viz. antenna elbowed in appearance, wing venation greatly reduced, in general one linear vein present, enclosed cells absent, and prepectus present. The sorted chalcidoids were placed in different concentrations of alcohol for sequential dehydration. Alcohol concentrations used for dehydration were 50%, 70%, 90% and 100%. The specimens were kept in each concentration for 30 minutes in a sequential manner. Specimens were later card point mounted on triangular cards prepared from acid-free paper.

## Specimen identification

The following literature was consulted for identification in the present study: Bouček (1988); Grandi (1952); Mani (1989); Narendran and Rao (1987); and Noyes (1982). The keys were run under ZEISS stereo microscope. The specimens of the present study are deposited in the National Insect Museum (NIM), ICAR- NBAIR Bengaluru, India.

## RESULTS AND DISCUSSION

Altogether 386 specimens were collected belonging to eight families of superfamily Chalcidoidea (Table 2), out of which 256 predominantly were of family Chalcididae belonging to five genera (Fig. 3). Additionally, specimens from Chattisgarh deposited in the National Insect Museum, ICAR-NBAIR, Bengaluru were also examined and included in the present study. Five predominant genera of Chalcididae family were identified from different agro-climatic zones: *Antrocephalus* Kirby 1883, *Brachymeria* Westwood 1829, *Dirhinus* Dalman 1818, *Epitranus* Walker 1834 and *Hockeria* Walker 1834.

The graphical representation states that out of 386 total specimens collected of superfamily Chalcidoidea, Chalcididae was the most predominant among eight families and the rarest family observed was Ormyridae (Fig. 2). From natural vegetation of Chhattisgarh genus *Brachymeria* was found to be the most dominant and the least dominant was *Epitranus*. Order of predominancy (descending) observed is as follows: *Brachymeria* (53) > *Dirhinus* (42) > *Antrocephalus* (34) > *Hockeria* (33) > *Epitranus* (2).

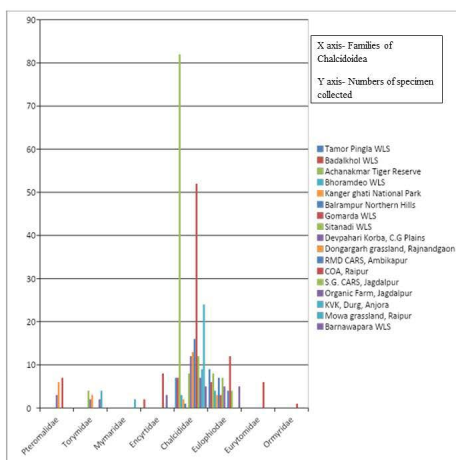


Fig. 2. Graphical representation of diversity of Chalcidoidea families from survey sites

Collection details of the examined specimens are as follows:

### I. Genus *Antrocephalus* Kirby, 1883 (Fig. 9 A)

**Specimens examined:** INDIA: Chhattisgarh: 1M, Tamor Pingla WLS, Surajpur, 23°45'31.09"N & 82°54'23.57"E, 03.vii.19, coll. Shekh Alisha; 1M, Badalkhol WLS, Jashpur, 22°89'60"N & 83°91'58"E, 04.ix.2018, coll. R. K. Ekka; 1M & 1F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 1M Bhoramdeo WLS, Kawardha, 22°10'22.1"N & 81°03'04.9"E, 28.x.2019, coll. Shekh Alisha; 1 M Sitanadi WLS, Dhamtari, 20°20'56"N & 81°57'39"E, 06.i.2019, coll. R. K. Ekka; 1M & 1F, Devpahari, Korba, CG. Plains, 22°38'12"N & 82°48'41"E, 17.ii.2019, coll. R. K. Ekka; 1M & 1F, Mowa grassland, Raipur, 21°16'14.3"N & 81°40'15.2"E, 07.x.2019, coll. Kriti Minz; 1M, Dongargarh grassland, Rajnandgaon, 21°13'20"N & 80°43'07"E, 20.i.2019, coll. R. K. Ekka; 1M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E, 28.ix.2019, coll. Shekh Alisha; 1M & 1F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019, coll. Shekh Alisha; 1M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha.

**Other specimens examined:** INDIA: Chhattisgarh: 2M, Tamor Pingla WLS, Surajpur, 23°45'31.09"N & 82°54'23.57"E, 03.vii.19, coll. Shekh Alisha; 2M, Badalkhol WLS, Jashpur, 22°89'60"N & 83°91'58"E, 04.ix.2018, coll. R. K. Ekka; 5M & 1F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 1M Bhoramdeo WLS, Kawardha, 22°10'22.1"N & 81°03'04.9"E, 28.x.2019, coll. Shekh Alisha; 2M Sitanadi WLS, Dhamtari, 20°20'56"N & 81°57'39"E, 06.i.2019, coll. R. K. Ekka; 2M & 1F, Devpahari, Korba, CG. Plains, 22°38'12"N & 82°48'41"E, 17.ii.2019, coll. R. K. Ekka; 4M & 2F, Mowa grassland, Raipur, 21°16'14.3"N & 81°40'15.2"E, 07.x.2019, coll. Kriti Minz; 1M, Dongargarh grassland, Rajnandgaon, 21°13'20"N & 80°43'07"E, 20.i.2019, coll. R. K. Ekka; 1M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E, 28.ix.2019, coll. Shekh Alisha; 3M & 3F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019, coll. Shekh Alisha; 2M & 1F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 28.viii.2019, coll. Shekh Alisha; 1M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha.

**Distribution:** Chhattisgarh (Surajpur, Jashpur, Mungeli, Kawardha, Dhamtari, Korba, Raipur, Rajnandgaon, Ambikapur, and Jagdalpur).

### II. Genus *Brachymeria* Westwood, 1829 (Fig. 9 B)

**Specimens examined:** INDIA: Chhattisgarh: 1M & 1F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 1M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E,

28.ix.2019, coll. Shekh Alisha; 1M & 1F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019, coll. Shekh Alisha; 1M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha; 1M, Organic Farm, Jagdalpur, Bastar Plateau, 19°09'26"N & 81°49'34"E, 31.i.2019, coll. R. K. Ekka; 1M, KVK, Durg, Anjora, 21°10'06"N & 81°14'10"E, 27.i.2019, coll. R. K. Ekka.

**Other specimens examined:** INDIA: Chhattisgarh: 39M & 12F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 3M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E, 28.ix.2019, coll. Shekh Alisha; 7M & 2F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019, coll. Shekh Alisha; 1M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha; 1M, KVK, Durg, Anjora, 21°10'06"N & 81°14'10"E, 27.i.2019, coll. R. K. Ekka.

**Distribution:** Chhattisgarh (Mungeli, Ambikapur, Raipur, Jagdalpur, and Durg).

### III. Genus *Dirhinus* Dalman, 1818

#### (Fig. 9 C)

**Specimens examined:** INDIA: Chhattisgarh: 1M, Tamor Pingla WLS, Surajpur, 23°45'31.09"N & 82°54'23.57"E, 03.vii.19, coll. Shekh Alisha; 1M, Badalkhol WLS, Jashpur, 22°89'60"N & 83°91'58"E, 04.ix.2018, coll. R. K. Ekka; 1M & 1F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 1M Sitanadi WLS, Dhamtari, 20°20'56"N & 81°57'39"E, 06.i.2019, coll. R. K. Ekka; 1M, Devpahari, Korba, CG. Plains, 22°38'12"N & 82°48'41"E, 17.ii.2019, coll. R. K. Ekka; 1M & 1F, Mowa grassland, Raipur, 21°16'14.3"N & 81°40'15.2"E, 07.x.2019, coll. Kriti Minz; 1M, Dongargarh grassland, Rajnandgaon, 21°13'20."N & 80°43'07"E, 20.i.2019, coll. R. K. Ekka; 1M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E, 28.ix.2019, coll. Shekh Alisha; 1M & 1F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019, coll. Shekh Alisha; 1M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha; 1M, Organic Farm, Jagdalpur, Bastar Plateau, 19°09'26"N & 81°49'34"E, 31.i.2019, coll. R. K. Ekka; 1M, KVK, Durg, Anjora, 21°10'06"N & 81°14'10"E, 27.i.2019, coll. R. K. Ekka.

**Other specimens examined:** INDIA: Chhattisgarh: 3M, Tamor Pingla WLS, Surajpur, 23°45'31.09"N & 82°54'23.57"E, 03.vii.19, coll. Shekh Alisha; 2M, Badalkhol WLS, Jashpur, 22°89'60"N & 83°91'58"E, 04.ix.2018, coll. R. K. Ekka; 9M & 4F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 2M, Devpahari, Korba, CG. Plains, 22°38'12"N

& 82°48'41"E, 17.ii.2019, coll. R. K. Ekka; 6M & 3F, Mowa grassland, Raipur, 21°16'14.3"N & 81°40'15.2"E, 07.x.2019, coll. Kriti Minz; 6M, Dongargarh grassland, Rajnandgaon, 21°13'20."N & 80°43'07"E, 20.i.2019, coll. R. K. Ekka; 2M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E, 28.ix.2019, coll. Shekh Alisha; 12M & 4F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019, coll. Shekh Alisha; 5M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha; 3M, Organic Farm, Jagdalpur, Bastar Plateau, 19°09'26"N & 81°49'34"E, 31.i.2019, coll. R. K. Ekka; 4M, KVK, Durg, Anjora, 21°10'06"N & 81°14'10"E, 27.i.2019, coll. R. K. Ekka.

**Distribution:** Chhattisgarh (Surajpur, Jashpur, Mungeli, Dhamtari, Korba, Raipur, Rajnandgaon, Ambikapur, Jagdalpur, and Durg).

### IV. Genus *Epitranus* Walker, 1834

#### (Fig. 9 D)

**Specimens examined:** INDIA: Chhattisgarh: 1M, Balrampur, 23°36'46.3"N & 83°36'36.3"E, 10.xi.2018, coll. R. K. Ekka; 1M, Sitanadi WLS, Dhamtari, 20°20'56"N & 81°57'39"E, 06.i.2019, coll. R. K. Ekka.

**Distribution:** Chhattisgarh (Balrampur and Dhamtari).

### V. Genus *Hockeria* Walker, 1834

#### (Fig. 9 E)

**Specimens examined:** INDIA: Chhattisgarh: 1M, Badalkhol WLS, Jashpur, 22°89'60"N & 83°91'58"E, 04.ix.2018, coll. R. K. Ekka; 1M & 1F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 1M & 1F, Barnawapara WLS, Mahasamund, 21°29'04.9"N & 82°31'31.0"E, 18.viii.2019, coll. Shekh Alisha; 1M Bhoramdeo WLS, Kawardha, 22°10'22.1"N & 81°03'04.9"E, 28.x.2019, coll. Shekh Alisha; 1M Kangerghati National Park, Jagdalpur, 18°57'14.3"N & 82°14'11.7"E, 17.x.2019, coll. Shekh Alisha; 1M Sitanadi WLS, Dhamtari, 20°20'56"N & 81°57'39"E, 06.i.2019, coll. R. K. Ekka; 1M, Devpahari, Korba, CG. Plains, 22°38'12"N & 82°48'41"E, 17.ii.2019, coll. R. K. Ekka; 1M & 1F, Mowa grassland, Raipur, 21°16'14.3"N & 81°40'15.2"E, 07.x.2019, coll. Kriti Minz; 1M, Dongargarh grassland, Rajnandgaon, 21°13'20."N & 80°43'07"E, 20.i.2019, coll. R. K. Ekka; 1M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E, 28.ix.2019, coll. Shekh Alisha; 1M & 1F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019, coll. Shekh Alisha; 1M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha; 1M, Organic Farm, KVK, Durg, Anjora, 21°10'06"N & 81°14'10"E, 27.i.2019, coll. R. K. Ekka.

**Other specimens examined:** INDIA: Chhattisgarh: 3M

& 1F Achanakmar Tiger Reserve, Mungeli, 22°26'04.4"N & 81°42'11.0"E, 18.vii.2019, coll. Shekh Alisha; 2M & 1F, Barnawapara WLS, Mahasamund, 21°29'04.9"N & 82°31'31.0"E 18.viii.2019, coll. Shekh Alisha; 1M Kangerghati National Park, Jagdalpur, 18°57'14.3"N & 82°14'11.7"E, 17.x.2019, coll. Shekh Alisha; 2M Sitanadi WLS, Dhamtari, 20°20'56"N & 81°57'39"E, 06.i.2019, coll. R. K. Ekka; 3M, Devpahari, Korba, CG. Plains, 22°38'12"N & 82°48'41"E, 17.ii.2019, coll. R. K. Ekka; 3M & 2F, Mowa grassland, Raipur, 21°16'14.3"N & 81°40'15.2"E, 07.x.2019, coll. Kriti Minz; 3M, Dongargarh grassland, Rajnandgaon, 21°13'20"N & 80°43'07"E, 20.i.2019, coll. R. K. Ekka; 2M, RMD CARS, Ambikapur, 23°08'58.3"N & 83°08'58.6"E, 28.ix.2019, coll. Shekh Alisha; 9M & 3F, COA, Raipur, 21°14'02.2"N & 81°42'42.5"E, 26.vii.2019,

coll. Shekh Alisha; 2M, S.G. CARS, Jagdalpur, 19°05'33.9"N & 81°57'38.7"E, 18.x.2019, coll. Shekh Alisha; 1M, Organic Farm, Jagdalpur, Bastar Plateau, 19°09'26"N & 81°49'34"E, 31.i.2019, coll. R. K. Ekka; 1M, KVK, Durg, Anjora, 21°10'06"N & 81°14'10"E, 27.i.2019, coll. R. K. Ekka.

**Distribution:** Chhattisgarh (Mungeli, Mahasamund, Jagdalpur, Dhamtari, Korba, Raipur, Rajnandgaon, Ambikapur, Raipur, Jagdalpur, and Durg).

The present study was a maiden attempt to document the abundance and diversity of chalcids from the natural and manmade agroecosystems of different agro climatic zones of Chhattisgarh state. Based on the survey results, Chalcidoidea with 256 specimens was found to be the most dominant

**Table 2. Number of specimens of different families of Chalcidoidea collected from different study sites**

Family	Pteromalidae	Torymidae	Myrmariidae	Encyrtidae	Chalcidoidea	Eulophidae	Eurytomidae	Ormyridae	Total
Sites									
Tamor Pingla WLS, Surajpur	0	0	0	0	7	9	0	0	16
Badalkhol WLS, Jashpur	0	0	0	2	7	6	0	0	15
Achanakmar Tiger Reserve, Mungeli	0	0	0	0	82	8	0	0	90
Barnawapara WLS, Mahasamund	0	0	0	0	5	5	0	0	10
Bhoramdeo WLS, Kawardha	0	0	0	0	3	4	0	0	7
Kangerghati National Park, Jagdalpur	0	0	0	0	2	3	0	0	5
Balrampur, Northern Hills	0	0	0	0	1	7	0	0	8
Gomarda WLS, Raigarh	0	0	0	0	0	3	0	0	3
Sitanadi WLS, Dhamtari	0	4	0	0	8	7	0	0	19
Devpahari, Korba, CG. Plains	3	2	0	0	12	5	0	0	22
Mowa grassland, Raipur	0	0	0	0	24	0	0	0	24
Dongargarh grassland, Rajnandgaon	6	3	0	0	13	0	0	0	22
RMD CARS, Ambikapur	0	0	0	0	12	4	0	0	16
COA, Raipur	7	0	0	8	52	12	6	1	86
S.G. CARS, Jagdalpur	0	0	0	0	12	4	0	0	16
Organic Farm, Jagdalpur, Bastar Plateau	0	2	0	3	7	0	0	0	12
KVK, Durg, Anjora	0	4	2	0	9	0	0	0	15
Total	16	15	2	13	256	77	6	1	386

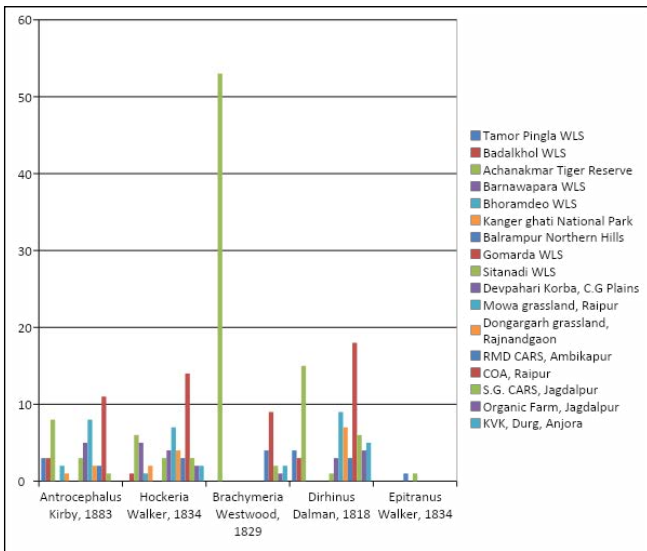
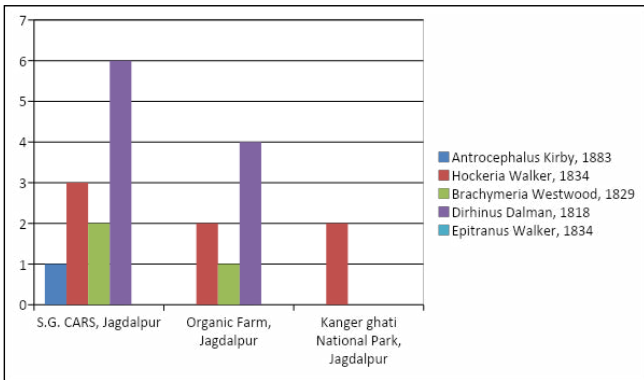
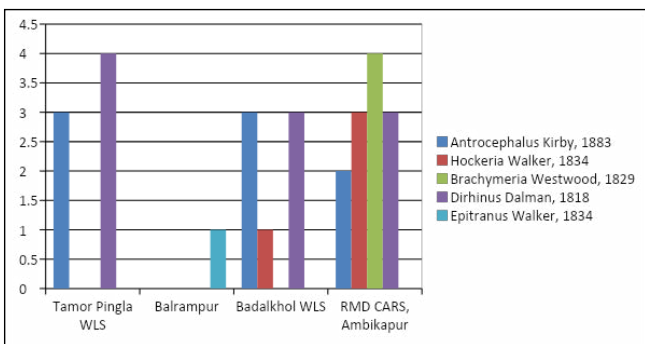


Fig. 3. Graphical representation of Chalcididae genera from various survey sites

1. Bastar Plateau



2. Northern Hills



3. Chhattisgarh Plains

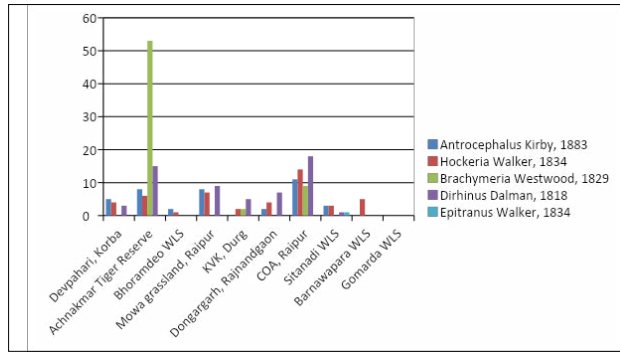


Fig. 4. Diversity of Chalcididae genera from different agro-climatic zones of Chhattisgarh

1. Bastar Plateau
2. Northern hills and
3. Chhattisgarh Plains

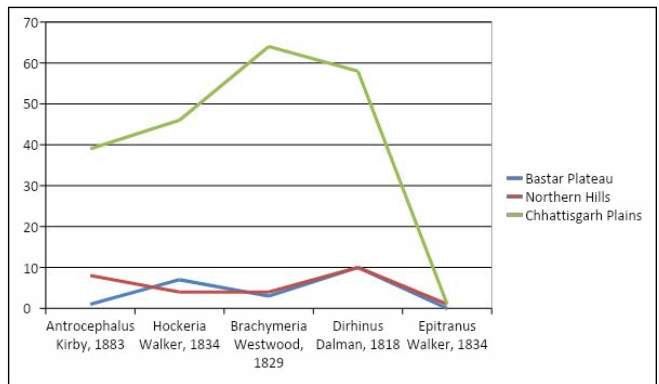


Fig. 5. Comparative study of Chalcididae genera from different agro-climatic zones of Chhattisgarh

Distribution of Chalcididae genera in natural ecosystems of Chhattisgarh

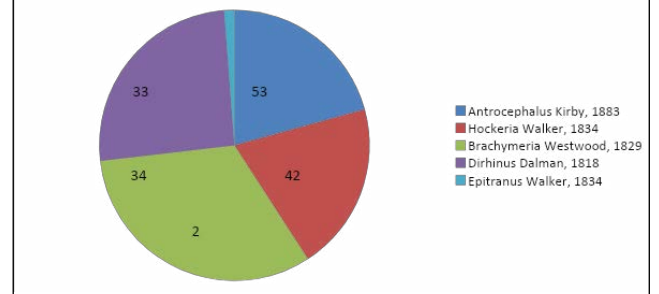
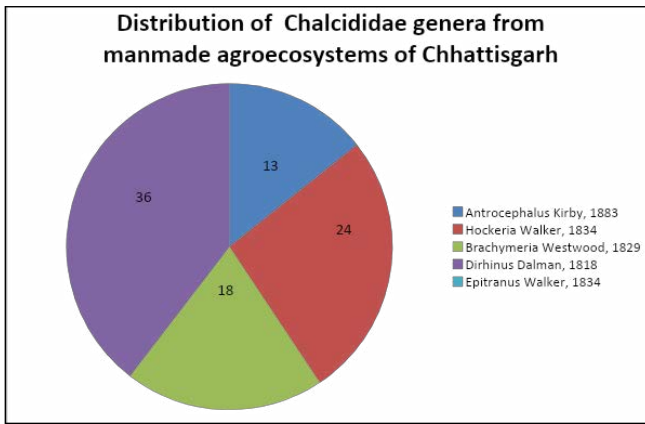
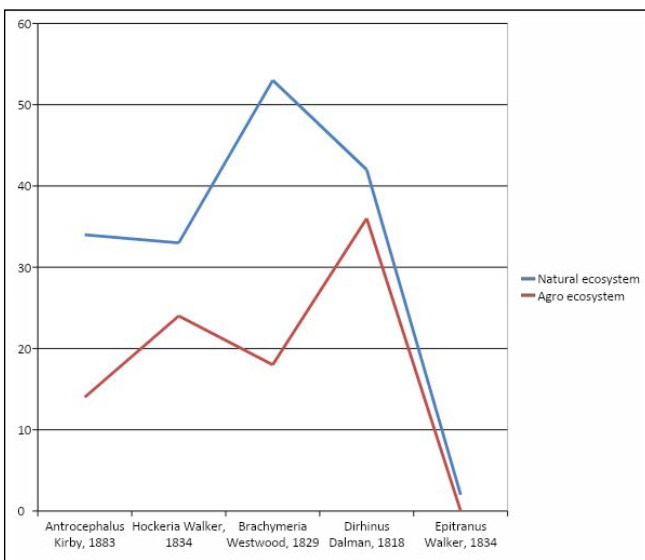


Fig. 6. Pie Chart representation of Chalcididae genera from natural vegetation of Chhattisgarh



**Fig. 7. Pie Chart representation of Chalcididae genera from manmade agroecosystems of Chhattisgarh**

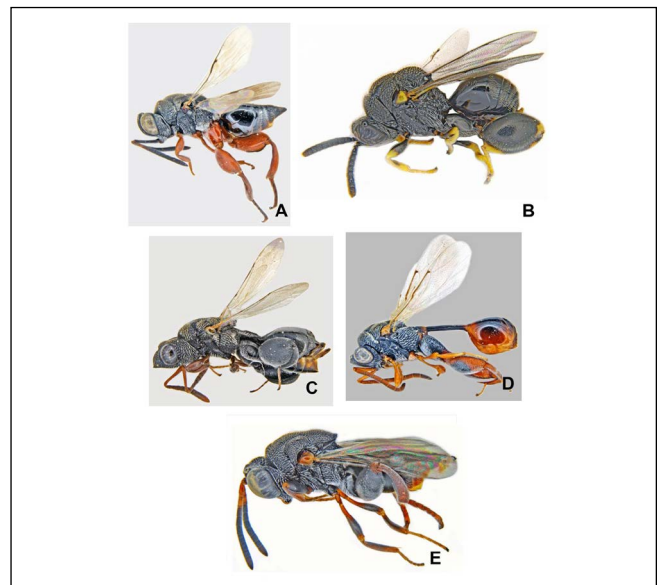


**Fig. 8. Comparative study of the Chalcididae genera diversity both agroecosystems of Chhattisgarh**

family with five predominant genera which were identified as: *Antrocephalus* Kirby, *Hockeria* Walker, *Brachymeria* Westwood, *Dirhinus* Dalman and *Epitranus* Walker. The most dominant genus was *Dirhinus* and the least dominant was *Epitranus* from the Northern Hills (Fig. 4). From the Chhattisgarh Plains, *Brachymeria* was the most dominant genus (Fig. 4). However from the Bastar Plateau, the most dominant genus was *Dirhinus* with absolutely no trace of the genus *Epitranus* (Fig. 4). Most of the specimens were collected from Chhattisgarh plains followed by Northern Hills and the least number of specimens were recorded from Bastar Plateau (Fig. 5). The central part of Chhattisgarh consists of fertile plains which includes forests, mountains, rivers and waterfalls. This was the main reason why the diversity was found to be rich in the central plains as compared to the other two agro climatic zones. The Chalcididae genera

collected from natural vegetation in descending order of their dominance are as follows: *Brachymeria* > *Dirhinus* > *Antrocephalus* > *Hockeria* > *Epitranus* (Figs. 3 and 6). Amongst all the uninhabited areas, Achanakmar Tiger Reserve Mungeli was found to be the natural vegetation with maximum number of specimens (Fig. 6). The Chalcididae genera collected from various manmade agroecosystems in descending order of their dominance are as follows: *Dirhinus* > *Hockeria* > *Brachymeria* > *Antrocephalus* (Fig. 7). From manmade agroecosystems of Chhattisgarh, it was found that the most prominent genus was *Dirhinus* and the genus with almost negligible presence was *Epitranus* (Fig. 7). Amongst all the manmade agroecosystem College of Agriculture, Raipur was found dominant with diversity richness, especially in vegetable fields of spine gourd, bottle gourd and sponge gourd. The natural vegetation was found to be more diverse than manmade agroecosystems (Fig. 8). From natural vegetation 164 specimens belonging to Chalcididae family were collected and from manmade agro ecosystems 92 specimens were collected, which means the diversity was rich in the natural vegetation with no human interference. The diversity richness can be correlated with the level of human interference in case of ecosystems. Additionally, maximum area of Chhattisgarh state comes under the fertile Chhattisgarh Plains directly contributing to the faunal diversity.

Overall this elaborate analysis of chalcidid diversity clearly acquired out good taxonomic data on the distribution and abundance of chalcidoid parasitoids associated with



**Fig. 9. Five predominant genera of Chalcididae from different agro-climatic zones of Chhattisgarh: A. *Antrocephalus* Kirby, B. *Brachymeria* Westwood, C. *Dirhinus* Dalman, D. *Epitranus* Walker and E. *Hockeria* Walker**

different ecosystems in three agro-climatic zones.

## CONCLUSION

The study reveals the distribution and abundance of the chalcidid parasitoids across three different agro-climatic zones of Chhattisgarh. Based on the present study it is concluded that the natural vegetation of Chhattisgarh Plains was the most diverse and species rich zone for the chalcidid fauna. The results of this study will definitely serve as the baseline data for any upcoming activity on the chalcid biodiversity research from this region in future.

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