BIOSYSTEMATIC STUDIES ON THE FAMILY CHALCIDIDAE (HYMENOPTERA: CHALCIDOIDEA).

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(2019-11-182)

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY

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VELLAYANI, THIRUVANANTHAPURAM-695 522

KERALA, INDIA

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by

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THESIS

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COLLEGE OF AGRICULTURE

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2023

DECLARATION

I, hereby declare that this thesis entitled **"BIOSYSTEMATICS STUDIES ON THE FAMILY CHALCIDIDAE (HYMENOPTERA: CHALCIDOIDEA)"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellayani

Date: 29-04-2023

Jaseel R

(2019-11-182)

CERTIFICATE

Certified that this thesis entitled **"BIOSYSTEMATICS STUDIES ON THE FAMILY CHALCIDIDAE (HYMENOPTERA: CHALCIDOIDEA)"** is a record of research work done independently by Mr. Jaseel R (2019-11-182) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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Jaseel R

INDEX

LIST OF PLATES

LIST OF ABBREVIATIONS AND SYMBOLS USED

F	Female
F1-F8	Funicular segments 1 to 8
M	Male
MV	Marginal vein
OOL	Ocello-ocular distance
PMV	Post marginal vein
POL	Post ocellar distance
SMV	Submarginal vein
SgMV	Stigmal vein
Syn.	Synonym
T1-T6	Tergites 1 to 6
%	Per cent
@	At the rate of
mm	Millimeter
et al.	and other Co workers
Fig.	Figure
g	Gram
i.e.	That is
KAU	Kerala Agricultural University
viz.	Namely
◦ C	Degree Celsius
Mg	Milligram

Introduction

1. INTRODUCTION

Taxonomy allows everyone to access a huge amount of previously published data of any species. In agricultural science, taxonomy is indispensable. It aids in the accurate detection of both the pest and the natural enemies interacting with the pest on the field, and it is crucial in bio-control programmes. The discipline of discovering, describing, and labeling the taxa, specifically a species is known as alpha taxonomy. The correct terminology of the organism, which would be the functional label of the species, is required for any research based on that organism. The functional label (scientific name) aids in the collection of any and all available knowledge that can be used as a guide. Taxonomic investigation not only aids in determining the identity of an organism but also allows scientists to learn about the organism's locality, distribution and hosts in order to develop an effective integrated management plan. It also has a crucial role in classical biological control programmes in which a natural enemy is imported to control an invasive pest. It's also important for the environmental studies because it aids in the identification of threatened or endangered species. Taxonomic data is also important since it aids in the conservation of biodiversity.

Hymenoptera, which includes wasps, ants, bees, and sawflies, is one of the most diverse orders of insecta. Aguiar *et al*. (2013) updated the Hymenoptera classification, specifying the current numbers of genera and species described so far. They are considered one of the most species-rich insects orders with 153,088 living species and 2,429 extinct species that have been described. There are two suborders, 27 superfamilies, 132 families, 8,432 extant genera, and 685 extinct genera in this order. Symphyta (sawflies) and Apocrita (wasps, bees and ants) are the two suborders. Parasitic hymenoptera serve an important role in the management of insect pests that attack diverse crops in terrestrial settings. They play a vital role in preserving natural equilibrium and are also an excellent indicator of the status of the environment (Dorn *et al*., 2002).

Chalcidoidea is Hymenoptera's largest, most taxonomically difficult, ecologically likely most complex, and commercially advantageous parasitic group. It has 23 families, 2,045 taxa and 22,784 species and is distributed in every biogeographical zone (Aguiar *et al*., 2013). Adult chalcids are free-living insects that seldom eat, but larvae have a wide range of feeding patterns that are primarily specialised. The majority of chalcids are entomophagous, while just a few feed on arthropods such as spiders and mites. Koinobionts and idiobionts are two forms of entomophagous parasitoids. Koinobionts coexist with their hosts until their life cycles are completed by letting the host to grow and thrive. Idiobionts either kill the host right away or halt the host's growth and feeding. Primary parasitism is most common among chalcids, although hyperparasitism is also widespread, with tertiary and quarternary parasitism being the most common. Superparasitism and multiparasitism are uncommon. Chalcids display a wide range of behaviours, including monophagy with strong host specialisation, oligophagy and, in many cases, polyphagy.

Chalcidids are mostly solitary main endoparasitoids of Lepidoptera and Diptera, however a few species target Hymenoptera, Coleoptera, and Neuroptera; certain tropical species seem ectoparasitoids, and a few are gregarious. The majority are idiobionts, ovipositing into somewhat completely formed hosts like adult larvae (in the case of Diptera parasitoids) or early pupae (parasitoids of Lepidoptera). On the other hand chalcis species are koinobiont parasitoids of *Statiomys* (Diptera: Stratiomyidae). Several species oviposit into *Stratiomys* eggs, which are placed in groupings at the water-side vegetation (Cowan, 1979).

Females can deposit up to 200 eggs, which seem to have elongateoval petiole and in certain cases, a very small petiole. The larvae of the first instar can be caudate or hymenopteriform, either with spiracles, but very well cuticular spines. Instars after that are more or less hymenopteriform. (Dowden, 1935; Arthur, 1958).The host pupa is where the pupation takes place. In the hosts, many chalcidids hibernate as adult females or mature larvae. For example *Goniozus nephantidis* Muesebeck was shown to

be responsible for 8.5 percent of all larval parasitism on *Opisina arenosella* Walcker (George et al., 1977). According to field investigations by Sunderamurthy and Santhanakrishnan (1979) noted that parasitism related mortality of *0. arenosella* Walcker larvae is directly proportional to *G. nephantidis* Muesebeck density and inversely proportional to host density.

Although several species of the family are commonly used in biological control agents, the data available on its systematics are scarce. With this in mind, the current research on this economically significant family is recommended with the following goal.

- Identification, morphological characterization and documentation of family Chalcididae.

Review of Literature

2. REVIEW OF LITERATURE

2.1. FAMILY CHALCIDIDAE

The family Chalcididae is part of the Chalcidoidea superfamily, which today contains 22groups (Heraty*et al*., 2013).

The earliest studies on Chalcididae were started by Linnaeus (1767). About 249 years ago he described species of the Chalcididae family which includes *Sphex sispes* Linnaeus and *Vespa minuta* Linnaeus which was renamed *Chalcis sispes* Linnaeus and *Brachymeria minuta* Dalman respectively. Two decades later Fabricius (1787) came up with the term "Chalcis," from which the current superfamily Chalcidoidea gets its name. The word Chalcididae was originally used in the presence sense by Walker (1862).

Ashmead (1904) discussed the chalcidid genera in his study on the classification of Chalcidoidea; The engorged hind femur, the imperceptible prepectus, the sharp occipital carina bordering the gena posteriorly, the clear punctuation of the mesosoma, the edge of the scapula dividing the pronotum from the tegula, the shallow femoral depression of the mesopleuron and the tarsi with five segments are the distinguishable characters of Chalcidids “facies femoralis” of Bouček (1952). There are about 90 valid genera and approximately 1500 valid species so far described from the world. Of the 38 genera and 447 species known from Oriental region (Noyes 2019), Binoy *et al.* (2021) recorded 241 species of Chalcididae belonging to all five sub families of Chalcididae from India.

The classification of Chalcididae follows Bouček (1988) by using five subfamilies. They are: 1) Chalcidinae (with tribes Chalcidini, Brachymeriini, Cratocentrini and Phasgonophorini); 2) Haltichellinae (with tribes Haltichellini, Hybothoracini and Tropimeridini); 3) Dirhininae (with tribes Dirhinini and Aplorhinini); 4) Epitraninae (no tribes) and 5) Smicromorphinae (no tribes). Until recently (Riek 1970), the family Leucospidae was included under the Chalcididae as a subfamily. However, Bouček and all other recent workers considered Leucospidae as a separate family.

The family chalcididae is classified in to five sub families (Noyes, 2019).

2.1.1 Subfamily: Chalcidinae

Kirby (1883) provided remarks on the genera of the subfamily chalcidinae, with synonymic notes and descriptions of new species of *leucospidinae* and *chalcidinae*. Hanna (1934A) described new species of Euchalcidia (Hymenoptera, Chalcidinae).They also described the male and female genitalia and the biology of Euchalcidia (Hanna, 1934B)**.** Later studies on the morphology and anatomy of *Euchalcidida carybori* Hanna (Hymenoptera - Chalcidinae) were published (Hanna, 1935).

Gahan (1925) defined a new species *Brachymeria excarinata* Gahan from the Philippines. Gahan, (1936) reported a new species of *Brachymeria* (Hymenoptera: Chalcididae) namely *Brachymeria carinatifrons* Gahan. Genus *Brachymeria* Westwood in America north of Mexico a revision made by Burks (1960). A new species of the genus *Brachymeria* Westwood (Hymenoptera: Chalcididae) from India reported by Chhotani (1966). Eight species of *Brachymeria* Westwood belonging to the subfamily Brachymerinae (tribe Brachymerini) are being described as new*viz*., *Rufotibialis, aligarensis, rufogasteri, flavotibialis, nigricorporis, compestris, josephii* and *hydrabadensis,* Key to the Oriental species of the genus proposed by Joseph *et al.,* (1973) is revised and enlarged to accommodate the new species and brought up-to-date (Husain and Agarwal, 1982). Chen and Liao (1985) comments on the subgenus *Matsumurameria* Habu of the genus *Brachymeria* Westwood with descriptions of three new species from Yunnan, China. Three new species of *Brachymeria* Westwood from India (Insecta, Hymenoptera, Chalcidoidea, Chalcididae) is reported by Husain and Agarwal (1989). New species of *Brachymeria* were reported by Askew (1991) from Spain and description is provided. Description of four new species, two new subspecies and new host records of the genus *Brachymeria* Westwood (Hymenoptera: Chalcididae) from India is provided by Farooqi *et al.* (1991).

Jamal (2009) reported a new species of *Brachymeria* Westwood (Hymenoptera: Chalcididae) on rice skipper, *Parnara guttata* Bremer & Grey (Lepidoptera: Hesperiidae) from South Kashmir Aquino *et al*. (2015) gave the notes of identity, host and geographic distribution of *Brachymeria subrugosa* Blanchard which is a natural enemy of micro lepidoptera. The new species of parasitoid wasp as *Brachymeria philornisae* Delvare, sp. nov. was reared from *Philornis trinitensis* Dodge & Aitken (Diptera: Muscidae) puparia that were found in the nests of the bird species *Mimus gilvus* (Vieillot) (Mimidae) and *Tiaris bicolor* (L.) (Thraupidae) in Tobago (Delvare *et al.,* 2017).

A new species of Chalcis, *Chalcis arapha* Burks & Watson is reported and described by Burks and Watson (1939). Notes on *Chalcis sispes* Linnaeus and *Haltichella rufipes* Olivier (Hym., Chalcididae) are given by Andersen (1974).Three new species of Chalcis Fabricius from Mexico are described: *nodis, colpotis,* and *cells,* key and descriptions are given to all species of Chalcis known to occur in Mexico (Burks,1977). The first record of *Chalcis sispes* Linnaeus from Poland is presented by Wiśniowski and Dobosz (1998). Baugnée and Vago (2006) found the presence of *Chalcis myrifex* Sulzer (Hymenoptera: Chalcididae) in Belgium and commented on it.

Moitoza(1994*)* revised the *Conura maculata* Fabricius species group of *Conura* Spinola in America, north of Mexico, and a new species of the *C. immaculata* Moitoza species group of *Conura* (Hymenoptera: Chalcididae). First occurrence of the parasitoid *Conura* sp. (Hymenoptera: Chalcididae) in pupae of *Tuta* (Lepidoptera: Gelechiidae) in tomato was reported by Marchiori *et al.* (2003*).* Parasitism of *Brassolis sophorae laurentii* Stichel (Lepidoptera: Nymphalidae, Brassolinae) pupae by *Conura morleyi* (Ashmead) (Hymenoptera: Chalcididae, Chalcidini) was observed by Marcicano *et al.* (2007) in the State of Alagoas, Brazil. Perez et al. (2012) Reported *Conura* sp. *immaculate* group (Hymenoptera: Chalcididae) parasitizing *Leptophobia aripa* Boisduvel (Lepidoptera: Pieridae) in Brassica.

Description of a new species of *Megachalcis* Cameron (Hymenoptera: Chalcidoidea: Chalcididae) from India with a revised key to species was given by Sureshan *et al.* (2018). First report of *Brachymeria carbonaria* (Zehntner), *Megachalcis timorensis* Boucek and *Tropimeris excavata* Steffan (Hymenoptera: Chalcidoidea) from India (Gowriprakash *et al*., 2018).

Observations on the biology of *Phasgonophora sulcata* Westwood (Hymenoptera: Chalcididae) a larval parasitoid of the two lined chestnut borer, *Agrilus bilineatus* Weber (Coleoptera: Buprestidae) in Wisconsin was made by Haack *et al.* (1981). Later, Roscoe *et al.* (2016) published a paper on observations on the life history traits of the *Phasgonophora sulcata* Westwood (Hymenoptera: Chalcididae) attacking *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae).

2.1.2 Subfamily: Haltichellinae

Roy and Farooqi (1984) studied the taxonomy of Indian Haltichellinae (Chalcididae: Hymenoptera) at National Pusa Collection.

Husain and Agarwal (1982) in their taxonomic studies on Haltichellinae of India (Hymenoptera: Chalcididae) described nine species (8 new) of HaItichellini, viz. *nikolskayae* and *vulgaris* under *Hockeria* Walker; *sativa* under *Nippohockeria* Habu; *indicus, vitatus, brevicorpus, hyalopennis* and *indicates* under *Antrocephalus* Kirby and *brevicorpus* under *Neotainania* Husain and Agarwal, keys to the world species of Hoekeria and *Antrocephalus* are given, *Nippohoekeria* is reported for the first time from Indian and a second new species added to the genus. Farooqi (1983) discussed the Indian Haltichellini and he considered ten genera under the tribe Haltichellini. The genus Neochalcis was originally placed in Chalcidinae (Chalcididae) by Kirby (1883) with *Halticella osmicida* Saunders designated as the type species. Several researchers studied this genus and placed it in the Chalcidinae (Dalla Torre 1898; Ashmead1904; Schmiedeknecht 1909; Masi 1929). Bouček (1952) put Neochalcis in the Haltichellinae (Chalcididae) and synonymized Orthochalcis Kieffer as a junior synonym. Subsequently,

Narendran (1984) added Eugastrochalcis Masi as a new synonym. The genus *Haltichella* Spinola, (*Chalcididae*, *Haltichellinae*, *Haltichellini*) currently contains 35 valid species worldwide (Noyes 2019).

New taxa of Hybothoracini (Hymenoptera, Chalcididae) from India is reported by Husain *et al.*(1985) and prepared a key to seventeen genera of the tribe Hybothoracini and the species of the genus Euchalcidia.

Boucek (1958) described a new species of Tropimeris and Tanycoryphus. Husain and Agarwal (1981) described a new species of Tropimeris Steffan from India in the same year. Gupta and Poorani (2009) recorded *Tropimeris monodon* Boucek for the first time from Andhra Pradesh. Narendran and Khan (2011) described two new species of Chalcididae, viz. *Psilochalcis mathuraensis* Narendran & Khan and *Brachymeria neoatteviae* Narendran & Khan from India (Uttar Pradesh and West Bengal respectively) and compared with related species of the genus.

2.1.3 Subfamily: Epitraninae

Boucek (1982) intensely studied the species of Epitraninae, a subfamily of Chalcididae; parasitic Hymenoptera are taxonomically revised and key is given to 29 species among which, 17 are described as new. Husain and Agarwal (1982) collected ten species of Epitranus Walker (Epitraninae) from India which were described as new, viz. perticellus, kashmiriensis, nlgrus, aruminatus, ndiclis. melogenus. glganticui. simplexuI, areolatus and roslrorpus. *Epitranus clavatus* Fabricius (and the subfamily Epitraninae) is reported by Grissell and Smith (2003) for the first time in the Nearctic. It was collected near Mathias, West Virginia and represents the first specimen of the genus reported in over one hundred years in the New World. Hoebeke *et al.* (2003) reported new Nearctic record for *Epitranus clavatus* F. (Hymenoptera: Chalcididae). Epitranus *husaini* sp. nov. from Kashmir is described and illustrated by Ahmad *et al*. (2012).

2.1.4 Subfamily: Dirhininae

The paper by Husain and Agarwal (1981)deals with the systematics of *Dirhinus* Dalman (Dirhininae), keys to species of the subgenera *Hontalia* Cam. and *Dirhinus* Dalman revised and enlarged to accommodate world species, a key to the species of subgenus *Dirhnoides* Masi, five species are described as new and *D. (H.) coromandelica* (Mani and Dubey) is proposed as a new combination for *Parenioca coromandelica* Mani and Dubey. Roy and Farooqi (1981) provided key to the available Indian species and reported a new species of *Dirhinus* Dalman (Hymenoptera: Chalcididae).The species of Dirhinini from the Indian Subcontinent are revised and a key given to the ten recognized species were given. These are classified in one genus, *Dirhinus* Dalman, with two subgenera. Four new species, *claviger, deplanatus, pilifer* and *altispina,* are described and seventeen new synonyms (sixteen specific, one generic) proposed (Bouček and Narendran, 1981). First record of *Dirhinus alticornis* Masi (Hymenoptera: Chalcidoidea) from India is reported by Sureshan (1997).

The species of Chalcidid wasps of *Dirhinus* Dalman, 1818 (Hymenoptera: Chalcididae) from Saudi Arabia are reviewed, Seven species are reported from Al Bahah, Asir, Jazan and Riyadh regions, additionally, three new species: *D. asirensis*sp. *nov*. (Asir), *D. sculpturatus*sp. *nov*. (Al Bahah, Asir and Riyadh) and *D. transversus*sp. *nov*. (Al Bahah, Asir and Jazan) are described and illustrated. An illustrated key to females of the species of Dirhinus from Saudi Arabia is provided (Gul *et al.,* 2018). Five new species belonging to *Dirhinus* Dalman are described: *D. quadrhinus* Delvare *sp. nov*., *D. gigasetosus* Delvare *sp. nov*., *D. kambae* Delvare *sp. nov*., *D. maasaii* Delvare *sp. nov. and D. leakeyorum* Delvare *sp. nov*. These species belong to the newly defined and characterized quadrhinus species group, included in the subgenus *Dirhinus* of *Dirhinus* Dalman (Delvare and Copeland, 2018). Description of new species of *Pseudeniaca* was provied by Masi (1939).

Eniacomorpha Girault was described from Australia and synonymized with Dirhinus by Bouček & Narendran in 1981. Delvare *et al.* in 2019 described a new species, *Eniacomorpha hermetiae* which is a pupal parasitoid of Diptera, *Hermetia*

illucens L is also given in this work and it is stated that in genus *Eniacomorpha* the anteromedian areola of the propodeum is at most somewhat longer than wide and the strigose area on the first gastral tergite is well expanded in the two dimensions, reaching at least one third of the dorsal surface of the tergite and occupying most of its width. These two characters distinguish *Eniacomorpha* from *Pareniaca.*

2.1.5 Subfamily: Smicromorphinae

The parasitoid wasp genus Smicromorpha consisting of six described species, is the only genus in the subfamily Smicromorphinae of the family Chalcididae (Naumann, 1986). Of the six species *S. doddi* Girault, 1913, *S. minera* Girault, 1926, and *S. lagynos* Naumann, 1986, are distributed throughout northern Australia, *S. eudela* Naumann, 1986, is known only from the northern part of the Northern Territory of Australia, and *S. banksi* Naumann, 1986, was described from north eastern Australia and New Guinea. The only species described from outside Australia and New Guinea is *S. keralensis* by Narendran (1979) which is known only from southern India.

Binoy (2021) reviewed the genus *Smicromorpha* Girault (Hymenoptera: Chalcididae) and description of a new species from India. *Smicromorpha manseri* Binoy a new species is reported and described from Vietnam (Darling, 2009).

Materials and Methods

3. MATERIALS AND METHOD

The current work on 'Biosystematic studies on the family Chalcididae (Hymenoptera: Chalcidoidea)' was carried out in the Department of Agricultural Entomology, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala with the aim of identifying, morphologically describing, and documenting Chalcids in Kerala. This chapter presents the resources and strategies used, observations made for the current study.

3.1. COLLECTION OF SPECIMEN

3.1.1. Study area

Samples were gathered from various locations in Kerala, covering a range of ecosystems and habitats, for the biosystematics study of the Chalcididae. Kerala is located in southern India and is bordered by Tamil Nadu to the east and south and Karnataka to the north and northeast. Despite being closer to the equator, it enjoys a pleasant and equable temperature all year long. This is brought on by both the land's proximity to the Arabian Sea and the Western Ghats' presence to the east. Its 38, 863 km2 area makes up 1.18% of India's total land area. It is located between longitudes 74.89400 and 77.15012 E and latitudes 8.32187 and 12.7549 N.

Geographically Kerala can be divided into three distinct regions, *viz*.:

1. Highlands that are above 76 m altitude. The highlands slope down from the Western Ghats, generally having an average altitude of 900 m with several peaks well over 1800 m.
2. Midlands, the area between 7.6and 76 m altitudes which lie between the mountains low lying coastal areas.
3. Lowlands are regions below 7.6 m altitude, which are formed by deposition of sediments brought down by rivers of Western Ghats and sand deposited by sea.

3.1.2. Field surveys

Different localities were chosen from various regions of Kerala and collections were made at random. The locations investigated include sanctuaries, forests that are a part of national parks, and certain agroecosystems that are close to forest covers. Between the years 2018 and 2022, Chalcid specimens were gathered, processed, and preserved.

3.1.2.1. Method of collection

Chalcids were collected using a sweep net that was round in shape (Plate 2 A). Sweep net collection yields were found to be at their highest in the early morning and late evening.

The net used for collection was manufactured by Hunt Wilde following the design by Boucek. The handle spans 120 cm in length and is separable when not in use. The body and handle are made of aluminium alloy. The net sack is approximately 60 cm long and constructed of fine, sturdy cotton cloth. The bag's rim is strengthened with thick canvas, which allows it withstand any impact while being swept.

Following collection, the Chalcids were transferred into 100% alcohol after being aspirator-separated from the cotton bag. The collection vials were labelled with information about the location and the date of collection (Plate 2 B.)

3.2. PROCESSING

Processing of the specimens include sorting, relaxing, mounting, labelling and preserving the mounted and un-mounted specimens (Plate 3).

3.2.1. Un-mounted material

The un-mounted specimens were kept in air tight vials containing absolute alcohol. The alcohol was changed periodically and the vials were kept in dark place (Plate 4 A.).

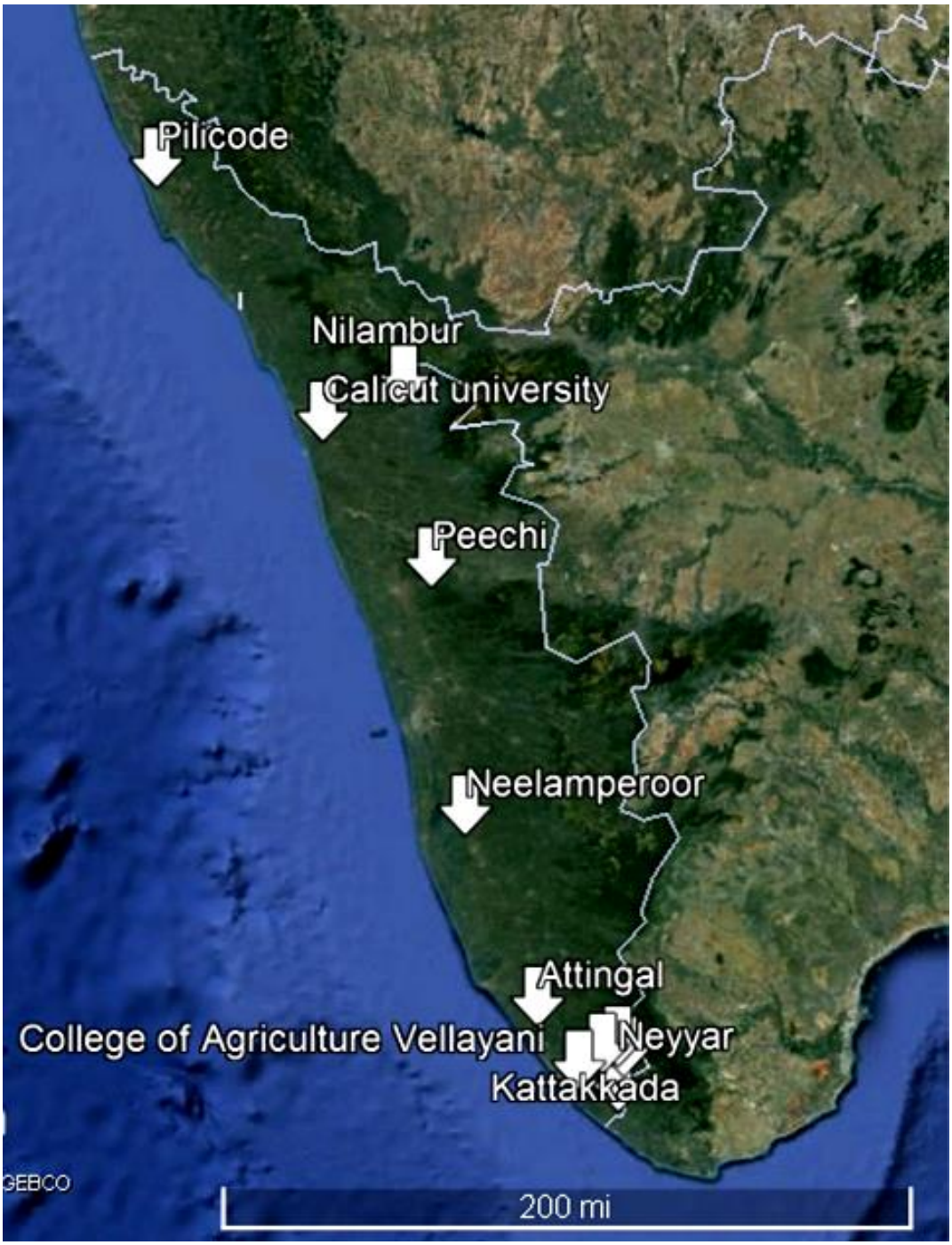


Plate 1 : Locations of purposive sampling

A.

B.

Plate 2: A. Sweep net B. Sample container

Plate 3: Sorting of Chalcid wasps from field sweep

3.2.2. Card mounting

The materials used for mounting the specimes are, cavity block, blotting paper, HMDS (Hexamethyldisilazane) series, fine zero-point brush, lamp, mounting cards, entomological pins, water soluble gum and stereo zoom microscope. Before mounting, the specimen is transferred into 1:2 solution of HMDS to alcohol and kept standing for about 20 minutes, later transferred to 2:1 solution of HMDS to alcohol and kept for 20 minutes. After this, the specimen is transferred to 100% HMDS and kept for 30 to 45 minutes before transferring to blotting paper for proper drying (Heraty, 1998). Hard bodied Chalcids were not treated with HMDS. A small droplet of water soluble gum is placed at the tip of triangular card, and specimens were glued to the card point on the mesosoma. Specimens were placed in such a way that all the taxonomically relevant characters are correctly visible. The card was pinned on an entomological pin on a pinning block. This was followed by labelling. Rectangular labels were made containing essential information regarding location, name of the collector and date of collection. After proper drying of specimens, it is kept in insect box containing naphthalene balls to avoid damage by fungi and other small insects (Plate 4 B.).

3.3. IDENTIFICATION OF CHALCID WASPS

3.3.1. Microphotography and Measurements

Photographs of specimens both whole and parts were taken under high resolution stereo microscope Leica M205C equipped with Leica DFC420 digital camera mounted on the microscope. The images were captured in desktop computer using the software LAS V3.6. Images were taken in different focal planes and focus stacked using Zerene stacker into a single in-focus composite image. Editing of the images in a permissive level was done using Adobe Photoshop CC. Measurements of different parts were taken manually by using ocular micrometer (Plate 5).

3.3.2. Morphological Characterisation

The generic level and species level identification was done using the keys provided by Narendran (1989), literatures available in Universal Chalcidoidea Database and Natural History Museum, London. The species encountered have been dealt with in detail and re descriptions have been done in brief with appropriate images.

3.3.3. Terminology

The morphological terms and abbreviations are, as used by Narendran (1989).

3.3.3.1.Head

Clypeus:The sclerite present in head just above the labrum.

Antennae: The appendage present in head between the eyes and is sensory in function (Plate 6 B.)

Toruli: The paired socket present on head in which the antenna is placed.

Scape: The first antennal segment.

Pedicel: The second antennal segment.

Anelli: Small ring segments between pedicel and funicular segments.

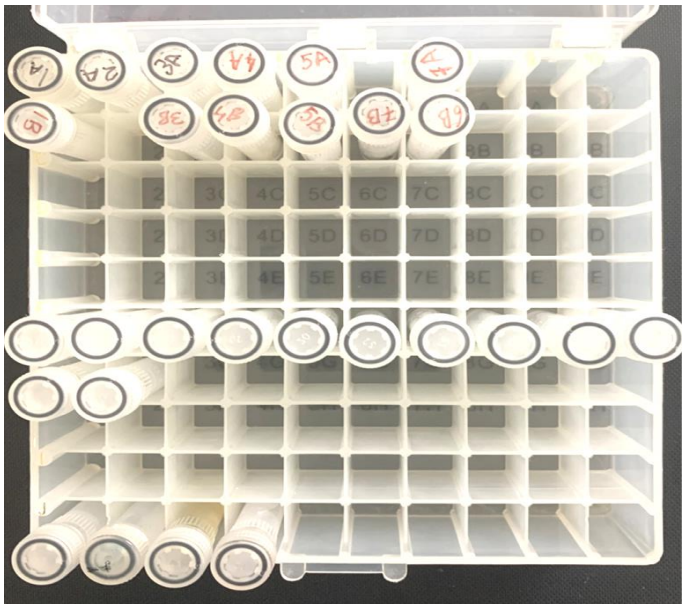
Funicle: Segments between anelli and clava (represented by F1, F2....F7).

Clava: The last three segments of antenna which looks like a clump.

Scrobe: The groove on head to accommodate the scape.

Frons: The area of head between the front ocellus and the toruli.

Malar space: The shortest lateral distance between the base of the mandible and the compound eye



A.

B.

Plate 4: A. Alcohol preservation B. Dry preservation of specimens

Plate 5:Focus stacking photography and micrometry

Gena: The lateral part of head below compound eyes.

Malar sulcus:The vertical groove present in malar space.

Carina: Ridge or raised area.

Mandible: Highly sclerotized paired lateral mouth appendage for chewing and contains teeth.

Occiput: The area behind vertex

Ocelli:Simple eyes present on the dorsal part of head, arranged in a triangle shape) (Plate 6 A.).

Vertex: The area between anterior ocellus and occiput.

3.3.3.2.Mesosoma

Pronotum: First segment of thorax dorsally(Plate 7 A.).

Mesoscutum: Pronotum followed by mesoscutum, it is the second thoracic segment and usually has three lobes.

Notauli: The groove placed longitudinally on mesoscutum.

Mesopleuron: Lateral part of mesothorax.

Metapleuron: Lateral part of metathorax.

Mesepisternum&mesepimeron: The mesopleural suture sub divides mesopleuron into mesepisternum and mesepimeron. The mesepimeron is further divided unto lower and upper messpimeron.

Tegula: Small rounded sclerite which covers the base of the forewing.

Prepectus: The triangular scleritebetween lateral sides of mesepisternum and pronotum.

Scutellum: The region between mesoscutum and propodeum. Posteriorly the scutellum sometimes has a subapical region, the frenum, differentiated by frenal groove

Propodeum: propodeum follows scutellum and can be slightly prolonged into a neck like nucha.

3.3.3.3. Metasoma

Petiole: The stalk like structure that connects gaster and propodeum.

Gaster: 7-8 post petiolar segments compose the gaster

Tergites: Dorsal segments of gaster (Plate 7 B.).

Sternites: The ventral segments of gaster.

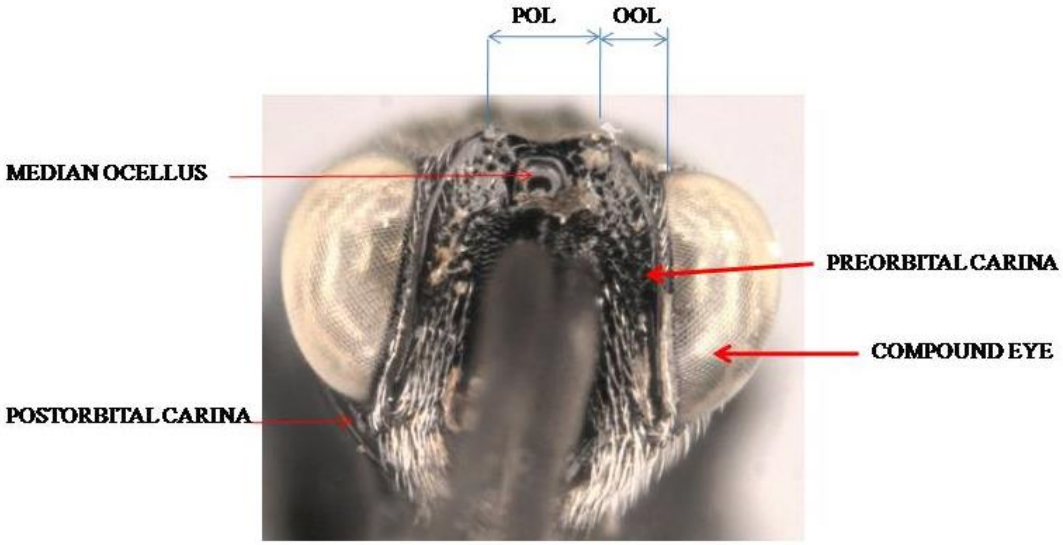
3.3.3.4. Wings

PMV: Post Marginal Vein(Plate 8 A.).

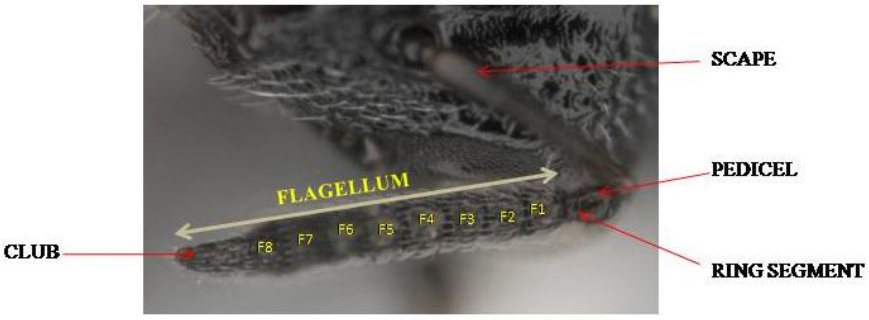
MV: Marginal vein.

SMV: Sub marginal vein.

STV: Stigmal vein.

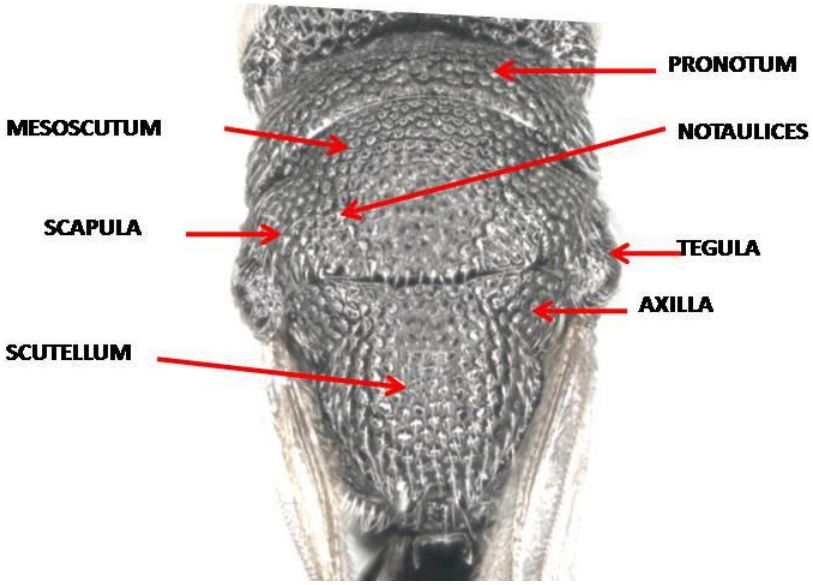


A.

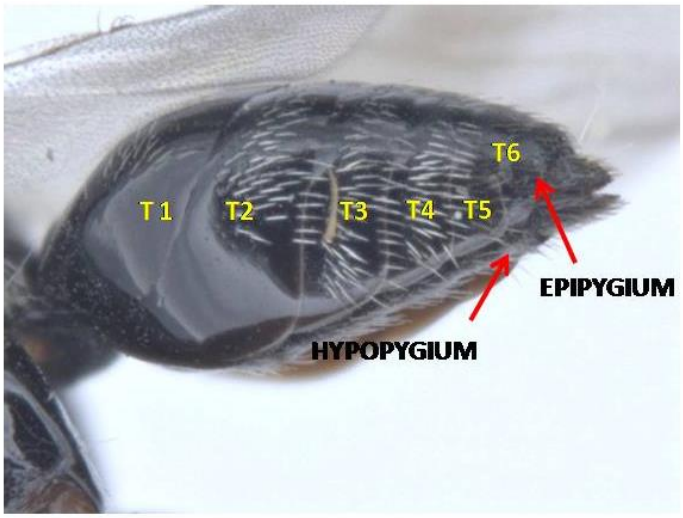


B.

Plate 6: A. Head front view B. Antennae and it's parts

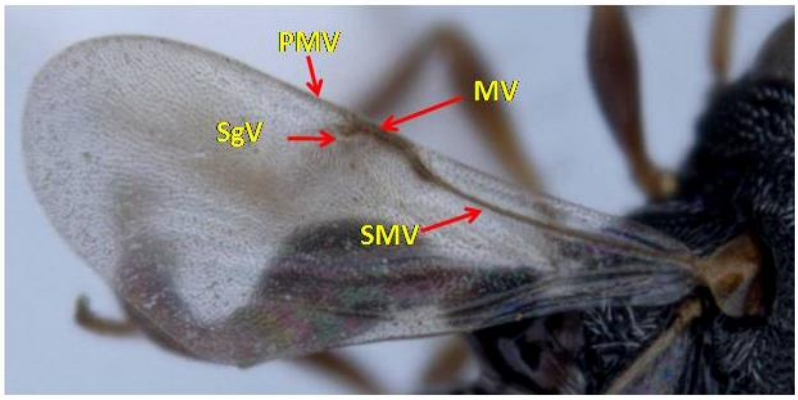


A.

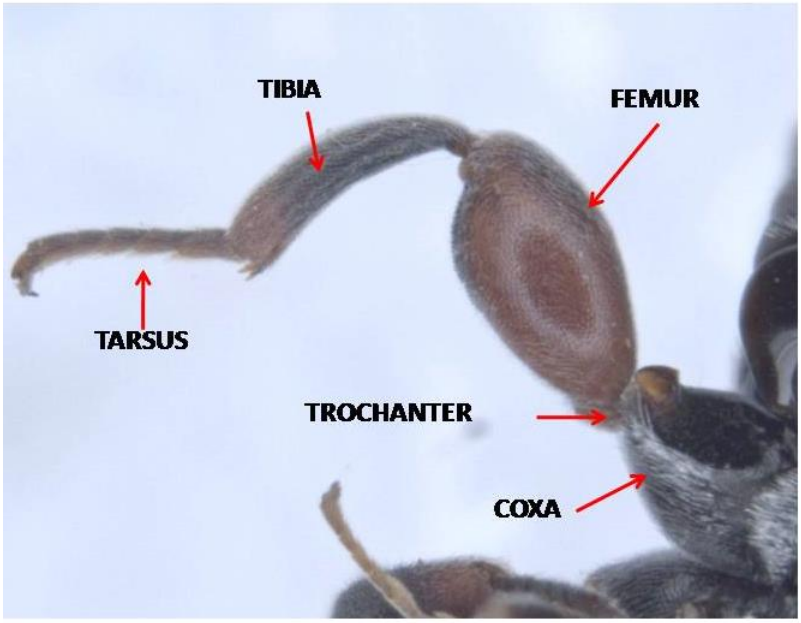


B.

Plate: 7 A. Thorax B. Gaster



A.



B.

Plate: 8 A. Forewing B. Hind leg

Results

4. RESULTS

During the present study, eight species belonging to 7 genera under 4 subfamilies are dealt with and 5 specimens were documented up to generic level, of which one species is a new record from Kerala and one species is re-described with male characters. A complete checklist to the Chalcididae of Kerala is provided.

Diagnosis

Chalcididae is one of the most difficult families of Superfamily (Chalcidoidea Hymenoptera: Parasitica). No single character or set of characters separate all species of Chalcididae from other families. Most of the chalcids can be separated from closely related families and related groups by enlarged hind femur (Plate 8 B.) and tegula relatively broad, not more than about 1.5x as long as broad.

4.1 SYSTEMATICS

4.1.1Subfamily: Haltichellinae

4.1.1.1.Neohaltichella Narendran.

Diagnosis: Head as wide at or sub equal to width of thorax with well-developed preorbital carinae; scrobe narrow; preorbital carinae on vertex faintly represented behind front ocellus; mesoscutum and sculellum more convex than in typical Haltichella; ventral margin of hind femur without a prominent dent. Head and body more pubescent than in Halichella. Gaster without basal carinae. This genus differs from Haltichella in having gaster without carina at base; first tergite of gaster relatively shorter and in having head and thorax stouter and more pubescent than in Haltichella. It differs from Neochalcis by the two characters, ventral margin of posterior femora without distinct dent and pre orbital carina present.

4.1.1.1.1 *Neohaltichella nilgirica* Narendran.

Diagnosis: Female: Length 3.68 mm. black (Plate 9 A.); scape, pedicel, distal half of club, middle part of fore and mid femora and middle parts of fore and mid tibiae liver brown, Bases and apices of fore and mid femora and bases and apices of fore and mid tibiae pale brownish; fore and mid tarsal segments pale yellowish brown; apex of hind tibia and tarsal segments brown, Pubescence whitish. Head width 1.42x its length, subequal lo maximum width of thorax; pre and postorbital carinae present; postorbital carinae running upwards towards vertex; scrobe reaching front ocellus; frontogenalsulcus carinate; genotemporal furrow slightly indicated; antenna with scape not reaching front ocellus; pedicel relatively short; Thorax with close pits on notum interstices narrow and rugulose, ecarinate (Plate 9 C.); apex of scutellum distinetly bilobed; propodeum not horizontal; submedian carina distinct, other propodeal carinae not well defined; lateral teeth indistinet. Forewing with relative proportion of veins submarginal: 107, marginal: 28, postmarginal: 37, stigmal: 6. Hind coxa with a tooth near base on dorsal side: hind femur without an inner basal tooth; Gaster a little longer than thorax ; first tergite without basal carinae, with a basal pit ; second tergite to fifth tergite micro sculptured and pitted on distal half on dorsal side; sixth tergite shallowly punctate, rugose and reticulate (Plate 9 B.); epipygium carinate and pubescent.

Distribution: Tamil Nadu, Kerala (New report)

Materials Examined: 1 female, INDIA, Kerala, Trivandrum, COA Vellayani, 03-02-2021, coll. Jaseel R;

4.1.1.2 *Antrocephalus* Kirby

Antrocephalus Kirby 1883: 54-63

Coelochalcis Cameron 1904.

Dilla Strand 1911.

Stomatoceroides Girault 1913b.

Metarretocera Girault 1927.

Tainania Masi 1929.

Subatiella Masi 1929.

A.

B.

C.

Plate: 9 A. *Neohaltichellanilgirica* B.Gaster dorsal C. Thorax dorsal

Stomatocerella Girault 1930.

Uxa Girault 1930.

Dillisca Ghesquiere 1946.

Uda Girauit 1930.

Diagnosis: Apex of meta tibia almost perpendicularly truncate or slightly sinuate and with two apical spurs; marginal vein nearing the margin of the forewing and the post marginal vein and stigmal vein distinctly developed; hind tibia without additional carina; fronts with strong horse-shoe shape carina running from above, behind front ocellus along the inner margin of eyes; pronotum regularly convex; hind femur either uni or bilobed or without distinct lobe; anterior pronotal carinae with paired weak or strong tubercles in the middle.

4.1.1.2.1 *Antrocephalus decipiens* Masi

Diagnosis: Female: Length 3.01 mm (Plate 10 A.), head width sub equal to width of thorax. Frons and vertex with distinct pits, POL 10x OOL; eye height is 1.11x its length; pre and post-orbital carina distinct(Plate 10 C.); genotemporal furrow absent. Thorax with interstices of pits narrow and rugulose; pronotal carinae absent; apex of scutellum bilobed; propodeum with distinct submedian carinae (Plate 10 B.). Forewing with relative proportion of veins submarginal: 83, marginal:24 , postmarginal: 9, stigmal: 2. Gaster longer than thorax; first tergite each carina with 2 parallel ridges or carinae at base, length of each carina subequal to width between them; first tergite smooth and shiny on dorsal side; sixth tergite rugose.

Distribution: Kerala

Materials Examined: 1 female, INDIA, Kerala, Kozhikode, Calicut University, 09-8-2022, coll. Jaseel R

4.1.1.2.2 *Antrocephalus* sp.

Diagnosis: Female: Length 4.23 mm (Plate 11 A.), head width sub equal to width of thorax. Frons and vertex with distinct pits, POL 1.7x OOL; eye height is 1.33x its length; pre and post-orbital carina distinct (Plate 11 B.); genotemporal furrow absent. Thorax with interstices of pits narrow and rugulose; apex of scutellum bilobed; propodeum with distinct submedian carinae (Plate 11 C..). Forewing with relative proportion of veins submarginal: 108, marginal:25 , postmarginal: 63, stigmal: 5.Hind femur and tibia liver brown color. Gaster longer than thorax; first tergite each carina with 2 parallel ridges or carinae at base, length of each carina subequal to width between them; first tergite smooth and shiny on dorsal side; sixth tergite rugose.

Materials Examined: 1 female, INDIA, Kerala, Trivandrum, COA Vellayani, 08-10-2021, coll. Jaseel R

4.1.1.3.*Hockeria* Walker

Stomatoceras Kirby 1883b.
Temnata Cameron 1897.
Centrochalcis Cameron 1905b.
Hypochalcis Girault 1915a.
Orthochalcis Silvestri 1943.
Afrochakis Schmitz 1946.
Hockerella Girault 1930.
Afrhockeria Steffan 1955.

Diagnosis: Marginal vein nearing the margin of the forewing and the postmarginal vein and stigmal vein distinctly developed; hind tibia without additional carina; frons with weak preorbital carina; face without/weak horse-shoe shaped carina (not turning dorsally behind anterior ocellus); abdomen without conspicuous pubescence; antenna with scape reaches the anterior ocellus.

4.1.1.3.1 *Hockeria* sp.1

A.

B.

C.

Plate: 10 A. *Antrocephalus decipiens* B. Thorax dorsal C. Head lateral

A.

B.

C.

Plate: 11 A. *Antrocephalus* sp. B. Head front view C. Thorax dorsal

Diagnosis: Female: Length: 2.093 mm. Black (Plate 12 A.); scape, pedicel and first funicular segment yellowish brown; eyes greyish; fore and mid legs yellowish brown; hind coxa blackish red; hind femur and tibia rufous; gaster blackish dorsally and rufous ventrally and laterally; tegulae yellowish brown; forewing with two large black bands and two white spots one spot adjoining stigmal and the other at median region of posterior side. Head height is 1.8x its length; vertex and temples somewhat narrow; frons not concave; relative measurement of POL: 26, OOL: 10, preorbital carinae faintly indicated; postorbital carinae absent; scrobe shallow, striated not reaching front ocellus; genotemporal furrow absent; frontogenal sulcus only faintly indicated. Thorax length is 1.4x its width; thorax with close pits and narrow interstices on pronotum. ecarinate and rugulose. Mesoscutum with interstices smooth and wider than diameter of pits on middle region, other regions with narrower and rugulose interstices. Scutellum characteristically very convex, pits close, interstices narrow, rugose, apex weakly emarginate, Propodeum with distinct submedian and sublaterai carinae, accessorial carinae absent, postspiracular teeth slightly indicated.

Materials Examined: 1 female, INDIA, Kerala, Trivandrum, Kulathunad, Kattakada, 08-09-2019, coll. Anju Krishnan G

4.1.1.3.2. *Hockeria* sp.2

Diagnosis: Female: Length: 1.97 mm. Black (Plate 12 B.); eyes grey; pedicel is yellowish; all legs black; gaster blackish dorsally, ventrally and laterally; forewing with two large yellowish black bands. Head height is 1.7 x its length; vertex and temples somewhat narrow; frons not concave; relative measurement of POL: 55, OOL: 10, preorbital carinae absent; postorbital carinae absent; scrobe shallow, striated not reaching front ocellus; genotemporal furrow absent; frontogenal sulcus only faintly indicated. Thorax length is 1.3 x its width; thorax with close pits and narrow interstices on pronotum. ecarinate and rugulose. Scutellum characteristically very convex, pits close, interstices narrow, rugose, apex weakly emarginate, Propodeum with distinct submedian and sublaterai carinae, accessorial carinae absent, postspiracular teeth slightly indicated.

Materials Examined: 1 female, INDIA, Kerala, Kasaragod, Pilicode (RARS), 28-11-2021, coll. Jaseel R

4.1.1.3.3. *Hockeria* sp.3

Diagnosis: Female: Length: 1.78 mm. Black (Plate 12 C.); antenna black; eyes grayish; all legs are black; gaster blackish; forewing with two large black bands and two white spots one spot adjoining stigmal and the other at median region of posterior side. Head height is 1.8 x its length; vertex and temples somewhat narrow; frons not concave; relative measurement of POL: 11, OOL: 1, preorbital carinae faintly indicated; postorbital carinae absent; scrobe shallow, striated not reaching front ocellus; genotemporal furrow absent; frontogenal sulcus only faintly indicated. Antenna with length of scape (0.28mm) subequal to combined length of segments 4-6 (0.27mm); pedicel shorter (0.070 mm) than fourth segment(0.09 mm); pedicel is long as 4 x length of ring segment; club length about 1.3 x length of preceding segment. Thorax length is subequal to its width; thorax with close pits and narrow interstices on pronotum. Scutellum characteristically very convex, pits close, interstices narrow, rugose, apex weakly emarginated.

Materials Examined: 1 female, INDIA, Kerala, Alappuzha, Neelamperoor , 19-01-2018, coll. Manu Govind K K

4.1.1.3.4. *Hockeria* sp.4

Diagnosis: Female: Length: 1.9 mm. Black (Plate 12 D.); scape and pedicel yellowish brown; eyes greyish; fore and mid legs yellowish brown; hind leg black; gaster blackish; Head height is 1.55 x its length; vertex and temples somewhat narrow; frons not concave; relative measurement of POL: 35, OOL: 10, preorbital carinae faintly indicated; postorbital carinae absent; scrobe shallow, striated not reaching front ocellus; genotemporal furrow absent; frontogenal sulcus only faintly indicated. Antenna with length of scape (0.29 mm) subequal to combined length (0.32 mm) of segments 4-7; pedicel shorter than fourth segment; ring segment half as long as pedicel; club length about 1.5 x length of preceding segment. Thorax length is sub equal to its width; thorax

A.

B.

C.

D.

Plate: 12 A-D Genus Hockeria

with close pits and narrow interstices on pronotum. Scutellum characteristically very convex pits close, interstices narrow, rugose, apex weakly emarginated.

Materials Examined: 1 female, INDIA, Kerala, Trivandrum, Nellikamala 28-11-2022, coll. Anju Krishnan G

4.1.1.4*Tropimeris* Steffan 1948

Diagnosis: Head nearly triangular with long converging genae which are slightly longer than breadth of small mouth; antennae inserted far above mouth; in dorsal view head strongly transverse; temples posteriorly strongly carinate; preorbital carina absent; postorbital carina present though blunt; frontogenal sulcus absent. Antenna short, scape tapering distally; pedicel subglobose.

4.1.1.4.1 *Tropimeris monodon* Bouček

Diagnosis: 2.4 mm. Black (Plate 13 A.); The antennal scape at the tip, the knees, and the tips of the tibiae are golden brown (Plate 13 C.). Tarsi with the exception of the claw segment light brown yellow. The first tergite is reddish brown. Wings white, forewing with length (1.53 mm.) width (0.594 mm.) ratio is 2.58, brown wing veins having the sub marginal marginal vein length ratio 6.4. Scape with length width ratio 6.6. Scape 5 x long as pedicel, pedicel length is 1.5 x its width. Hind femora rather slender, with one sharp dent in distal half, hind tibia on side against femoral dent slightly curved(Plate 13 B.).

Distribution: Kerala, Andhra Pradesh, Maharashtra, Uttar Pradesh

Materials Examined: 1 female, INDIA, Kerala, Kozhikode, Calicut University, 09-8-2022, coll. Jaseel R; 1 female, INDIA, Kerala, Alappuzha, Neelamperoor, 09-01-2018, coll. Manu Govind

4.1.2 Subfamily: DIRHININAE

4.1.2.1 *Dirhinus* Dalman

Eniaca Kirby 1983b.

Dirrhinoidea Girault 1912.

Paraniaca Crawfor 1914b.

Eniacella Girault 1914.

Dirhinoids Masi 1947.

Diagnosis: Head with two projecting horns(Plate 14 B.); gaster with petiole; ventral margin of hind femur with smoothly arched comb of teeth.The anteromedian areola of the propodeum is at most somewhat wider than length and the strigose area on the first gastral tergite is not expanded in the two dimensions.

4.1.2.1.1 *Dirhinus anthracia* Walker 1846

Dirhinus aligarhensis Husain and Agarwal 1981b:183

Dirhinus ignobilicornis Husain and Agarwal 1981b: 187

Dirhinus sinon Fernando 1957:214

Eniacella rufricornis Girault 1913d

Eniacella bicornuticeps Girault 1915b

Dirhinus sarcophagae Froggat 1919

Dirhinus frequens Masi 1933

Dirhinus intermedins Mani and Dubey 1972

Dirhinus georgei Mani and Dubey l974

Diagnosis: Length: 3.85mm; Black(Plate 14 A.); antennae with scape, pedicel and club yellowish brown; fore and mid legs pale brown; hind tarsi pale yellowish; wings hyaline with veins pale yellow; eyes yellowish black; head in lateral view with outline of vertex convex(Plate 14 c.), relative measurements of POL: 1, OOL: 2. Thorax densely and closely punctate; interstices narrow and rugose; scutellum slightly wider than long, its apex subangulate, slightly raised; propodeum not very short, median areola convex at sides, margin. Postmarginal vein absent, distinct hairline recurring from forewing with apex of marginal vein virtually on side, hind coxa 1.57x as long as broad; hind tibia without an additional groove on outer side; first tergite occupying more than three-fourth of gaster. Basal carinae not well developed but distinct.

A.

B.

C.

Plate: 13 A. *Tropimeris monodon*. B. Hind leg C. Head front view

A.

B. C.

Plate: 14 A. *Dirhinus anthracia* B. Head dorsal C. Head lateral view

Distribution: Andaman and Nicobar Islands, Andhra Pradesh, Bihar, Karnataka, Kerala, Madhya Pradesh, Manipur, Mizoram, Puducherry, Punjab, Tamil Nadu, Tripura, Uttar Pradesh

Materials Examined: 1 female, INDIA, Kerala, Trivandrum, Parassala, 07-01-2019, coll. Anju Krishna

4.1.2.2 *Eniacomorpha* Girault

The scrobal depression have a secondary tooth; narrow horn and mostly sharp at apex in contrast to the wide scrobal depression; hypopygium without long and paired apical setae. The anteromedianareola of the propodeum is atmost some what longer than wide and the strigose area on the first gastral tergite is well expanded in the two dimensions, reaching at least one third of the dorsal surface of the tergite and occupying most of its width.

4.12.2.1 *Eniacomorpha bakeri* Crawford

Description of male allotype. Body length 2.8 mm. Body black(Plate 15 B.). Apex of femora and base and apex of tibiae of fore and mid legs are yellowish; tarsi pale yellow. Fore wing length width ratio is 2.81. Head 1.73× as wide as long, 0.97× as wide as high and 1.77× as high as long; eye 1.79× as long as high; temple as 0.73× long as eye when latter is seen in dorsal view. Vertex and dorsal surface of horns densely punctured. Two horns on head, mostly tapering near their apex(Plate 15 C.); length of horn on dorsal view is 0.6× eye length and the fronto-vetrex width and horn length ratio is 2.22. Distance between lateral ocelli 0.83× as long as that of inter-ocellar distance. Companied length of pedicel and flagellum is 1.13× head width. Scape length and head height ratio is 0.67 Pedicel, anellus and second funicular respectively 1.67×, 1× and 1.33× as long as wide; 8th flagellomere 0.6× as long as wide and 1.67× as wide as 2nd flagellomere. Clava ovoid, 1.25× as long as wide, narrowly rounded at apex.

Mesosoma 1.22× as long as wide, dorsally flattened. Pro-and mesonotum densely punctured with smooth interspaces and bearing lanceolate setae. Punctured groovelike notaulus. Mesoscutum width 1.17× pronotum width Lateral lobe only slightly less densely punctured than mid lobe but more coarsely so, bearing`reclinate setae while they are proclinate on the axilla. Mesoscutellum 0.88× as long as wide, virtually flat, angulate anteriorly because axillar grooves almost join each other on transscutal line, and with a small micro posteriorly, overhanging postscutellum. Propodeum with surface virtually horizontal, setation absent on anteromedian areolae; anteromedian areola as long as wide (Plate 15 D.); subcoxal and precoxal teeth on posterior margin projecting and sharp. Metacoxa 0.88× as long as wide, with broad apicodorsal flange having a regularly rounded edge. Metafemur quite long, 6× as long as wide and with strongly convex dorsal margin at base; short and wide basal tooth visible on ventral margin of metafemur before serrulation. Wings Fore wing 2.81× as long as wide. Petiole bare, with dorsal surface transverse, 2.42× as wide as long.

Gaster 2.24× as long as wide, 1st gastral tergite large, 0.68× as long as gaster, longitudinally strigose on basal third, the strigose surface about as long as wide with slightly convex posterior limit (Plate 15 D.), following tergites much shorter with progressively more concave posterior margins.

Distribution: Delhi, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal.

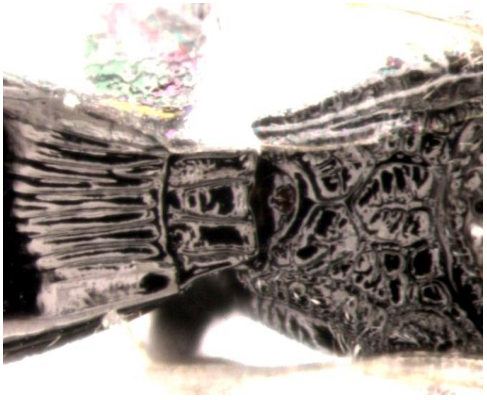
Materials Examined: 1 female, INDIA, Kerala, Trivandrum, CoA Vellayani, 07-07-2022, coll. Jaseel R; 3 male, INDIA, Kerala, Trivandrum, Parassala, 07-07-2022, coll. Anju Krishnan G

4.1.2.2.2 *Eniacomorpha madagascariensis* Masi

Dirhinus madagascariensis Masi 1947.
Pareniaca madagascariensis Masi 1947: 7 1 - 74.

A.

B.



C. D. E.

Plate: 15 A. *Eniacomorpha bakeri* Female B. *Eniacomorpha bakeri* Male C. Head and Thorax dorsal D. Anteromedianareola of the propodeum and Strigose area on the first gastral tergite E. Head lateral

Pareniaca corornandelica Mani and Dubey 1974: 30-31.

Diagnosis: Female. 4.2mm (Plate 16 A.). Antennae reddish but often broadly infuscate before apex; wings often subinfumate. Horns in dorsal view very narrow and diverging, in lateral view ocellar area prominent but upper tooth unusually low (Plate 16 E.) well surpassed by apex of scape and rather close to frontal tooth which is high and sharp; also prominences bearing antennae strongly projecting, appearing tooth like. Head (laterally) unusually short, less than 1.4 times as high as stout. Raised clypeal area about twice as high as its distance from scrobal cavity. Punctation on thorax rather dense, on mesoscutum and scutellum often partly confluent longitudinally into grooves separated by smooth ridges. Pronotum depressed narrowly in median line. Median areola elongate (Plate 16 B.); hairs on lateral areas not very conspicuous. Hind femur very stout, only 1.47 times as long as broad. Hind tibia distally on outer side finely striate but without additional carina. Postmarginal stump in forewing distinctly longer than stigmal vein; a streak of hairs recurrent from stigma. Petiole transverse but area of four striae only slightly broader than long (Plate 16 C.). Striate area of first tergite relatively large, striae deep even posteriorly where ending in a convex line.

Distribution: Karnataka, Kerala, Tamil Nadu, West Bengal.

Materials Examined: 1 female, INDIA, Kerala, Trivandrum, Parassala, 07-07-2022, coll. Anju Krishna

4.1.3 Subfamily: Epitraninae

4.1.3.1 *Epitranus* Walker 1834

Chalcitella Westwood 1835.

Anacryptus Kirby 1883b.

Arretoceru Kirby 1883b.

Neoanacryptus Girault 1913a.

Chalcitelloides Girault 1914.

Paranacryptus Girault 1915b

Pararretoceroidcs Mani 1938.

Diagnosis: Gaster with slender striate petiole, gaster ventrally bulging.Antennal toruli located very low on a shield protruding over mouth.Marginal vein very long, stigmal vein rudimentary, post marginal absent.Hind leg: coxa large, subcylindrical to subconical; trochanter large and closely applied to truncate base of femur, this beneath with one row of teeth; tibia produced into apical curved spine, tarsal sulcus present but of varying length, sometimes deep and long, then reaching up to subbasal protuberance consisting of one or several teeth which may be concealed by hairs. Gastral body rather small, compressed from side-to-side and as if suspended at end of narrow striated petiole

4.1.3.1.1 *Epitranus erythrogaster* Cameron 1888

Anacryptus sculpturatus Crawford 1910 b.

Anacryptus kankauensis Masi 1933.

Arretoceroides ceylonensis Mani 1936.

Anacryptus raoi Mani and Kurian 1953.

Chalcitetloides devadatta W. Fernando 1957.

Chalcitelloides ajatasattu Fernando 1957.

Chalcitetla cinca W. Fernando 1958.

Pararretoceroides austini E. Fernando 1959.

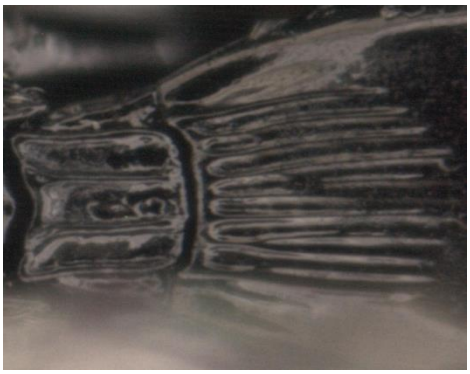
Arretocera ambadtvia Mani and Dubcy 1973.

Arretocera nilamburense Mani and Dubey 1973.

Arretocera pallava Mani and Dubey 1973.

Arretocera tanjorensis Mani and Dubey 1973.

A.



B. C.

D. E.

Plate: 16 A. *Eniacomorpha madagascariensis* B. Anteromedianareola of the propodeum C. Strigose area on the first gastral tergite C. Head dorsal E. Head lateral

Chalcitella nilamburensis Mani and Dubey 1974.

Arretocera malabarensis Mani and Dubey 1974.

Diagnosis: Length 2.52 mm(Plate 17 A.).. Body mostly black, but with reddish colour on legs beyond coxae and at least ventrally on gaster. Antennae extremely 1.24 mm in length, balck color except scape; scape is yellowish, POL and OOL ratio is 2.25. Thorax with the length of 1.43× its width; forelegs and middle legs are pale yellow; hind leg is black with base and apex of femur is brownish; hind femur having a length that twice of width. For wing is hyaline and having submarginal and marginal vein with the length ratio of 1.4. Abdomen is elongate with a length width ratio of 2.23.

Distribution: Andaman and Nicobar Islands, Bihar, Karnataka, Kerala, Maharashtra, Manipur, Pondicherry, Tamil Nadu, Uttar Pradesh, West Bengal

Materials Examined: 1 female, INDIA, Kerala, Kozhikode, Calicut University, 09-8-2022, coll. Jaseel R

4.1.4 Subfamily: Chalcidinae

4.1.4.1*Brachymeria* Westwood 1829

Tumidicoxa Girault 1911.
Pseudepitelia Girault 1913b.
Brachepitelia Girault 1913b.
Tumidicoxoidcs Girault 1913b.
Twnidicoxella Girault 1913b.
Meyeriella Kxausse 1916.
Onchoehalcis Cameron 1904.
Ceyxia Cameron 1911.
Holochalcis Kieffer 1904.

Diagnosis: Postmarginal vein often longer than stigmal vein; upper part of head without horn shaped structure; petiole without longitudinal ridges; malar suture between mouth and eye distinct, usually indicated by carina.

4.1.4.1.1*Brachymeria apicicornis* Cameron 1911

Diagnosis: Female: Length 2.68 mm. Balck colored body(Plate 17 B.).; antennae black with brown tinge; hind femur is black; base and apex of hind tibia yellow tarsus are whitish yellow Head height 1.83x as length, eye length is half of its height pre and postorbital carina well developed; scrobe smooth and shiny reaching front ocellus: POL is 335x OOL; antennae with scape not quite reaching front ocellus. Thorax with length subequal width; apex of bilobed. Forewing with relative measurements sub marginal 157, marginal: 60, post marginal : 20 and stigmaL 10. Hind femur with length width ratio of 1.8. Gaster suboval in shape, a little longer than thorax (1.09 mm), first tergite smooth and shiny. Epipygium and ovipositor well visible from dorsal side.

Distribution: Bihar, Karnataka, Kerala, Tamil Nadu.

Materials Examined: 1 female, INDIA, Kerala, Trivandrum, COA Vellayani, 03-02-2021, coll. Jaseel R; 1 female, INDIA, Kerala, Alappuzha, Nilamperur, 09-01-2018, coll. ManuGovind

A.

B.

Plate: 17 A. *Epitranus erythrogaster* B**. *Brachymeria apicicornis***

Discussion

5. DISCUSSION

The results of the study 'conducted during 2019-2022' with an objective of Identification, morphological characterization and documentation of family Chalcididae are discussed in this chapter.

5.1 IDENTIFICATION AND MORPHOLOGICAL CHARACTERIZATION

One of the most intriguing and challenging hymenopteran families to investigate taxonomically is Chalcididae. They share similar morphological characteristics with other Chalcidoidea groups, and thus, is difficult to distinguish them at the species level. Whilst many Chalcididae species have a similar appearance, they exhibit very different behaviours. This family includes medium-sized to big chalcids that range in size from 1.5 to 15 mm (Narendran and Achterberg, 2016).Thirteen distinct species of Chalcid wasps belonging to 6 genera under 4 subfamilies collected from various sites in Kerala were morphologically described and photographed.

In the world there have been roughly 1500 legitimate species of chalcids in nearly 90 valid genera among this 447 species and 38 genera are recognised from the Oriental region and the family currently includes 5 subfamilies globally (Noyes, 2019). Chalcidinae, Haltichellinae, Dirhininae and Epitraninae are the four subfamilies are treated here.

The subfamily Chalcidinae is widely distributed in the world. In this sub family there are about 28 valid genera all around the world of which only five are reported from Kerala*viz*., *Brachymeria* Westwood,*Chalcis* Fabricius,*Conura* Spinola,*Megachalcis* Cameron and *Phasgonophora* Westwood (Noyes, 2019). Three specimens collected from Trivandrum district of Kerala (CoA Vellayani, Neelamperur , Attingal) showed all characters of the subfamily mainly,the hind tibia is sharply truncated at the apex, generating a powerful spine that extends beyond the insertion of the tarsus and the tarsus typically has just one spur, either substantially shorter petiole or hidden one. In the five reported genera *Brachymeria* is the most diverse genus with about 43 reported species.

The species *Brachymeria apicicornis* Cameron was studied in detail. The most reliable character of the species are,post marginal vein significantly longer than stigmal vein, longitudinal ridges in the petiole lacking, prominent malar suture between the mouth and the eye, yellow colour at the base and tip of the hind tibia, tarsus light yellow in colour (Narendran, 1989). This species is distributed in Indonesia, Malaysia and India where it occurs in Kerala, Tamil Nadu, Karnataka and Bihar (Binoy *et al.*, 2021). Ferrière (1940) recorded *B. apicicornis* as a possible hyperparasitoid of *Ptychomyia* Brauer and von Bergenstamm, *Cadurcia* Villeneuve (Diptera, Tachinidae) or *Goryphus* Holmgren (Hymenoptera, Ichneumonidae) parasitizing the coconut leaf moth *Artona catoxantha* (Lepidoptera, Zygaenidae) in Java, Indonesia.

Haltichellinae is the largest subfamily in Chalcididae in which 19 genera are reported from Kerala with a total of 77 species (Binoy *et al*., 2021). This subfamily can be easily identified by the hind tibia, almost straight truncated at apex and with two spurs, if apex with a curved spine then tibia without spurs at apex. In this study two tribes Haltichellini and Tropomeridini are encountered among the three known tribes. These two tribes can be distinguished by the two characters. M.V near to the margin of the forewing and distinctly developed PMV and SgV which can be seen in Haltichellini, however, in case of Tropomeridini, PMVis seen slightly away from wing margin, PMV absent, SgV rudimentary and hind tibia showing extra carina. The present study includes 8species under 4 genera in which, one genus belong to tribe Tropomeridini and three genera from Haltichellini.

The genus *Neohaltichella* Narendran currently include five species among which, only two are reported from Kerala and the genus has the most reliable of the two characters *viz*., ventral edge of the posterior femora lacks a pronounced dent and pre orbital carina is present. *Neohaltichella nilgirica* Narendran is reported for the first time from Kerala. Narendran in 1989 reported *Neohaltichella nilgirica* as a new species from Tamil Nadu, India and described the species with the distinguishing characters *viz*., elongate gena; posterior genotemporal furrow present; maximum length of eye is 1.65x

frontogenal sulcus; marginal sub equal to post marginal; last tergite without having distinct rows of pits, rugosopunctate.

Two species of *Antrocephalus* Kirby, *Antrocephalus decipiens* Masi and *Antrocephalus* sp. in-determined were examined during the study. The genus *Antrocephalus* Kirby is distributedworldwide, with 125 reported species among which 20 species are recorded from Kerala. The genus can be identified by their prominent characters such as hind tibia not having additional carina, fronts having strong horse-shoe shape carina running from behind front ocellus along the inner margin of eyes; convex pronotum; anterior pronotal carinae with paired tubercles in the middle. *Antrocephalus decipiens* Masi was collected from Calicut university, Kozhikode and the species characters include, forewing with relative proportion of veins submarginal: 83, marginal:24 , postmarginal: 9, stigmal: 2, POL 10X OOL, first tergite each carina with 2 parallel ridges. One specimen was collected from CoA Vellyani, Thiruvananthapuram.

Genus Hockria currently contain 98 identified species globally (Noyes, 2019). From Kerala 14 species are reported (Binoy *et al*., 2021). Four specimens were collected from Pilikode (Kasaragod), Neelamperoor (Alappuzha), Kattakada and *Nellikamala (Thiruvanandapuram) identified at generic level. The genus have the reliable characters of Haltichellinae, the postmarginal* vein is considerably longer in this taxa. The presence of varied carinae on the distal tergite of the gaster distinguishes this genus, and species may have either two or three little longitudunal carinae (Narendran, 1989)

Tropimeris Steffan is the genus under the tribe Tropomeridini which consist of three reported species *Tropimeris excavata* Steffan, *Tropimerisi ndicus* Husain and Agarwal *Tropimeris monodon* Boucek (Noyes, 2019). But only *Tropimeris monodon* Boucek is reported from Kerala and the 3 specimens of the species collected from Calicut university (Kozhikode), Neelamperoor (Alappuzha) were studied here. The genus can easily identified by Hind femur with sharp tooth in distal third, short comb behind the tooth and antennae inserted high, more than half length of scape above mouth

level. This species is recorded as the pupal parasitoid of *Exelastis atomosa* (Gupta and Poorani, 2009).

Sub family Dirhininae are very easily identifiable because of their shape of head the head contain two projecting horns however, species of this group are very difficult to separate (Bouček, 1988). In this study the two genus *Dirhinus* Dalman and *Eniacomorpha* Girault are dealt.

From Kerala the genus *Dirhinus* Dalman currentlty have a reported strength of five species. Three specimen *Dirhinus anthracia* Walker was collected from Parassala and Nallikkamala in Thiruvananthapuram district. It act as parasitoids of *Calliphora stygia* Fabrecius, *Calliphora villosa* Robineau-Desvoidy, *Musca domestica* Linneaus, *Sarcophaga aurifrons* Macquart, *Sarcophaga inzi* Curran, *Sarcophaga tibialis* Macquart, *Bactrocera cucurbitae* Coquillett, *Bactrocera dorsalis* Hendel, *Dacus cucurbitae* Coquillett, *Dacus ferrugineus* Fabrecius, *Bombyx mori* Linneaus, *Placoptera reflexa* Guenee, *Eutectona machaeralis* Walker, *Hapalia machaeralis* Hapama, *Pyrausta machaeralis* Walker, *Artona catoxantha* Hampson, *Brachartona catoxantha* Hampson and *Chortoicetes terminifera* Walker (Noyes, 2019).

The genus *Eniacomorpha* Girault have similarity to the sub genus *Paraniaca* of genus *Dirhinus* in which scrobal depression having secondary tooth but in case of *Eniacomorpha* the propodeum with anteromedian areola. The first gastral tergite's strigose region is substantially enlarged in two dimensions, encompassing at least one third of the dorsal surface and most of the breadth (Delvare *et al*., 2019). Two species of *Eniacomorpha* are collected and studied. Six specimens of *Eniacomorpha bakeri* Crawford were analyzed in which four are males the full description for male characters aren't exploited yet. In this work a good re-description is given to the species with the available male characters. The other one species studied is *Eniacomorpha madagascariensis* Masi and there are only these two species far reported from Kerala.

The sub family Epitraninae doesn't have tribes in it. A specimen of *Epitranus erythrogaster* Cameron, 1888 is collected from Calicut University, Kozhikode studied. Small moths belonging to the genera *Corcyra* and *Tirathaba* of the family Pyralidae as well as *Tinea* and *Crypsithyris* of the Tineidae, are known to serve as hosts for the *Epitranines*, which are not uncommon in the Oriental area. But only four species, *Epitranus impulsator*, *Epitranus clavatus*, *Epitranus ramnathi*, and *Epitranus erythrogaster* are known to be parasitic on these hosts (Bouček, 1982).

5.2 CHECK LIST

Genus: Brachymeria Westwood, 1829

1. *B. albicrus* Klug, 1834
2. *B. albotibialis* Ashmead, 1904
3. *B. apicicornis* Cameron, 1911
4. *B. atteviae* Joseph, Narendran and Joy, 1972
5. *B. aurea* Girault, 1915
6. *B. banksi* Ashmead, 1905
7. *B. bengalensis* Cameron, 1897
8. *B. burksi* Chhotani, 1966
9. *B. carinata* Joseph, Narendran and Joy, 1970
10. *B. coxodentata* Joseph, Narendran and Joy, 1970
11. *B. croceogastralis* Joseph, Narendran and Joy, 1972
12. *B. euploeae* Westwood, 1837
13. *B. excarinata* Gahan, 1925
14. *B. femorata* Panzer, 1801
15. *B. habui* Özdikmen, 2011
16. *B. hime* Habu, 1960
17. *B. indica* Krausse, 1917
18. *B. inermis* Fonscolombe, 1840
19. *B. jambolana* Gahan, 1942
20. *B. lasus* Walker, 1841
21. *B. lugubris* Walker, 1871
22. *B. manjerica* Narendran, 1989
23. *B. margaroniae* Joseph, Narendran and Joy, 1973
24. *B. marginiscutis* Cameron, 1907
25. *B. marmonti* Girault, 1924

26. *B. megaspila* Cameron, 1907
27. *B. menoni* Joseph, Narendran and Joy, 1972
28. *B. minuta* Linnaeus, 1767
29. *B. nephantidis* Gahan, 1930
30. *B. nosatoi* Habu, 1966
31. *B. podagrica* Fabricius, 1787
32. *B. rufotibialis* Husain and Agarwal, 1982
33. *B. ryukyuensis* Habu, 1963
34. *B. salinae* Narendran, 1989
35. *B. scutellocarinata* Joseph, Narendran and Joy, 1972
36. *B. shansiensis* Habu, 1961
37. *B. silentvalliensis* Narendran and Emiliyamma, 2014
38. *B. taiwana* Matsumura, 1911
39. *B. tapunensis* Joseph, Narendran and Joy, 1972
40. *B. trinidadensis* Narendran and Varghese
41. *B. thracis* Crawford, 1911
42. *B. wiebesina* Joseph, Narendran and Joy, 1972

Genus: Chalcis Fabricius, 1787

1. *C. gibsoni* Narendran, 1987

Genus: Conura Spinola

1. *C. abdominalis* Walker, 1861

Genus: Megachalcis Cameron, 1903

1. *M. kannapuramensis* Sureshan and Girish Kumar, 2018
2. *M. malabarica* Narendran, 1989

Genus: Phasgonophora Westwood, 1832

1. *P. steffani* Narendran

2. *P. rubra* Binoy 2022

Genus: Dirhinus Dalman, 1818

1. *D. alticornis* Masi, 1927
2. *D. anthracia* Walker, 1846
3. *D. auratus* Ashmead, 1905
4. *D. banksi* Rohwer, 1923
5. *D. claviger* Bouček and Narendran, 1981
6. *D. himalayanus* Westwood, 1836

Genus: Eniacomorpha Girault, 1915

1. *E. madagascariensis* Masi, 1947
2. *E. bakeri* Crawford, 1915

Genus: Epitranus Walker, 1834

1. *E. chilkaensis* Mani,, 1936
2. *E. elongatulus* Motschulsky, 1863
3. *E. erythrogaster* Cameron, 1888
4. *E. nigriceps* Bouček, 1982
5. *E. oxytelus* Bouček, 1982
6. *E. parvidens* Strand, 1911
7. *E. ramnathi* Mani and Dubey, 1973
8. *E. uterellophagus* Binoy and Santhosh, 2020

Genus: Antrocephalus Kirby, 1883

1. *A. abui* Narendran, 1989
2. *A. brevidentata* Roy and Farooqi, 1984
3. *A. brevigaster* Masi, 1932
4. *A. cariniaspis* Cameron, 1911

5. *A. cariniceps* Cameron, 1911
6. *A. decipiens* Masi, 1929
7. *A. dividens* Walker, 1860
8. *A. fascicornis* Walker, 1871
9. *A. hakonensis* Ashmead, 1904
10. *A. japonicus* Masi, 1936
11. *A. lugubris* Masi, 1932
12. *A. maculipennis* Cameron, 1905
13. *A. masii* Özdikmen, 2011
14. *A. mitys* Walker, 1846
15. *A. narendrani* Sureshan, 1994
16. *A. nasutus* Holmgren, 1868
17. *A. nigrus* Masi, 1929
18. *A. peechiensis* Narendran, 1989
19. *A. phaeospilus* Waterston,, 1922
20. *A. sepyra* Walker, 1846

Genus: Bucekia Steffan, 1951

1. *B. differens* Bouček, 1949

Genus: Haltichella Spinola, 1811

2. *H. clavicornis* Ashmead, 1904
3. *H. delhensis* Roy and Farooqi
4. *H. luzonica* Narendran, 1989
5. *H. macrocera* Waterston

Genus: Hockeria Walker, 1834

1. *H. aligarhensis* Roy and Farooqi, 1984
2. *H. anupama* Narendran, 1989

3. *H. argentigera* Holmgren, 1868
4. *H. atra* Masi, 1929
5. *H. bangalorica* Narendran, 1989
6. *H. bifasciata* Walker, 1834
7. *H. carinata* Narendran, 1989
8. *H. fronta* Narendran, 1989
9. *H. hayati* Narendran, 1989
10. *H. manii* Narendran, 1989
11. *H. menoni* Narendran, 1986
12. *H. nipponica* Habu, 1960
13. *H. tarsata* Dalla Torre, 1898
14. *H. tristis* Strand

Genus: Indoinvreia Roy and Farooqi, 1984

1. *I. menoni* Roy and Farooqi, 1984

Genus: Kriechbaumerella Dalla Torre, 1897

1. *K. cordigaster* Roy and Farooqi, 1984
2. *K. destructor* Waterston, 1922
3. *K. kraussi* Narendran, 1989
4. *K. ornatipennis* Cameron, 1902
5. *K. rufimanus* Walker, 1860
6. *K. titusi* Narendran, 1989

Genus: Lasiochalcidia Masi, 1929

1. *L. narendrani* Binoy and Sureshan, 2019
2. *L. pilosella* Cameron

Genus: Neochalcis Kirby, 1883

1. *N. breviceps* Masi, 1929

Genus: Neohaltichella Narendran, 1989

1. ***N. nilgirica* Narendran (New record from kerala)**
2. *N. thresiae* Narendran
3. *N.uterellophaga* Binoy, 2021

Genus: Notaspidiella Bouček, 1988

1. *N. shyamagatra* Narendran, 2013
2. *N. sringeriensis* Narendran, 2006

Genus: Notaspidium Dalla Torre, 1897

1. *N. grisselli* Narendran, 1987

Genus: Oxycoryphe Kriechbaumer, 1894

1. *O. komui* Narendran
2. *O. thresiae* Narendran

Genus: Proconura Dodd, 1915

1. *P. asiatica* Narendran, 1989
2. *P. caryobori* Hanna, 1934
3. *P. emarginata* Roy and Farooqi, 1984
4. *P. minusa* Narendran, 1989
5. *P. orientalis* Husain, Rauf and Kudeshia, 1985

Genus: Psilochalcis Kieffer, 1905

1. *P. adhara* Narendran, 1989
2. *P. anupama* Narendran, 1989
3. *P. carinigena* Cameron, 1907
4. *P. erythropus* Cameron, 1897
5. *P. ghanii* Habu, 1970
6. *P. keralensis* Narendran, 1989
7. *P. subarmata* Foerster, 1855

Genus: Rhynchochalcis Cameron, 1905

1. *R. brevicornuta* Strand, 1911
2. *R. thresiae* Narendran, 1989

Genus: Steninvreia Bouček, 1988

1. *S. noyesi* Narendran, 1989

Genus: Tainaniella Masi, 1929

2. *T. malabarica* Narendran, 1989
3. *T. spinator* Walker, 1862

Genus: Tropimeris Steffan, 1948

1. *T. monodon* Bouček

Genus: Uga Girault, 1930

1. *U. javanica* Kerrich, 1960
2. *U. menoni* Kerrich
3. *U. sinensis* Kerrich, 1960

Genus: Smicromorpha Girault, 1913

1. *S. keralensis* Narendran, 1979

Summary

6. SUMMARY

The investigation on "Biosystematics studies on the family Chalcididae (Hymenoptera: Chalcidoidea)" was conducted in three stages. - collection of Chalcid wasp from various parts of Kerala; morphological characterization of specimens through micrometry; documentation with photographs. The study was conducted at College of Agriculture Vellayani with an objective of identification, morphological characterization and documentation of family Chalcididae.

A total of 13species under 8 genera and 4 subfamilies of Chalcididae collected from 11 locations spread across 6 districts of Kerala are treated in this study. The study revealed the presence of *Neohaltichella nilgirica* Narendran in Kerala, which was earlier reported from Tamil Nadu, India and hence, is consider a new record from Kerala. In addition to the new record, the species *Eniacomorpha bakeri* Crawford 1915is re-described with the addition of male characters.

The specimens were collected by random sweep net method. The insect activity was observed at its highest in the morning from 9 AM to afternoon hours till 3 PM, and the collections were carried out during the peak time. The net sweep contents were immediately transferred to absolute alcohol and the locations and collecting dates were noted. Under a high power stereo microscope. The specimens that were obtained from the field were sorted and stored in labeled vials with absolute alcohol. The chalcid specimens were card mounted for morphometric analysis and characterization.

Thirteen species of chalcid wasps were morphologically characterized and documented through photographs. This includes one new report and previously reported seven species which belong to 6 genera under 4 subfamilies. The documented species are *Neohaltichella nilgirica* Narendran, *Antrocephalus decipiens* Masi 1929, *Tropimeris monodon* Bouček, *Dirhinus anthracia* Walker 1846, *Eniacomorpha bakeri* Crawford 1915, *Eniacomorpha madagascariensis* Masi 1947, *Epitranus erythrogaster* Cameron 1888, *Brachymeria apicicornis* Cameron 1911, and

one specimen of genus *Antrocephalus* Kirby 1883 and 4 specimens of genus *Hockeria* Walker, 1834.

Based on the collection made in this study it was confirmed that Haltichellinae is the most widespread Subfamily in Kerala followed by Dirhininae. During the study only one species of Subfamily Chalcidinae and Epitraninae were observed. From the subfamily Haltichellinae out of eight species studied, seven belong to the tribe Haltichellini and remaining one is from Tropomeridini.

A complete checklist of 143 species of Chalcids occurring in Kerala is provided.

References

7. REFERENCES

Aguiar., Alexandre, P., Deans., Andrew R., Engel., Michael S., Forshage., Mattias., Huber., and John T. 2013. Order Hymenoptera. *In*: Zhang, Z.-Q. (Ed.) Animal Biodiversity: An Outline of Higher-level Classification and Survey of Taxonomic Richness (Addenda 2013). *Zootaxa*. 3703 (1):51.

Ahmad, M.J., Khursheed, I. and Azim, M.N. 2012. A new species of *Epitranus* Walker (Chalcidoidea: Chalcididae) from Kashmir, India. *J. Insect Sci. Ludhiana* 25(3): 316-317.

Andersen, T. 1974. Notes on *Chalcis sispes* Linnaeus and *Haltichella rufipes* Olivier (Hym., Chalcididae). *Norsk Entomologisk Tidsskrift* 21(1): 109.

Aquino, D. A., Tavares, M.T., Balducci, E., Baca, V. and De Quinteros, S.Q. 2015. The microlepidopterous natural enemy *Brachymeria subrugosa* Blanchard, 1942 (Hymenoptera, Chalcididae): identity, hosts and geographic distribution. *Zootaxa 4013*(2): 293-300.

Arthur, A.P., 1958. Development, Behaviour, and Descriptions of Immature Stages of Spilochalcis side (Walk.)(Hymenoptera: Chalcididae) 1. *The Canadian Entomologist*, *90*(10), pp.590-595.

Ashmead, W.H. 1904. *Classification of the Chalcid Flies: or the Superfamily Chalcidoidea, with Descriptions of New Species in the Carnegie Museum, Collected in South America by Herbert H. Smith* :Vol. 1. Authority of the Board of Trustees of the Carnegie Institute.

Askew, R. R. 1991. Some Chalcididae from Spain with description of a new species of *Brachymeria* Westwood. *Eos. Revista Española di Entomologia. Madrid.* 67: 131-133.

Baugnée, J. Y. and Vago, J. L. 2006. Note on the presence of *Chalcis myrifex* (Sulzer, 1776) (Hymenoptera: Chalcididae) in Belgium. *Notes fauniques de Gembloux* 59(4): 219-220.

Binoy, C., Santhosh, S. and Nasser, M., 2021. Review of Smicromorpha Girault (Hymenoptera: Chalcididae) with description of a new species from India. *Zootaxa*, *4991*(1), pp.131-149

Boucek, Z. 1951. The first revision of the European species of the family Chalcididae (Hymenoptera). *Acta Entomol.Musei Natl.Pragae*27(1).

Bouček, Z. 1952. Results of the zoological scientific expedition of the National Museum in Praha to Turkey. 7. Hymenoptera I Chalcidoidea (first part). *Acta Entomologica Musei Nationalis Pragae*, *27*, pp.47-57.

Boucek, Z. 1958. Descriptions of a new *Tropimeris* and anew *Tanycoryphus* (Chalcididae, Hym.). *Acta Entomol. Musei Natl. Pragae*32:481-486.

Bouček, Z. 1982. Oriental chalcid wasps of the genus *Epitranus*. *J. Natl. History*, *16*(4): 577-622.

Bouček, Z. 1988. Australasian Chalcidoidea (Hymenoptera) - A biosystematic revision of genera of fourteen families, with a reclassification of species. CAB International, Wallingford, U. K. 832p.

Boucek, Z. and Narendran, T.C., 1981. Indian calcid wasps (Hymenoptera) of the genus *Dirhinus* Parasitic on synanthropic and other Diptera. *Systematic Entomol. 6*(3): 229-251.

Burks, B. D. 1960. A revision of the genus *Brachymeria* Westwood in America north of Mexico (Hymenoptera: Chalcididae). *Trans. Am. Entomol. Soc.* 86(3): 225-273.

Burks, B.D. 1977, The Mexican species of *Chalcis* Fabricius (Hymenoptera: Chalcididae). *Proceedings of the Entomological Society of Washington* 79(3):383-399

Burks, B.D. and Watson, F.E., 1939. A new species of Chalcis from the Dominican Republic. American Museum novitates; no. 1039

Chen, T. L. and Liao, D. X. 1985. Comments on the subgenus *Matsumurameria* Habu of the genus *Brachymeria* Westwood with descriptions of three new species from Yunnan, China (Hymenoptera: Chalcidoidea, Chalcididae). *Chin. J. Zool. Res.* 6(2): 131-13.

Chhotani, O. B. 1966. A new species of the genus *Brachymeria* Westwood (Hymenoptera: Chalcididae) from India. *J. Zool. Soc. India* 18: 89-93.

Cowan, D.P., 1979. function of enlarged hind legs in oviposition and aggression by Chalcis canadensis (Hymenoptera: Chalcididae). *Great Lakes Entomologist*.

Crawford, J.C. 1910, A new *Chalcis* from China. *Proceedings of the Entomological Society of Washington* 11:207

Dalla Torre, K.W.1898. *CatalogusHymenopterorumhucusquedescriptorumsystematicus et synonymicus: Tenthredinidae incl. Uroceridae (Phyllophaga&Xylophaga)* (Vol. 1). G. Engelmann.

Darling, D.C., 2009. A new species of Smicromorpha (Hymenoptera, Chalcididae) from Vietnam, with notes on the host association of the genus. *ZooKeys*, *20*, pp.155-163.

Delvare, G. 2017. Order Hymenoptera, family Chalcididae. Arthropod fauna of the UAE 6: 225-274.

Delvare, G. and Copeland, R.S. 2018. Four-horned wasps, description of some remarkable *Dirhinus* (Hymenoptera, Chalcididae) from Kenya, with a discussion on their taxonomic placement. *Zootaxa* 4374(3): 301-349

Delvare, G., Copeland, R.S. and Tanga, C.M., 2019. Description of Eniacomorpha hermetiae Delvare sp. n.(Hymenoptera, Chalcidoidea, Chalcididae) a pupal parasitoid of Hermetia illucens (L.)(Diptera, Stratiomyidae), and a potential threat to mass production of the fly as a feed supplement for domestic animals. *Zootaxa*.

Dorn, S., Schmale, I., Schärer, D., Wäckers, F., and Cardona, C. 2002, Parasitic wasps for on-farm control of a coleopteran pest feeding within stored grains. [abstract].In:*Abstracts, Eighth European Congress of Entomology*; 13, July, 2012,Thessaloniki, Greece, p.318. Abstract No. 206.

Dowden, P.B., 1935. Brachymeria intermedia (Nees), a primary parasite, and B. compsilurae (Cwfd.), a secondary parasite, of the gypsy moth. *Journal of Agricultural Research* **50(6)**:495-523

Fabricius, J. C. 1787. Mantissa Insectorum Sistens eorum species detctas. Copenhagen 1. 20: 348.

Farooqi, S.I. 1983. Notes on Indian Haltichellini (Hymenoptera: Chalcididae). *J. EntomolRes.* 7(2):199-200.

Farooqi, S.I.; Husain, T.; Ghai, S. 1991, Description of four new species, two new subspecies and new host records of the genus *Brachymeria* Westwood (Hymenoptera: Chalcididae) from India. *Annals of Entomology, Dehra Dun* 9(2):11-24

Ferrière, C. 1940 . On some parasites and hyperparasites of *Artona catoxantha*, Hmps. *Bulletin of Entomological Research* 31(2):131-139

Gahan, A. B. 1925. A second lot of parasitic Hymenoptera from the Philippines. *Philipp. J. Sci. 27*(1): 83-109.

Gahan, A.B. 1936, *Brachymeria carinatifrons*, new species (Hymenoptera: Chalcididae). *Proceedings of the Entomological Society of Washington* 37(8):165-167

George, T.G., Sahasranaman, K.N. and George, M.V., 1977. Note on natural parasitism of Nephantis serinopa Meyrick. *Curr Res*, *6*, pp.27-28.

Gowriprakash, J., Manickavasagam, S. and Gupta, A. 2018. First report of *Brachymeria carbonaria* (Zehntner), *Megachalcis timorensis* Boucek and *Tropimeris excavata* Steffan (Hymenoptera: Chalcidoidea) from India. *Munis Entomol. Zool.* 13(1): 196-200.

Grissell, E.E. and Smith, D.R. 2003. First report of Epitraninae (Hymenoptera: Chalcididae) in the Nearctic. *Proceedings Entomological Society Washington* 105(1): 240-242

Gul, M.A., Soliman, A.M., Dhafer, H.M.A. and Gadallah, N.S., 2018. Species of *Dirhinus* Dalman, 1818 (Hymenoptera: Chalcididae, Dirhininae) from Saudi Arabia: new species and a new record. *Zootaxa*, 4483(3): 455-479.

Gupta, A., Poorani, J. 2009, Taxonomic studies on a collection of Chalcidoidea (Hymenoptera) from India with new distribution records. *Journal of Threatened Taxa* 1(5):300-304

Haack, R. A., Benjamin, D. M. and Shuh, B. A. 1981. Observations on the biology of *Phasgonophora sulcata* (Hymenoptera: Chalcididae), a larval parasitoid of the two lined chestnut borer, *Agrilus bilineatus* (Coleoptera: Buprestidae) in Wisconsin. *Gt. Lakes Entomol.* 14(2): 113-116.

Hanna, A. D. 1934a. The description of a new species of *Euchalcidia* (Hymenoptera, Chalcidinae). *J. Nat. Hist.* 13(76): 474-479.

Hanna, A. D. 1934b. The male and the female genitalia and the biology of *Euchalcidia caryobori* Hanna (Hymenoptera, Chalcidinae). *Trans. R. Entomol. Soc. Lond.* 82(1): 107-136.

Hanna, A. D. 1935. The morphology and anatomy of *Euchalcidida carybori* Hanna (Hymenoptera - Chalcidinae). *Bulletin de la Société Entomologique d'Egypte* 19: 326-364.

Heraty, J. M. 1998. Hexamethyldisilazane: A chemical alternative for drying insects. Entomological News 109: 369-374

Heraty, J. M., Burks, R. A., Cruaud, A., Gibson, G. A., Liljeblad, J., Munro, J., Rasplus, J. Y., Delvare, G., Janšta, P., Gumovsky, A. and Huber, J. 2013. A phylogenetic analysis of the megadiverse Chalcidoidea (Hymenoptera). *Cladistics* 29(5): 466-542.

Hoebeke, E.R., Kaufmann, P.E., Glenister, C.S. and Stringham, S.M., 2003. New nearctic record for *Epitranus clavatus* F. (Hymenoptera: Chalcididae). *Proceedings of the Entomological Society of Washington*.

Husain, T and Agarwal, M.M. 1981. A new species of the genus *Tropimeris* Steffan (Hymenoptera: Chalcididae) from India. *J.EntomolRes.* 5(1):36-38.

Husain, T. and Agarwal, M.M. 1981. Systematic studies on Indian Dirhininae (Hymenoptera: Chalcididae). *Oriental Insects* 15(2):179-193

Husain, T. and Agarwal, M.M., 1981. Taxonomic studies on Indian Epitraninae (Hymenoptera: Chalcididae). *Oriental Insects*, *15*(4): 413-432.

Husain, T. and Agarwal, M.M., 1982. Indian species of Branchymeria Westwood (Hymenoptera: Chalcididae). *Oriental Insects*, *16*(4), pp.491-509.

Husain, T., Rauf, A., andKudesia, P.P. 1985. New taxa of Hybothoracini (Hymenoptera, Chalcididae) of India. *Pol.Pis.Entomol.* 55:523-530.

Husain, T.; Agarwal, M.M. 1982, Taxonomic studies on Haltichellinae of India (Hymenoptera: Chalcididae) PT.I. Haltichellini. *Orient. Insects* 16:313-336.

Jamal Ahmad, M. 2009, A new species of *Brachymeria* Westwood (Hymenoptera: Chalcididae) on rice skipper, *Parnara guttata* (Lepidoptera: Hesperiidae) from South Kashmir. *Journal of the Bombay Natural History Society* 106(2):198-200

Joseph, K.J., Narendran, T.E. & Joy, R.J. 1973. Oriental Brachymeria (Hym., Chalcididae). Zoo/. Monogr. No. I, Dept. Zoo)., Univ. Calicut : 215 pp.

Kirby, W. F. 1883. Remarks on the genera of the subfamily Chalcidinae, with synonymic notes and descriptions of new species of Leucospidinae and Chalcidinae. *Zool. J. Linn. Soc.* 17(98): 53-78.

Kirby, W.F.1883. Remarks on the genera of the subfamily Chalcidinæ, with synonymic notes and descriptions of new species of Leucospidinae and Chalcidinae. *Zool J. Linn Soc.*17(98): 53-78.

Linnaeus, C. V. 1767. *Systema naturae*. Editio duodecima, reformata. *Holmiae,* 1(2): 533-1327.

Marchiori, C. H., Silva, C. G. and Lobo, A. P. 2003. First occurrence of the parasitoid *Conura* sp. (Hymenoptera: Chalcididae) in pupae of *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) in tomato in Larvas, Minas Gerias, Brazil. *Arq. Inst. Biol. Sao Paulo* 70(1): 115-116.

Marcicano, M. D. L., Lima, I. M. M., Tavares, M. T. and Casagrande, M. M. 2007. Parasitism of *Brassolis sophorae laurentii* Stichel (Lepidoptera: Nymphalidae, Brassolinae) pupae by *Conura morleyi* (Ashmead) (Hymenoptera: Chalcididae, Chalcidini), in the State of Alagoas, Brazil. *Neotrop. Entomol.* 36(4): 629-631.

Masi, L. 1939. Descrizione di una nuova specie di *Pseudeniaca* (Hymen. Chalcididae). *Bollettino della Società Entomologica Italiana* 71(5): 96-98

Masi, L., 1929. Contributo alla conoscenza dei calcididi orientali della sottofamiglia Chalcidinae. *Bollettino del Laboratorio di Entomologia del R. Istituto Superiore Agrario di Bologna*, *2*, p.e177.

Moitoza, F. J. 1994. A revision of the *C. maculata* species group of *Conura* Spinola in America, north of Mexico, and a new species of the *C. immaculata* species

group of *Conura* (Hymenoptera: Chalcididae). *Pan-Pac. Entomol.* 70(2): 168-182.

Narendran, T. C. 1989. Oriental Chalcididae (Hymenoptera: Chalcidoidea). Zoological Monograph. Department of Zoology, University of Calicut, Kerala, India, 441 pp

Narendran, T.C. 1979, A new species and a new record of the interesting genus *Smicromorpha* Girault (Hymenoptera: Chalcididae) from Oriental region. *Journal of the Bombay Natural History Society* 75(3):908-910

Narendran, T.C. 1984. Key to Indian genera of the family Chalcididae (Hym.: Chalcidoidea). *Entomophaga* 29(4): 431-438.

Narendran, T.C. and Khan, F.R.2011. Two new species of Chalcididae (Hymenoptera: Chalcidoidea) from India. *J. Threat. Taxa*1514-1519.

Narendran, T.C., Achterberg, C. van 2016. Revision of the family Chalcididae (Hymenoptera, Chalcidoidea) from Vietnam, with the description of 13 new species. *ZooKeys* 576:1-202

Naumann, I.D. 1986, A revision ofthe Indo-Australian Smicromorphinae (Hymenoptera: Chalcididae). *Memoirs of the Queensland Museum* 22:169-187

Noyes, J.S. 2019. Universal Chalcidoidea Database [on line]. World Wide Web Electronic Publication. Available: http://www.nhm.ac.uk/chalcidoids

Perez, A., Moreno-Elcure, F., Sanchez, J., Arias-Penna, D. C. and Sarmiento-Monroy, C. 2012. Report of *Conura sp. immaculata* group (Hymenoptera: Chalcididae) parasitizing *Leptophobia aripa* (Lepidoptera: Pieridae) in *Brassica oleracea* var. *italica*. *Entomotropica* 27(2): 99-101.

Riek, E. F. 1970. Hymenoptera. In'The Insects of Australia'.

Roscoe, L. E., Lyons, D. B. and Smith, S. M. 2016. Observations on the life history traits of the North American parasitoid *Phasgonophora sulcata* Westwood

(Hymenoptera: Chalcididae) attacking *Agrilus planipennis* (Coleoptera: Buprestidae) in Ontario, Canada. *Can. Entomol.* 148(3): 294-306.

Roy, C.S. and Farooqi, S.I. 1981. A new species of *Dirhinus* Dalman (Hymenoptera: Chalcididae) along with a key to the available Indian species. *J. Entomol. Res.* 5(1): 12-15.

Roy, C.S. and Farooqi, S.I. 1984. Taxonomy of Indian Haltichellinae (Chalcididae: Hymenoptera) at National Pusa Collection, IARI, New Delhi. *Memoirs of the Entomological Society of India* 10:1-5.

Schmiedeknecht, O.1909. Hymenoptera family Chalcididae. *Gen.Ins.* 97:1-550.

Sundaramurthy, V.T. and Santhanakrishnan, K. 1979, The effect of population density of parasite Perisierola nephantidis (Hymenoptera:Bethylidae) on the mortality of coconut caterpillar Nephantis serinopa (Lepidoptera:Cryptophasidae), Entomophaga 24: 115 -117.

Sureshan, P. M., Girish Kumar, P. and Charesh, C. 2018. Description of a new species of *Megachalcis* Cameron (Hymenoptera: Chalcidoidea: Chalcididae) from India with a revised key to species. *Halteres* 9: 180-184.

Sureshan, P.M. 1997. First record of *Dirhinus alticornis* (Masi) and *Anneckeida angustifrons* Boucek (Hymenoptera: Chalcidoidea) from India. *J. Bombay Natl. History Soc.* 94(1):173-175

Walker, F. 1862. XXVIII. Notes on Chalcidites, and Characters of undescribed Species. *Trans. R. Entomol. soc. Lond.* 11(4): 345-397.

Wisniowski, B. and Dobosz, R. 1998. *Chalcis sispes* (Linnaeus, 1761) (Hymenoptera: Chalcidoidea) - a new to the Polish fauna chalcid-wasp species. *Wiadomosci Entomologiczne* 17(1): 55-58.

Abstract

BIOSYSTEMATIC STUDIES ON THE FAMILY CHALCIDIDAE (HYMENOPTERA: CHALCIDOIDEA).

by

JASEEL R

(2019-11-182)

ABSTRACT

Submitted in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture

Kerala Agricultural University

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY

COLLEGE OF AGRICULTURE

VELLAYANI, THIRUVANANTHAPURAM-695 522

KERALA, INDIA

2023

ABSTRACT

The study entitled "Biosystematics studies on the family Chalcididae (Hymenoptera: Chalcidoidea)" was conducted during 2019-22 at the Department of Entomology, College of Agriculture, Vellayani with the objective of identification, morphological characterization and documentation of family Chalcididae. The base material for the study was field collected specimens. Purposive sampling was carried out in 11 locations spread across 6 districts of Kerala. The specimens were collected by random sweep net method.

The collections were carried out in the morning and afternoon hours (9AM to 3PM) when the insect activity was at its highest. The net sweep contents were immediately transferred to absolute alcohol and the locations and collecting dates were noted. Under a high power stereo microscope, the specimens that were obtained from the field were sorted and stored in labeled vials with absolute alcohol. The chalcid specimens were card mounted for morphometric analysis and characterization.

The chalcid specimens were keyed out based on regional taxonomic keys and original descriptions. During the morphological characterization, the chalcid specimens which did not fit into any species keys were compared with all existing species descriptions.

The study revealed the presence of *Neohaltichella nilgirica* Narendran in Kerala, which is a new record. In addition to the new record, the species *Eniacomorpha bakeri* Crawford 1915 is re-described with the addition of male characters.

A total of 13 Chalcid wasps obtained from different locations in Kerala were morphologically characterized and documented through photographs. This includes one new report and previously reported seven species belonging to 6 genera under 4 subfamilies. The documented species are, *Neohaltichella nilgirica* Narendran, *Antrocephalus decipiens* Masi 1929, *Tropimeris monodon* Bouček, *Dirhinus anthracia* Walker 1846, *Eniacomorpha bakeri* Crawford 1915, *Eniacomorpha*

madagascariensis Masi 1947, *Epitranus erythrogaster* Cameron 1888, *Brachymeria apicicornis* Cameron 1911, and one specimen of genus *Antrocephalus* Kirby 1883 and 4 specimens of genus *Hockeria* Walker, 1834.A complete checklist of all the reported species of Chalcids from Kerala was prepared which includes 143 species.

[illegible]

2019-22 [illegible] 6 [illegible] 11 [illegible] (9 [illegible] 3PM) [illegible]

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