ज्ञान-विज्ञान विमुक्तये

Minor Research Project
In Zoology

Entitled

"Biosystematics Study of Braconidae Parasitoids on Lepidopteran Larvae of economic Important Crop pest from Pune."

Submitted to

The Joint Secretary

UGC (Western Regional Office), Ganeshkhind, Pune

UGC Reference No.: File No.: F-47-921/14 (WRO)

Dated: 20 February 2015

By

Principal Investigator

Dr. Shakera Inamdar

Department of Zoology

Progressive Education Society's

Modern College of Arts, Science and Commerce, Ganeshkhind, Pune-16(M.S.)

To,

The Joint Secretary

UGC – Western Regional Office,
Ganeshkhind,

Pune.

Subject: **Submission of Minor Research Project Completion Report in Zoology**

Reference: **UGC-WRO, Pune File No.: F-47-921/14 (WRO), DATED 20 February 2015.**

Respected Sir,

With reference to the subject cited above, UGC-WRO Pune approved the Minor Research Project entitled **"Biosystematics Study of Braconidae Parasitoids on Lepidopteran Larvae of economic Important Crop pest from Pune."** In the subject- **Zoology** has been completed by **Dr. Shakera Amir Inamdar** in the Head, Dept. of **Zoology**. The MRP research work has been submitted to you along with the enclosed documents for your perusal.

You are requested to accept the same and oblige us.

Thanking you.

Sincerely Yours,

Dr. Shakera Amir Inamdar

CERTIFICATE

This is to certify that the Minor Research Project of Principal Investigator (PI**) Dr. Shakera Amir Inamdar** has uploaded the executive summary of the project on the college website, the URL link Is http://www https://www.moderncollegegk.org/zoology-dep.php/2021/ Dr. Shakera A. Inamdar pdf

This certificate is as per the requirement under Minor Research Project guidelines.

Principal

Annexure-III

UNIVERSITY GRANTS COMMISSION

Final Report of the work done on the Minor Research Project

1. Project Report No.1st/2nd/3rd Final **:** **Final**

2. UGC letter Reference No. : **File No.: F-47-921/14 (WRO)**

3. Period of Report from : **01/04/2016 to 01/04/2018**

4. Title of Research Project : **"Biosystematics Study of Braconidae Parasitoids on Lepidopteran Larvae of economic Important Crop pest from Pune."**

5. a) Name of the Principal Investigator **: Dr. Inamdar S.A.**

b) Department and College where work has progress : **Modern College of Arts, Science and Commerce, Ganeshkhind, Pune- 16**

6. Effective date of starting of the Project : **February 2015**

7. Grant approved and expenditure incurred during the period of the report.

a) Total amount approved : **200000.00 /-(Two Lakh Rupees only.)**

b) Total expenditure : **2,00,329.00 (Two lakhs three hundred and twenty-nine only)**

8. Report of the work done :

Ours has been the day and age of chemical pest control. Ever since the advent of DDT almost half a century ago, overuse and misuse of potent chemical pesticides have become major source of environmental pollution and various other problems such as :

i) Air and water pollution due to repeated application of chemicals,

ii) Physical and physiological changes in the soil,

iii) Deleterious effects on beneficial insects, like parasitoids, predators, honey bees, etc.

iv) Destruction of natural balance and ecological cycle,

v) Development of resistant varieties of pests which enforces in the multiplication in the concentration of the powerful chemicals,

vi) Pest resurgence,

vii) Secondary pest out-break,

viii) Stimulation to the reproduction rate in certain pests, etc.

Biological control has realized that alternatives to the wholesale use of pesticides should be sought of the various alternatives available to us, (Cultural, Mechanical, Physical, Biological and Autodial control), Biological Pest control or utilization of natural enemies, has been the most successful so far, with hundreds of outstanding successes all over the world, and is undoubtedly the most promising alternative for the foreseeable future. When it works, biological control can be a permanent inexpensive and most important, virtually hazard free method of controlling pests.

9. Brief objective of the project:

a. Collection of Lepidopteran larvae

b. Identification of lepidopteran larvae

c. Collection and rearing of parasitoids

d. Study of life-cycle and taxonomy of Braconids

10. Work done so far and result achieved and publications, if any resulting from the work (Give details of the papers and name of the journal in which it has been published in :

1. Biotaxonomic Study if *Apanteles prodeninae* (Hymenoptera: Braconidae) Journal of Dnyanomay (2016), ISSN No. 2395-7484, Pg.No. 22-27

2. Biosystematic study of *Glyptapanteles malshri* sp. Nov (Hymenoptera: Braconidae) 2018, ISSN: 2395-6011

11. Has the progress been according to original plan of work and towards achieving the objective: **Yes**

12. Please indicate the difficulties, if any experienced in implementing the project: **No**

13. If the project has been completed, please enclose a summary of the finding of the study : Diversity of Brachonidae parasitoids on pestiferous lepidopteran larvae of vegtable crops is studied from Western Maharashtra. The term “Parasitoid" was firstly used by Reuter in 1913 to describe a life history, intermediate between that of predators and true parasites. Adult female parasitoids are free living, feed on nector, pollen ar as predators and forage, actively for their arthropod hosts on plants and other substrates. Usually, on locating a host, the female lays one or more eggs on or in it, and ensuing consume the host tissue, killing the host in the process. The parasitoid lifestyle is found chiefly ii the orders Strepsiptera, Hymenoptera and Diptera, and is probably exhibited by over 8 quarter of a million species worldwide. Their diversity makes identification and systematic studies difficult, which hampers, many aspects of research. The order Hymenoptera is extremely important from the view of Biological control of insect pests. Thousands of parasitic wasps frequently determine the population densities of their hosts, since they have been used extensively in Bio control programme. Inchneumonidae, Braconidae, Chalcidae, Thricogrammatidae, Eurotomidae are the parasitic families of the order Hymenoptera. Among the parasitic families,Braconidae is the second largest family

(after the Ichneumonidae) in the Hymenoptera and one of the largest families of the Animalia, including at least 40,000 species, as many as all the vertebrate species combined, size, morphology, biology and ethology are highly variable.

Since last three decades, biosystematics of Braconids have received very little attention in India and it is first attempt from Western Maharashtra. The taxonomical study was made on the following genera viz. *Apanteles* Foerster, *Parenion* Nixon, *Glyptapenteles* Ashmead, *Semionis* Muesebeck Protomicroplitis Ashmead, *Microplitis* Fberster, Promicrogastor Brues S. Richardson.Diolicogenidea Vierack Cotesia Cameron, Rhygoplitis Gahan and Bracon Fabricius, belonging to the 4 tribes viz, Apantelini, Microgastrini, Cotesini and Microplitini of the sub family, Microgastrini i and one tribe, Braconini of sub family Braconinae of the family Braconidae. Under the genera Apanteles, Cotesia Dolicogtnedea two species were described while rest of the genera have represented by single species.

Biological control will not progress on a larger scale without taxonomy knowledge of the parasitoids. Such knowledge makes information on parasitoids available and at the same time predicts directions of further research and explorations. Biological studies will be helpful for mass rearing and augmenting the parasitoids in biological control programme. Keeping in view the above facts, the present work is carried out.

Signature of the
Principal Investigator

Principal
Modern College, Ganeshkhind, Pune

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Biosystematics Study of Braconidae Parasitoids on Lepidopteran Larvae of economic Important Crop pest from Pune."

Introduction

Agriculture is the oldest industry which has direct impact on the existence of human beings. A group of thinkers (Barker, Wilson Barsodi and Humpries etc.) has commonly held the orthodox view that.Agriculture is par excellence fundamental industry. The importance of agriculture in the economic development of any country, rich or poor, is borne out by the fact that, it is the primary sector of the economy which provides the basic ingredients necessary for the existence of mankind and also provides most of the raw material which fulfills the basic necessities .of human race. The rapidly rising world population makes the better understanding of the potential for the development of agriculture.

Agriculture in India is a contribution to the progress during future plans. To increase the production of food for the developing dynamic society, scientific basis and knowledge of agricultural crops and their pests is essential. On an agricultural basis we are concerned to the loss in yield and quality caused by insects. Indian agriculture is predominantly characterized by the cultivation of a wide variety of food and non-food crops. The food crops refer to rice, wheat, millets, barley, maize and pulses etc. and cash crops include tea, coffee, rubber, oil seeds , cotton, jute, sugarcane, tobacco, etc. (Sing and Sadhu, 1£8£.). Oil seeds, pulses and vegetables have immense value in human diet. India is the third largest producer of oil seeds in the world. It ranks first in the production of groundnut and second in rapeseeds arid mustard. The bulk of oil production in India is derived from nine oil seeds namely, groundnut, rapeseed, mustard, sesame, safflower, Niger, soybean, sunflower forming the edible group and linseed and castor, forming non-

edible group. Development in production of oilseeds and oils holds an important place in our economy. In spite of a large share in world production, the per capita consumption of oil in India is very low of about 5 kg. as against the world average of 11 kg. and the consumption of about 28 kg. in the affluent countries (Anonymous, 1987). In India groundnut is one of the major oil seed cropwhich covers about 7 m- hectares out of the 19 m- hectares under oilseed cultivation.

The crop is attacked by number of insect pests like Tobacco Caterpillar, Spodoptera litura (Fabricius); the Lucerne caterpillar, Spodoptera exiqua, Hubner; the groundnut leaf miner, Stomopteryx nertaria Myrick; the stem borer Sphenoptera perotetti G; the aphids, Aphis craocivora Koch; the termites etc. The share of pulses in agriculture is crucial. Pulses are very important constituents of the diet of the Indians and main source of protein for the vegetarians and also animals. But unfortunately, the area under cultivation of pulses has not shown appreciable rise in last 30 years. Area under pulses stood at 23.41 million hectares in 1983-1984. In fact green revolution has had no effect on pulses production and the planner has been criticized vehemently for this lapse. The per capita pulses in the country has actually gone down during the plan period (Anonymous, 1987).Various types of pulses grown in India are cow" pea, pigeon pea, chick pea, masur, moong, peas, lentil etc. Amongst these, cow pea ranks very high.

The cow pea species Vigna unguiculata (L) Walp is one of the principal pulses in common use. The cow pea appears to have been spread from India to China and other South-East Asian countries. Vavilov (1936) recognized India as the main center of origin for this crop. Africa and China are considered as secondary centers of origin. The protection of cow pea from various kinds of pests remain a chronic problem. From the order Lepidoptera the losses are mainly caused by the Bihar hairy caterpillar^ Diacrisia oblique Walker; the Tobacco caterpillar, Spodoptera litura (Fabricius); the pod borer, Hellothis armigera Hubner, etc.

The role of vegetables in our diet needs no emphasis as they are rich source of carbohydrates, proteins, fats, minerals and vitamins and are regarded as protective foods well equipped to combat malnutrition.According to the latest information available the area under vegetable cultivation is of the order of 2-5 per cent of the total cropped area in the country (Katyal and Chadha, 1987). The present area that is putunder vegetable and

tuber crops in the country is very inadequate to meet the national requirements. The recommended requirement of vegetables for human consumption in India is 300 gram but at present the total intake of vegetables by the people is only 58 gram per day (Katyal and Chadha, 1987). In Maharashtra, the area under cultivation of vegetables is about 26.82 lakh hectares (Anonymous, 1987). The important vegetables cultivated in India can be grouped as cole crops, root vegetables, leguminous vegetables, solanaceous vegetables, cucurbits or vine crops, leafy vegetables, saland crops, malvaceous crops and perennial vegetables.

The Diamond-back moth, *Plutella xylotella* (Linnaeus); the Cabbage Caterpillar, *Pieris brassicae* (Linnaeus); the Cabbage Semilooper, *Plusia orichalcea* (Fabricius); The Tobacco Caterpillar,*Spodoptera litura* (Fabricius), etc. are the important pests of cabbage. Amongst them the Diamond-back moth, *Plutella xylostella* (Linnaeus) is very serious pest.

In general agricultural crops are prone to the attack of a number of pests damaging the stems, leaves, flowers and fruits by feeding upon them. Many soil inhibiting insects attack root and many kill the plants altogether inflicting serious injuries and destroying the root zone. On an averga 35% annual world crop loss due to the pests (i.e. Insects, pathogens and weed) have been estimated (Cramer, 1967). There is constant struggle between man and insects for staking their claims for choice of food and fibers for their survival. The protection of crops from various kinds of pests remains a pressing problem. The introduction of high yielding varieties has also increased the pest problem. Various techniques are in existence namely, Hormonal control, Radiational control, Genetic control, Behavioral control, Biological control. Pheromones, Allomones, Kairomones, etc. are components of IPM. The Hormonal control, Genetic control, Radiational control and Sterilization have not at this time proved to be successful in pest management. JHAs are effective against insects which are in sensitive period. Most of JHAs are thermolabile and photolabile and hence underfield conditions their potential efficacy is adversely hampered. JH sensitive period as such is of few hours and under

field conditions presence of mixed developmental stages of tedious and less effective (Hebbalkar, 1987).

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DeBach (1964) defined Biological control as "the action of parasitoids, predators and pathogens in maintaining other organisms' density at a lower average than would occur in their absence." Coppeland Mertlis (1977) gave a definition of Biological control as "Biological pest suppression in its narrow, classical sense, usually restricted to the introduction by man of parasitoids, predators, and/or pathogenicmicroorgar isms to suppress population of plant or animal pests; C. F. biological insect pest suppression, natural control and further they defined Biological insect pest suppression as . The use or

encouragement by man of living organisms or their productions for the population reduction of pest insects, of biological control.

Biological control is by no means a new technique Cotesia (Apanteles) glomeratus (L) was the first parasitic insect reared from caterpillars of cabbage white butterfly *Pieris rapae* Boisduval as early as 1502. Publications on the biological control of the 18th century refer to the descriptions of wasps and flies emerging from other insects.Linnaeus suggested for the first time that Aphids on plant can becontrolled by using Ichneumonid parasitoid, Ichneumonid aphidum, he also suggested the use of carbid beetle *Calosoma sycophanta* for the control of caterpillars in orchards. Control of leaf eating insects of citrus bycollecting predaceous ant Qccophylla semaragdina, and by putting themon citrus plants was the earliest attempt by Fisher (1965). Aristotle(384-322 3.C.) in his Historia animalium, described the ravages of thewax moth of honey comb and suggested that it brings, 1 disease into theswarm' (Steinhaus, 1956). In 19th century, Darwin suggested various parasitic insects to control number of economic pests (Coppel andMertins, 1977). About 110 pest species have been controlled bybiological means in 16 countries involving more than 225 cases (DeBach,1964). Simmonds (1970) reported 11 species of pests that have beencontrolled by the introduction of parasitoids and predators in variouscountries in collaboration with the Common Wealth Institute of BiologicalControl. In 20th century several historical treatments, localization andbroad range of biological control have appeared, (Jonson, 1957), Huffakerand Stinner (1971), Greathead (1971), Rao (1961), Rao et al^ (1971),Sailer (1972), Haegan and Franz (1973), Coppel and Mertins (1974,1977), Nagarkatti (1981), Nikam and Sathe (1983a), King (1984a S b), Lutterellet al (1985), Sathe, and Nikam (1983, 1984b, 1985a,b,c), Yeargam (1985), C.ossentine and Lewis (1986), Sathe et.al(1986), Sathe et al.(1987 a, b, c, d), Lingren et al (1988), Narasimham and Chacko(1988), Sathe et.al. (1988), Sathe et al (1989) and Sathe (1990).

CIBC, Bangalore has made extensive survey for natural enemies ofRice, Sugarcane and Coconut, (Aphids, Rhinoceros beetle, eta) Rao et al.(1971) reviewed several exotic natural enemies that have beenintroduced against some of the more

important agricultural pests. Somespecies have figured prominently in biological control programmes. Forexample, Cotesia (Apanteles) flavipes Cameron is a larval parasitoid ofgraminaceous stem borers in India. It was shipped to Barbados fortrials against the sugarcane stem borer, *Diatraea saccharalis* Fabriciuswithin two years (1966-1967).

In India, after the establishment of the Indian, station of Commonwealth Institute of Biological control (CIBC) at Bangalore in 1957 gave to the study of entomophagous insects, since then a number of centers are actively engaged in the biological control programme. Amongst them the central Biological control stations at Gorakhpur! U. P) ;Solan(H. P) ;Hyderabad(A. P) ;Sriganganagar Rajasthan); Indian Agricultural Research Institute, Pusa (New Delhi); International Crop, Research Institute for the Semi Arid Tropics, Patanchery (A.P); Tamilnadj Agriculture University, Coimbatore; Marathwada University, Aurangabad; Shivaji University, Kolhapur; Bio-control Research Laboratory, Chengalpattu and other agricultural Universities are outstanding.

The term “Parasitoid" was firstly used by Reuter in 1913 to describe a life history, intermediate between that of predators and true parasites. Adult female parasitoids are free living, feed on nector, pollen as predators and forage, actively for their arthropod hosts on plants and other substrates. Usually, on locating a host, the female lays one or more eggs on or in it, and ensuing consume the host tissue, killing the host in the process. The parasitoid lifestyle is found chiefly ii the orders Strepsiptera, Hymenoptera and Diptera, and is probably exhibited by over 8 quarter of a million species worldwide. Their diversity makes identification and systematic studies difficult, which hampers, many aspects of research. The order Hymenoptera is extremely important from the view of Biological control of insect pests. Thousands of parasitic wasps frequently determine the population densities of their hosts, since they have been used extensively in Bio control programme. Inchneumonidae, Braconidae, Chalcidae, Thricogrammatidae, Eurotomidae are the parasitic families of the order Hymenoptera. Among the parasitic families,Braconidae is the second largest family (after the Ichneumonidae) in the Hymenoptera and one of the largest families of the Animalia,

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Material and Methods

Control measures are extremely essential for redacting the pest populations below the level of economic damage. Biocontrol method is an ongoing process and more efficient methods are continuously being adopted, sometime very minor changes in techniques can have drastic result, both positive and negative (Patana, 1975). Continuous breeding stocks of both the host and their parasitoids are required for an uninterrupted study. Quality insect rearing indicated by intended use of the product. The application of cleanroom techniques and best available environment control system has greatly facilitated the production of pest and parasitoid species in continuous and closed cultures. Ample scope exists for enhancing the benefit to parasitoids through the simplified handling and rearing methods.

Material:

Glass cages Plate No, I, Fig. 1 8 2) Two types of glass cages were used for biological studies. Both were quadrangular (Size 25 X 25 X 30 cm.) in shape. Each type consist of wooden base and glass walls on three sides. In 1st type, the 4th side was closed by muslin with a sleeve for handling the insects (Fig.l) and in the 2nd type the 4th side of cage consists a glass window (Fig. 2). With l St and 2nd type, rearing of host and parasitoid species was carried out.

Glass troughs: (Fig. 3) two sizes of glass troughs viz. 9 to 12 cm. in height and 20 to 25 cm. in diameter respectively were used for keeping caterpillars that were collected from the fields and further for screeing their parasitoids. The glass troughs were covered with muslin cloth.

Plastic containers: (Fig. 4 6 5) Four different types (Size, diameter and height, 6.5 X 8, f X 6.2, 5X5, 4X4 cm.) of plastic containers were usedfor rearing the hosts and their parasitoids. The plastic lids ofall containers were perforated for ventilation. The small size(4 X 4 cm.) containers were used for keeping the larvae separately to avoid overcrowding.

Petridishes: (fig. 6) Petridishes, 18.5 cm and 9 cm. In diameter were used for rearing eggs and parasitized/ unparasitized larvae of hosts.

Test tubes: For mating and oviposition of parasitoids and for handling the parasitoids test tubes (size, 19 x 2.5, 15 x 2, and 14.5 x 2.8 cm) were used.

Glass jars: Glass jars of 29 x 9.5 cm. Size were used for mating and Oviposition of host species and also for the rearing of pupae of the same,

Specimen tubes:

Specimen tubes of 10 cm. And 5 cm. In height and 2 cm. In Diameter were used to keep the parasitoid cocoons for adults emergence. The open ends were covered with muslin cloth for ventilation.

During the course of present investigation all necessary precaution were taken to avoid the fungal and other microbial attacks. All experiments were carried out under laboratory conditions (Temp.25 ± 1°C, R.H. 60 ± 6 % and photoperiod 12 ± / hr.) Photographs of hostsand parasitoids were taken by Macroscopic lenses (Olympus, 35 mm.and Yashioa, and 35 mm).

Rearing of parasitoid species: The parasitoids (M&F) were caged into test tubes(Size: 15 X 2 cm.) For their mating. The mating was followed immediately after caging of sexes in test tubes. Female parasitoids were exposed to early second instar larvae of the host in insect cages. With the help of fine hair brush, the host larvae were introduced in cage through sleeve. One or other parasitoid quickly oviposited into host larvae offered and thus more parasitized host larvae were obtained within a short time. In addition, parasitization was also made in test tubes (Size: 19 < 2.5 cm.). Only a single female was allowed to oviposit inone host lo avoid superparasitism. After parasitism, host larvae were removed and kept separately in containers/ petridishes for further development. The parasitoids were fed with 50% honey solution.

Introduction of Parasitoids

The parasitic hymenoptera is an important component in biological control programme. Any advance in knowledge of the taxonomy of parasitic hymenoptera is, therefore, of potential practical value. Biological control and taxonomy are interrelated and interdependent. Taxonomists need for the identification of biological control agents, understanding of their evolutionary history, compilation and to guide explorations for native and exotic parasitoids. It is estimated that there are about 250,000 species of parasitic Hymenoptera in the world, of which only about 50,000 have been described (Gupta, 1988). The family Braconidae of parasitic Hymenoptera alone consists of at least 40,000 species (vanAchterrberg, 1988) with over 150 described genera and nearer 200 in total (Quicke, 1988). From U.S.S.R territory more than 1100 species are reported. Our knowledge on the Oriental Braconidae is extremely meagre although many species have been described from time to time, yet we know only about a 10th of the fauna that occur in nature. There is consolidated monograph to identify the species. No comprehensive volume of Indian Braconidae has ever been published except Bhat and Gupta (1977). The earlier workers, Brulle (1846), Smith (1861-1865), Cameron (1899-1913), Ashmead (1900-1920), Fullaway (1919), Viereck (1912-1918), etc. have described a large number of genera and species of the Oriental Braconidae.

Presented keys to separate various genera and subfamilies of Braconidae. Subsequently, workers like Bingham (1901), Ayyar (1920-1928), Wilkinson (1927-1935), and Watanabe (1934-1937). Beeson and Chatterjee (1935), Chatterjee (1941), Lai (1939-1942), Narayanan (1941), Mathur (1942) and Bhatnagar (1948) revised many subfamilies and genera of Oriental Braconidae. Studies pertaining to Indian Braconidae had an effective foundation at the end of 19th century. This has followed by Bhatnagar (1900-1948), Wilkinson (1928-1929), Beeson and Chatterjee (1935), Gupta (1955,1957), Narayanan and

Subba Rao (1960), Rao (1961, 1167), Rao and Chalikwar (1970, 1971), Chalikwar (1974) Shama Bhat (1979), Chalikwar, jat ad (1984), Gupta and Saxena (1987) and Sathe et al (1989 a ,b,1990). However, the taxonomy of Braconidae is least known until recent years, it has received even less attention than most other groups of parasitical. There is, therefore, a pressing need for taking the lead in this field. The family Braconidae is characterized by groove between first and second tergite of abdomen, the posterior vertical edge of the first tergite and the anterior vertical edge of the second are concealed or barely visible, first tergite of the abdomen usually longer than half of the abdomen. Hind wing has a long sub medial cell which is almost half of its length, is more than one third the length of the medial cell and several times wider, recurrent vein usually present, sometimes it can be recognized only as a faint line (in smaller forms), sometimes the sub medial cell and /or the recurrent vein not present, first abdominal tergite without central field and the paratergites which are usually seen from above, prepectal ridge in mesoplura usually developed, in the fore wing the nervullus usually post furcal, propodeum sculptured as a rule usually with more or less clear space, sides of mesonotum frequently have longitudinal furrows. The family Braconidae is divided into 21 subfamilies, some important among them are Microgastrinae, Braconinae, Rogadinae, Euphorinae, Agathidinae, etc. The subfamily Microgastrinae is distinguished from all other members of Hymenoptera by two important characters, the 16 jointed flagellum and the spiracle of laterotergite I In most primitive braconids the next set of characters are reductional apomorphic and considerably less definitive in phylogenetic studies but useful taxonomically.

1. Occipital carina absent.
2. Palpal formula 5-3.
3. Prepectal Carina absent.
4. Spiracles on metasoma I-VI only, absent on VII.
5. Apical venation desclerotized and usually transparent-
6. Interanellan (2A) absent.
7. Discoidellan (2 Cula) absent.
8. 2nd interanal (a) absent.

Mason gave plesiomorphic characters for the Braconidae, only those that seen useful in separating Microgastrinae from other braconids:

1. Vannal lobe of hind wing large and delimited distally by a notch.
2. Intercubitellan (2 r- m) present.
3. Interradiellan (r) present.
4. Transverse, median part of pronotum essentially simple, flat, and lore except for a weak anterior marginal suture that connects two shallow, sub median depressions.
5. Larval palpi developed as 1- jointed sclerotized appendages. The subfamily Microgastrinae is of economic significance because they breed from the Lepidoptera's hosts. Microgastrinae was considered to include the three genera into which Foerster split Microgaster Latreille, i.e. Microgaster, Microplitis and Apanteles with the addition of Adelius Haliday 1833, Mirax Haliday 1833, and Dirrhpo Foerster 1851, Fornica Brulle was variously treated but often added to Microgastrinae. Nixon (1965) made a correct analysis in excluding Adelius, Paradelius, Dirrhope and Oligoneurus. He suggested three tribes:

1. Cardiochiiss and its close relatives,
2. Mlrax,
3. The traditional genera Microgaster, Microplitis and Apanteles. But, recently, Mason (1981) judged that there are no strongenough synapomorphic characters to group Mirax, Cardiochilesand Microgastrini in one subfamily. Therefore, he preferred torecognize three sub-families i.e. Cardiochilinae, Miracinaeand Microgastrinae.

The subfamily Microgastrinae is divided into 4 tribes viz,Apantelini, Microgastrini, Cotesiini and Microplitini.

The tribe Apantelini represents:

1 Ovipositor sheath almost always (97%) longer than half thehind tibia and always hairy throughout, sheaths are short, they arestill uniformly hairy and arise from the valvifers distally.2. Hypopygium usually large and medially desclerotized,longitudinally striate, and often folded.3. Tergite I usually longer than broad and often with a medianbroad groove on the apical half, tergite II usually wider than longand shorter than tergum III.

4. Fropodeum often with a partial to complete areolet .thebounding carinae often reduced anteriorly, so that the areolet hasthe appearance of a 'U' or 'V' and sometimes the propodeum isentirely ecarinate.

5. Anterior margin of metanotum usually withdrawn from scutellarmargin laterally and there armed with an acute setose forwardlydirected lobe. Prepectal carina never present, pronotum almostalways with both upper and lower grooves laterally, notauli absentor weakly indicated by denser sculpture.

6. Antennal articles mostly with 2 ranks of placodes, at leaston the central articles. The tribe Microgastrini is identified by the followingcharacters:

1. Ovipositor sheath longer than half of hind tibia and alwayshairy throughout its length. Hypopygium usually large.

2. Tcrgite I usually longer than broad but sometimesapproximately as long as wide, tergite II variable, most often

Rectangular and little shorter than tergum III but occasionallyspiral and sub triangular or square and larger than tergum III.

3. Propodeum almost always with a strong, recurrent mediancarina; sometimes propodeum with transverse carinae orwrinkling's in addition to the median carina, these sometimesforming a variably distinct areola.

4. Metanotum almost always with sub lateral setose lobes low andclosely apprised to the hind margin of the scutellum,prepectal carina always absent; notauli strong in few smallgenera. Pronotum almost always with both upper and lowergrooves but rarely smooth.

In tribe Cotesiini, following differential characters are observed:

1. Ovipositor sheath almost always shorter than half of hind tibia and few hairs are concentrated near the apex.

2. Tergites extremely variable and thus of little diagnostic value on the tribal level; Tergite I sometimes with a sharp median groove occupying the basal half or more.

3. Propodeum often with a median longitudinal carina; rarely with other strong carinae except for frequent short traces later basally near the spiracle.

4. Metanotum often lacking setae on the sub lateral lobes, the plrjrdgma more or less exposed, and prepectal carina always absent, pronotum with one or two grooves laterally.

5. Antennal articles mostly with 2-ranked placodes but rarely these all irregularly arranged. In female with very short antennae placodes are arranged in single rank on each article.

The Tribe Microplitini is recognized by: 1. Ovipositor sheath almost short ; hairs concentrated at apex even in the few species that have long ovipositor sheath ;ovipositor short, stout basally,

abruptly tapered about midlength; hypopygium completely sclerotized. 2. Tergite I squarish to much longer than wide, almost always sculptured; tergite II rarely sculptured or separated from tergum III by a suture, sometimes laterally by shallow grooves; trgite II and III forming a smooth undivided plate.

3. Propodeum almost rugose and bearing median longitudinal carina.

4. Metanotum almost always with large setose sub lateral lobe that touches the scutellar rim, notauli sometimes present ,hind coxa shorter than tergite I; tibial spurs short, the hind ones about half as long as the basitarsus.5. Antennal articles mostly with 2 ranks of placodes. As far as Indian Microgastrinae is concerned very less attention has been paid since more than 5 decades, except the works of Rao (1961) and Nixon (1967). Very recently Sathe and his coworkers contributed some descriptions (1989 a, b 8 1990) on Indian Microgastrinae. The Braconinae is relatively well defined subfamily. It is at present divided into ten tribes viz. Adeshini, Aphrastobraconini, Bhatiyaulalini, Braconinae, Coalotiini, Europraconini, Gtyptamorphini, Iphiau-acini, Rhamnurini and Vietoroviellini. The Braconinae, Coeloidini and Glyptamorphini are known to include New world representatives while rest of the above tribes are based on principally old world genera. The present chapter deals with the taxonomic details on parasitic Hymenoptera of family Braconidae from Western Maharashtra, India. This is first attempt on Braconid Parasitoids of some lepidopteraus pests from this region. The study covers the description of 12 new species and description of two species belonging to 11 genera of 5 tribes of the subfamilies Microgastrinae and Braconinae.

Material and Methods of Parasitoids:

Survey of Braconid flies was carried out from Puneregion during 2015-1017 and a large number of specimens were collected from the fields of Jowar (Sorghum ulgare Pers), Groundnut (Arachis hypogaea Linn), cow pea (Vigna unguiculata (L)}, Safflower (Carthamus tinctorius Linn.), Caster (Ricinus comnuniug Linn.) Soybean(Glyeine max), Cabbage (Brasica oleracea L), etc. Tie Braconid species considered in this thesis were also collected from (Fig.27), ecologically varying types of habitat, like agricultural fields, fruit tree, etc. Many times, parasitized larvae of lepidoptera and cocoons of the braconids were collected on host plants and reared in the laboratory. Collection was made early in the morning during the months of July to February. For preservation and study the specimens

were killed in cyanide killing bottle and pinned. The pinned specimens were dried and kept in insect store boxes. Some of the specimens were also preserved in 70% alcohol. After sorting of different groups and genera, each fields collection was duly labelled with date of reference number, locality, date of collection, name of collector and possible identification. Then wings, antennae, legs, abdomen, propodeum head were mounted on slides in DPX/Canada balsam.Morphological study are carried out with the help of monocular microscope. Figures were drown with the help of DPX/Camera Lucida. Comparative' measurements were noted 'with eye piece micrometer. Body length of specimens calculated with the help of graduated mechanical stage. All measurements were recorded in millimeters. Large collections of Braconid parasitoids were identified to be belonging to genera of different subfamilies proposed by Mason (1981). To facilities exact understanding of the terms, the terminology adopted here is the same as that of Morley (1913) & Eady (1968). The terms used by Muesebeck (1920, 1922) Wilkinson (1928, 1929, 1930, 1932, 1934), Snodgrass (1941), Bhatnagar (1948), Nixon (1965) and Mason (1981) are adopted in the description of the species. The type material is for the time being in the collection waspreservedA large number of references were consulted in the course of the studies those listed are not cited in the text of the thesis. The following terms adapted in the thesis for the head, thorax, wing venation and leg are modified diversified terminology of different authors.

Diversity of Braconidae wasps (Hymenoptera: Braconidae) on pestiferous lepidopteron larvae of crops

Introduction:

Biocontrol is the use of natural agents, usually parasitoids, predators and pathogens to increase the mortality of the pest though it is variously defined. Reuter (1913) used the term Parasitoid for the first time to describe a life history, intermediate between predators and true parasitoids. The parasitic hymenoptera is an important component in any biological control programme since thousands of parasitic wasps suppress the population densities of their hosts. The parasitic Hymenoptera appears to be a rapidly evolving and specifying group. It is estimated that there are about 2,50,000 species of parasitic Hymenoptera in the world of which only about 50,000 have been described (Gupta, 1988).

The family Braconidae of parasitic hymenoptera alone consistsatleast 40000 species (Van Achterberg, 1988) with over 150 described genera and nearer 200 in total (Quicke, 1988). From

U.S.S.R. territory more than 1100 species are known. Our Knowledge on the oriental braconidae is extremely mearge. Yet we know only about a 10^{th} of the fauna although many species have been described time to time. There is neither a consolidated monograph nor comprehensive volume on Indian Braconidae been published except Bhat and Gupta in 1977.

The family Braconidae is divided into 21 subfamilies, some important families among them RE Microgastrinae ,Braconinae, Rogadinae, Euphorinae and Agathidinae.

Material and Methods:

The pestiferous larvaeof the hosts and parasitoidsof vegetable crops were collected from fields and maintained in the laboratory. The larval stages were treated with 50% chloroform and 50% ethanol and mounted in Hoyer‟s medium on microslides after being stained with acetocarmine for identification and studied.

Result:

Pest Parasitoid Index oforder Hymenoptera family Braconidae

Sr	Paraitoid	Host
1.	*Agathisindica*	*Spilosoma oblique (Walker)*
2.	*A malshri*	*S. oblique*
3.	*A rageshri*	*S. oblique*
4.	*Apantelesacherontiae Cameron*	*A. styx*
5.	*A angaletimusebek*	*Pectinophoragossypiella (Saunders)*
6.	*A asawarisathe*	*Spodopteralitura fab*
7.	*A baoris Wilkinson*	*Pernaramaithias*
8.	*A boseibhatnagar*	*Amsactamoorei*
9.	*A colemaniviereck*	*P gossypiella*
10.	*A creatonotiviereck*	*Thiacidasposticawlk.*
11.	*A crocidolomaeashmead*	*Crocidolomiabinotalis (zeller)*
12.	*A earterus Wilkinson*	*Eariasinsulanaboisdual*
13.	*A euproctisiphagusmuzaffar*	*Euproctislunata walker*
14.	*A javensisrohwer*	*Stomopteryxsubsecivellazeller*
15.	*A jayanagarensisbhatnagar*	*Plusiaorichalcea*
16.	*A multani S & I*	*S oblique*
17.	*A papilionisViereck*	*Papiliodemoleus*
18.	*A plutellaewikinson*	*Plutellaxyllostella*
19.	*A pusaensislal*	*Syleptaderogata fab*
20.	*A ruficrus (haliday)*	*H Armigera*

21.	*A ruidis Wilkinson*	*Acheajanata*
22.	*A schoenobiwilkinson*	*Scirpophagaincertulus*
23.	*A sicarius marsh*	*P xylostella*
24.	*A subandinus Blanchard*	*Phthorimaeaoperculella*
25.	*A sundanuswilkinson*	*A Janata*
26.	*A taragamaeviereck*	*Nephantidisserinopa (meyrick)*
27.	*Braconalbotineatus Cameron*	*Chilopolychrysa*
28.	*B chinensisbhatnagar*	*Chiloauricitius dudgeon*
29.	*B gelechiaeashmead*	*H armigera*
30.	*B greeniashmead*	*Earias spp.*
31.	*B hebetor say*	*P. gossypiella*
32.	*B lefroyi D. & S.*	*P. gossypiella*
33.	*Calyptusvirhinisathe&dawale*	*C partellus*

34.	*Chilonus Cameron*	*P operculella*
35.	*C heliopaegupta*	*H armigera*
36.	*C naranayanirao*	*H armigera*
37.	*C pectinophorae Cushman*	*P gossypiella*
38.	*Cotesiaanari*	*viracolaisocrates*
39.	*C arachi*	*Groundnut caterpillar*
40.	*C bazari*	*Latoialepida gran*
41.	*C flavipus*	*C partellus*
42.	*C chiloi*	*C partellus*
43.	*C diurnii*	*Exelastisatomosa fab*
44.	*C Janata*	*A Janata*
45.	*C mangifera*	*Inderbelamoore*
46.	*C parrnari*	*Parnaramathias*
47.	*C sunfloweri*	*S inferens*
48.	*G shri*	*E vitella*
49.	*Tropobraconviereck*	*S incertulus*
50.	*Wachsmaniadarbarisathe*	*M separata*

Conclusion:

Biological control of insects is a very broad concept because of the various strategies and techniques involved in it (Huffakar et. al. 1971).The use of chemicals in pest control is reduced due to the natural control method and provides good vegetables to humans. The effective natural enemies have the following characteristics: good searching abilities, high degree of host specificity preferences, good adaptation to a wide range of environmental conditions and greater longevity.

Biosystematics study of Glyptapanteles malshri sp. nov (Hymenoptera: Braconidae)

I. Introduction

The parasitic hymenoptera is an important component in biological control programme. Biological control and taxonomy are interrelated and interdependent. Taxonomists need for the identification of biological control agents, understanding their evolutionary history, compilation and to guide explorations for native and exotic parasitoids. The detailed taxonomical works on Indian species were those of Wilkinson (1928, 1929), Bhatnagar (1948), Rao (1961), Nixon (1967), Rao and Chalikwar (1970), and Sathe and Inamdar (1988, 1989). In assessments of parasitic hymenoptera a reliable approach would be to study their lifecycle stages. Biometrical data is helpful in separation of different instars of the species. Fulton (1940), Cardona and Oatman (1971), Rojas – Rouse and Benoit (1977), and Sathe and Nikam (1985) have attempted such type of studies. It is estimated that there are about 250,000 species of parasitic Hymenoptera in the world, of which only about 50,000 have been described (Gupta 1988). The family Braconidae having almost 40,000 species is divided into 21 subfamilies, some important among them are Euphorinae, Microgastrinae, Braconiae, etc. The subfamily Microgastrinae is of economic importance because they breed from the lepidopteraus hosts. It includes the three genera into which Foerster Microgaster Laetrile, Microgaster, and Microplitisand Apanteles. Apanteles genus was given by Foerster in 1862. Nixon (1965) divided this genus into 44 species groups. Some of these groups are very large like ater, ultor, etc: some groups, on other hand, have less than half a dozen species. Rao (1961) compared critically this genus with the help of all available literature and type specimens and divided Apanteles into two subgenera viz. Areolatus and Carinatusby presence or absence of propodeal areola as the main, valid and important character for the division. The catalogue of Apanteles Shenefelt (1972) lists 1118 valid species and nearly 200 more

have been described since then for a total of about 1300 species. 2000 species have been included under this genus by Mason (1981) from different parts of the world. Organized. The genus Glyptapanteles is recognized bu Ashmead in 1905. It is one of the larger segregates of the old "Apanteles". 5-10% of the species in temperate regions and about 25% in tropic , probably 1000 species in Wilkinson's group A or Nixon species group virtripennis, octonarius, pallipes, siderion ,demerter, fraternus, triangulator are included under Glyptapanteles. The vitripennis being especially well developed in cool and humid temperate climate while the octonarius in humid warm temperate and tropical climate. The genus Glypatapanteles is less well represented from dry climate.

Mason kept the following neartic species to Glyptapanteles(new combination) : (octonarius group). Apanteles affray Muesebeck A.cassianus Riley A.floridanum Mues., A.herbertii Ashmead.

Glyptapanteles malshri sp. Nov.:

Length 4.08 mm excluding ovipositor , forewing 4.00mm long , antenna 3.56 mm long , weakly trapered to apex.

Head:

0.80 mm long, it is circular and convex smooth ; interorbital space is 0.80mm which Is width of head , ocelli in triangle , ocellar space equal to the interocellar Space , front ocellar is 0.16mm frons smooth dark brown , shiny . Antenna 16 segmented 3.56mm, smaller than length of the body , first 7 segments having transverse band , first segment smaller than other 15 segments penultimate segment 0.25mm .

Flagellar formula:

2 L/W = 2.5; 14 L/W =2.4; L 2/14= 1.1, W 2/14 = 1.0 Eye pubescent, 0.37mm long, 0.1mm wide; molar space rugose.

Thorax:

1.68mm long; mesonotum lacking setae on the sub lateral lobes, punctuate; width of tegulae is slightly broader,brown, 0.12mm long. Propodeum 0.48mm broad and 0.40mm long, smooth, only middle region is coarsely punctuate, no trace of areola, prepctal carina absent. Fore wing length 4.00mm ; stigma is dark black in colour and hairy ; radius and

intercubitus slightly equal ; radius is strong ; basal vein strongly angulated Hind wing 3.5mm long , vennal lobe convex with fringe of hair , areolet open . Hind leg 4.67mm long , yellow in colour ; hind tibia with strong spines on outer side ; length of femur is 1.04mm tibia is dark brown colour , 1.08 mm long , spurs equal , 0.24 mm long , sharply pointed ; 0.60mm length of hind basitarus ; tarsal segment are 1.08mm long claws 0.12mm long , curved inside , black in colour , pointed .

Abdomen:

Spindle shaped , 1.60mm long ; tergite I never wider at apex , 0.28 mm long , the sides gradually converging apically and strongly rounded to apex ; tergite II 0.23mm long tergite III ; basal two tergites completely smooth and polished , ovipositor 0.28mm long and ovipositor , few hairs concentrated near the apex .

Male:

Similar to female, length 4.0mm.

Cocoon:

White, 3.4mm long.

Host:

Plutella xylostella (Binn), on cabbage.

Holotype:

Female , India , Maharashtra , Kolhapur , on cabbage , Brassica apitata L , collection , January to June 1988 -1989 ; antenna legs , wings , on slides , labelled as above .

Paratype:

23 females, 52 males, sex -ratio,Male:Female,1:0.44. Same data as in holotype , reared from larvae of the above mentioned host in India , Maharashtra , Pune , collection in January to June 2015-2017 .

Discussion:

Glytapanteles malshri species run close to Glyptanteles militaris (weed) in Mason's key in its characters.

1. Ovipositor sheath is shorter than ovipositor and with few hairs concentrated near the apex.

2. Areolet open (2 r-m absent).

3. Tergites I always tapering apically, tergite II sub triangular and wider posteriorly.

4. In propodeum, areola absent but trace of longitudinal median carina present.

It differs with

1. Propodeum is with two lateral carinae.

2. Antenna smaller than its body.

3. The first 7 segments having transverse band.

4. Vannal lobe of hind wing convex and fringed with hairs.

5. Hind leg 4.67mm long, faint brownish - yellow in colour.

6. Tergite-I rugose and punctuate.

Glyptapanteles malshri sp. Nov. (Fig I):

Egg (Fig I-2):

At the time of oviposition the egg of G.malshri is translucent, white, smooth surface and is cylindrical, slightly acute. Usually only one egg is deposited per host. The ends of the egg are somewhat rounded and there is no visible stalk or pedicel. The chorion is transparent and lacks surface sculpturing but somewhat smaller than the newly laid eggs .Eggs is randomly deposited in the hemocoele of the larvae. At deposition, the eggs contents are homogeneous. However, as development proceeds, the embryo was distinctly visible with nine narrow segments in the middle portion of the body. Free embryonic cells have been found in the host blood, it appears that may constitute part of the food of the parasitoid. The ripe ovarian 25 eggs averaged 0.52 mm in length (range 0.49- 0.54) and 0.187 mm in width (range 0.175 - 0.196 mm). Egg hatching period is 1-2 days.

Larvae:

G.malshri has 3 larval instars.

First instar (Fig I-3):

It is noted that the first instar found floating freely in the body cavity of the host, usually at about 5th or 6th abdominal segments. The head of the parasitoid larva directed towards the head of its host. Eclosion isprotracted process which may require up to four hours.

The larva forces its head through the egg, splits from anterior side. The body consists of a broad quadrate Head, 3 thoracic and 7 abdominal segments. There are two raised oral papillae situated anterior to the mouth which are capable of contraction and retraction. This instar is manipulate type. The mandibles are long and sharply pointed when at the rest their edges cross each other. These are not densely sclerotized at this stage and are capable of free and quick movement. The tracheal system was not seen in this stage. The mean body length and width of 25 individuals averaged 1.31 mm (range 1.28 - 1.38 mm) and 0.24 mm (range 0.21- 0.26 mm) respectively . The mean length and width of head capsule in 25 individuals were 0.101 mm (range 0.098 - 0.11 mm) 0.085 mm (range 0.079 - 0.095 mm respectively. The average length of 25 mandibles was 0.05 mm (range 0.032 - 0.061mm) and width was 0.015 mm (range 0.012 - 0.017 mm) while vesicle averaged in its length and width 0.22 mm (range 0.21 - 0.24 mm) and 0.24 mm (0.19 - 0.29 mm) respectively. Mature first instar is almost pale yellowish in colour. The head become less prominent and narrower than the rest of the body. The vesicles is minute in young host instar, but it appears to be well developed, bladder like by 2nd day after eclosion. The first instar lasts for 3 days.

Second instar (Fig I-4):

Second instar was first found on the 5th day after oviposition. It was hymenopteri form and somewhat oval in shape. The opaque body is creamy white and consists of a narrow head, 13 well defined segments and a prominent vesicle. The cuticle is smooth and appears to lack setae. The cephalic structure is very weakly sclerotized, so that the mandibles are easily discernible even in cleared specimens. The head is smaller and more sclerotized. Evagination of the last segment has prominently developed into a vesicle with clearly seems to consist of a single layer intestine. The paired salivary glands were very conspicuous forming series of loops. The tracheal system is well developed with two longitudinal trunks. Into the head, someshort branches are extended and posteriorly then run almost the entire length of the larva. These longitudinal trunks are connected just behind the head by a dorsal commissural. Still no spiracles have seen. Spines or setae were not apparent on the body. The mean body length and width of 25 individuals were

averaged 1.72 mm (range 1.53 - 1.91 mm) and 0.378 mm (range 0.355 - 0.389 mm) respectively. In 25 individuals, head capsule measured 0.189 mm in length (range 0.172 - 0.183 mm). The averaged length and width of 25 mandibles were 0.63mm (range 0.048 - 0.79 mm) and 0.23 mm (range 0.016 - 0.027 mm)respectively. Measurement of vesicles in 25 individuals averaged 0.53 mm in length (range 0.15 - 0.58 mm) and 0.64 mm in width (range 0.61 - 0.67 mm). The second instar lasts for only one day.

Third instar (Fig I-5):

The third instar appeared 7th day after oviposition. The body of larva is creamy white and opaque , consists of the head and 13 well defined segments . It tapers slightly toward both the ends. Early last instar have an anal vesicle, the structure gradually decrease in size and lastly disappears in matured larvae.

The cephalic structure is well developed and is described according to the terminology of short (1952 - 1953). The head is well developed with two prominent mandibles and sclerotized facial structure. The head is divided into a dorsal epicranial part and ventral buccal region. The epicranial part consists of a frons with two lateral rudimentary antennal stockets and a clypeus. The buccal area consists of a supra oral labrum the mouth and two dark brown sclerotized mandibles with saw like teeth on the dorsally directed cutting edge. Each mandible is with a broad proximal base tapering distally to a sharp point. The broad base articulates dorsally with the anterior pleurostomal process and ventrally with the posterior pleurostomal process. A strongly curved hypostoma with a ventrally directed sclerotized hypostomal spur lies behind each maxilla. The labial sclerite is supported by lateral stipites sclerites on each side. The labium has two oval labial palpi a silk rest of the body and is apparently telescopic.

Digestive system is well developed; which consists of the mouth, a slender esophagus, a large mid intestine closed at its posterior end and the anus. The silk glands found surrounding the digestive tract. In 3rd instar larva 8 pairs of spiracles are very prominent. One pair is situated in 2nd thoracic segment and one pair in each of the 7 abdominal segments. While rest of the tracheal system is similar to 2nd instar. The average diameter of thoracic spiracular opening was 0.009 mm. The average body length and width Of 25

third instar were 2.75mm (range 2.52 -2.85mm) and 0.679 mm (range0.45 -0.832 mm) respectively . The measurement of head capsule in 25 individuals averaged 0.32mm in length (range0.31 - 0.34mm) and 0.301mm in width (range0.292 - 0.304mm). The average length and width of mandible in 25 cases were 0.102mm (ranges 0.090mm - 0.104mm) and 0.040 mm (range 0.038 - 0.042 mm) respectively. The average length and width of vesicles were 0.25mm (ranges 0.20 - 0.31mm) and 0.30mm (range 0.26 0.33 mm) respectively, vesicles were smaller than second instar. The third instar lasted 1 -2 days. The parasitoid larvae were found floating in the posterior half of host larva. The mature parasitoid larvae exist from the host larvae, with the help of their mandibles by cutting the lateral line and thus killing their host.

Biometry:

Biometry studies of different instars of G.malshri showed that there is an increase in the length and width of larval form as well as in head capsule, mandible with respect to age (Table-1). The result obtained clearly indicated that there exists (length -$P < 0.50$, width - $P < 0.30$) correlationship between the age of the larval instar and the size which was tested with regression analysis ($r = 1.0$) for length and ($r = 0.974$) for width. The statistical result is tabulated in the (Table-2).

Cocoon (Fig I-6):

After emergence, the last instar larva of parasitoid form a silvery white, densely spun, cylindrical cocoon

which is round at both ends. The cocoon formed is attached with host food plant parts. The mean length and width of 25 cocoon were 3.4 mm (range 3.35 - 3.50mm) and 1.3 mm (range 1.21 - 1.35 mm) respectively.

Prepupa:

The prepupa appeared on the 9th day after oviposition and last for one day . It is differentiated from late 3rd instar by the appearance of the constriction in the middle portion of the body and by the pupal structures, such as segmentation of the abdomen, can be seen through the integuement. The length of 20 individuals were 3.2 mm (ranges

3.1 -3.4mm) and width 0.92 mm (range 3.1 - 3.4 mm) and width 0.92 mm (range 0.88 - 0.95mm).

Pupa(Fig I-7):

The pupa of G.malshri is of the exarate or free type, it is creamy white. The eyes were blackish and ocelli brown. As development proceeds, the entire pupa gradually darkens. The pupal appendages found loosely oppressed to the body. With the help of developing ovipositor the female pupa can be readily distinguished. The average length and width of 25 individuals were 2.90 mm (range 2.88 - 3.00 mm) and 1.05 mm (range 1.00 - 1.08mm) respectively. Under laboratory conditions 26 +- 1° c, the pupal period lasts for 6 - 7 days. The average duration of the life cycle of G.malshri from egg to adult emergence was 15 - 16 days.

Emergence:

Emergence of the adult G.malshri as found at day time. The adult emerged from cocoon by cutting off at side a circular cap, which was pushed aside and usually remain attached. After emergence the adult spent a brief time for cleaning their bodies. If food available, feeding could occur immediately. Usually make emerged before female.

Adult (Fig I-1, 8):

The male differentiated from the female by its sexual characters and dark abdomen. Antenna was 16 segmented and 4.08 mm long , shorter than body , propodeum contain longitudinal median carina and also both of lateral carina , vannal lobe of hind wing convex and fringe of hair , legs are faint yellow colour , Tergite rugoes and punctuate at apex . Length of female was 4.5mm, ovipositor 0.28mm long.

Mating:

Mating amongst the adult parasitoid was observed within 12 hr after emergence and it lasted for about 1 minute. Both sexes attracted towards each other when caged in plastic container (size 4 x 4 cm). The male recognized the female. After several attempts the male catch-up the female. By catching, the male suddenly mounted the female, and if there was no resistance, copulation took place. During mating, both sexes were remained,

stationary. The males found perusing other females after separation and copulated with several. However the female apparently mate only once.

Preoviposition:

Immediately after emergence, both sexes were placed in small glass tube. The adults were supplied honey as food. At the time of emergency females already have a number of mature ovarian eggs but not deposited as soon as host material was encountered. It takes 20 hr. before oviposition the preened and newly emerged

Females do not respond the host larva. The substrate is examined with the antennae by extending forward.

Oviposition:

After landing on the cabbage boll the female found searching for its host by moving around and tapping the cabbage surface with her antennae. If damage part come across, she become excited and start searching vigorously, and later, stabbing intention movements are made. The female examine continuously until she located the probable position of the host larva onthe cabbage. She then quickly inserted the ovipositor in the host larva, the parasitoid deposited an egg in larva, requiring less than 2 - 3 sec. If the host was not contacted, the female withdrew her ovipositor and inserted it in a new place. The probing operation was persistently repeated until the host larva was parasite.

Host age selection (Table -3, 4):

In this experiment optimum age for maximum was find out, Result are recorded in Table 12 & 13. The number of parasitoid emerged from host of age 2,3,4,5,6,7,8,9 and 10 days old larvae were 8,28,44,72,60,46,28,18 and 7 respectively , while parasitoids have not emerged from the hosts which were one day old . Maximum 48% parasitism was recorded on 5 days old hosts and mean number of parasitoids emerged per replicate under this age was 72. Host larvae, older than 5 days that have been progressively less suitable. The regression analysis indicated that there was a significant correlation between host age parasitism ($r=0.067$, $P<0.10$)

Longevity:

Neither sex survived for more than two days without food and water. The result is shown in table 14. The mean survival of males fed with 10% and 20% honey was 5.3 and 7.0 days and in females 5.52 and 7.5 days respectively. Maximum survival of females was 13 days while make survived for 12 days when fed with 50% honey. In general, females live longer than males.

Table no. 1: Biometrical Measurement of Larval instars *G. Malshri*

Sr.No.	**Body structure**	**Larval instars**	
First	**Second**	**Third**	
I		**Larval Body**	
Length	**1.31**	**1.725**	**2.75**
Width	**0.24**	**0.378**	**0.678**
II		**Head**	
Length	**0.1.1**	**0.189**	**0.323**
Width	**0.085**	**0.180**	**0.301**
III		**Mandibles**	
Length	**0.05**	**0.063**	**0.323**
Width	**0.015**	**0.023**	**0.040**
IV		**Vesicle**	
Length	**0.22**	**0.53**	**0.25**
Width	**0.24**	**0.64**	**0.30**

Table no. 2: **Statistical Linear Regression relationship between larval age and Length of body of** *G. malashri*						
Instars No.	Age in days	X2	Larval leg.	Y2	xy	Expected value y
1	2	4	1.31	1.7161	2.62	1.82
2	4	16	1.723	2.9687	6.892	1.927
3	6	36	2.75	7.5625	16.5	2.675
12	56		5.783	12.2098	26.012	
Mean x= 4,Mean :y= 1.927,a=0.437,b=0.3725,r= 1.0 t=0.615,p < .50						

Taxonomy of Glyptapanteles malshri.

1

2

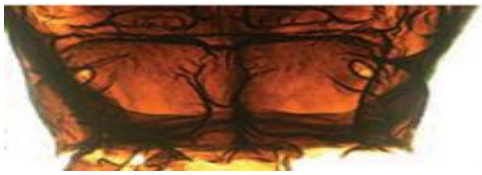

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Fig. 1, Female in dorsal view (1), mesosoma with metasoma in part (2) Propodeum (3), Abdomen (5).

Biology of Parasitoids

Introduction:

Over the last 30 years, considerable attention has beenpaid to what has become known as the "Classical" approach inthe development of biological control techniques. This usuallyinvolve the introduction of exotic parasitoids or predators into, there is a growingrealization that much can be gained from the exploitation of Natural enemies of indigenous or long established pests. Thisnormally entails efforts to conserve and enhance the activity ofthese natural enemies by manipulating their environment. Aspectsof this approach are biological peculiarities, the provision of alternative hosts and adult nutrition, modification of culturalpractices for reducing parasitoid mortality and the manipulationof parasitoids using behavior controlling chemicals.Two distinct categories, for augmenting the use ofparasitoids have been recognized (DeBach 8 Hagen, 1964) asInoculative and inductive release. The former involves releasing,relatively small number as colonizing population, with thepurpose of providing relatively long-term pest regulation.Inductive releases, on the other hand, released large number tocause an immediate and direct mortality in the pest population,with no expectation of long term regulation. Inoculative releasesmay be made over several weeks and involve relatively large number of individuals released, whereas at certain times, asingle release of relatively low numbers to achieve a ratio ofpredators or parasitoids to. Prey sufficient to control(Stinrer, 1977).

It has been noted that these particular entamophagous Hymenoptera differ from true parasites in ways to set themapa't and accordingly to justify the use of the distinguishingterm ' parasitoid'. They are recognized as being differentbecause (i) the development of an individual destroys its host,(ii) the host is usually of the same taxonomic class, i.e.Insecta, (iii) in comparison with their hosts, they are ofrelatively

large size (iv) they are parasitic as larvae only, theadult being free living forms, (v) they do not exhibitheteroecism, (vi) as a parameter in population dynamics, theiraction resembles that of predators more than that of true parasites.The so called parasitic hymenoptera, traditionally embracingthe Ichneumonidae, chalcidoidae, and cynipoidae, include a vastnumber of small to large insects, the majority of which live atthe expense of their phytophagous or carnivorous relatives(Matthews, 1974). Of these superfamilies'', Ichneumonidae constitutesone of the leading groups both in number and effectiveness(Chatterjee, 1944). The dominant families of this branch of thehymenoptera parasitoid are the Ichneumonidae and Braconidae, bothof which attack a wide range of host species.All Braconidae are parasitic upon other insects and a broadcorrelation between braconid subfamilies (or tribes) and host orderis reflected in most braconid classification schemes. Table $indicates the principal host known for the subfamilies of Braconidae (Matthews, 1974). The host records in previously noted catalogue. (Stary/ 1967; Mackauer, 1968; Fisher, 1971; Snenefelt, 1969; 1970a and b, 1972, 1973), considerably extend and update Thompson's(139) lists, a standard reference in the past.Since Braconidae with few exception are all primary parasitoid, this family in particular has attracted increasing interest as emphasis in pest control has shifted toward biotic agents. Partly as a result, the quantity of literature upon the family is staggering, as of 1965 it comprised in excess of 80,000titles (Shenefelt, 1965) probably representing only 6000 valid described species, it includes nearly 30,000 names (R.D. Shenefelt, personal Communication).

The number of larval instars in parasitic hymenoptera is difficult to determine and is unknown in most species. Investigations on the number of larval instars are generally only possible by continuous breeding of the parasitoids and their hosts. One of the main difficulties in determining the number of larval instars is the fact that the parasitic way of living does not permit easy observation of moults or study of exuviae. Previous investigations (Clausen (1940), Fulton (1940), Short (1952, 1953), Fisher (1959), Tikar and Thakare (1961), Broodryk (1969), Kajita and Drake (1969), Oatman et al< (1969),

Cardona and Oatman (1971), Odebiyi and Oatman (1972), Matthews (1974), Sato (1975), Narendran and Joseph (1976),
Nikam and Basarker (1976), Calkins and Sutter (1976), Rajas-Rouse and Benoit (1977) , Madar and Miller (1983), Chow and Sullivan (1984), Sathe and Nikam (1985), Isenhour (1986) and Sathe (1990)
have underline the variability of the number of larval instars in parasitic hymenoptera.In general, the adult characteristic is the criteria for taxonomic assessments in parasitic hymenoptera. However, the reliable understanding of the species would be more correct by studying their immature, forms. This also corelates the probable phylogeny of the group. Though many workers studied the larval forms in various species the solid foundation to these aspects was made b/ Short (1952, 1969, 1970 and 1981). A. prodeniae belongs to the tribe Apantelini subfamily Microgastrinae of family Braconidae. The genus Apanteles comprises chiefly the very large diverse and world wide 'ater' group of Nixon (1965). The catalogue of Apanteles (Shenefelt, 1972) lists 1,118 valid species and nearly 200 more have been described. Mason
(1981) estimated 20 00 species of the genus Apanteles in all parts of the world, he believes that 5,000 to 10,000 species would be the reasonable estimate of the genus in the world. A. prodeniae has been distributed in Indo-Australian and pacific region. In India, the species was reported bv Ayyar
(1921) and Wilkinson (1928a) on the Tobacco caterpillar, S. litura and Krishnamurti and Usman (1955) from Mysore State and Sathe (1987b) from Maharashtra. It is an important parasitoid of the Tobacco caterpillar feeding on Groundnut in the fields of Kolhapur, Maharashtra.

The Tobacco caterpillar S. litura belongs to the family Noctuidae of order Lepidoptera. It is found in the tropical and subtropical parts of World. It is widespread in India. Besides Cobacco.it feeds on groundnut, caster, tomato, cabbage and various other cruciferous crops.In India *f* this species is distributed in Andhra Pradesh, Maharashtra and all over the India. Larvae feed voraciously on the tender leaves, shoots and fruits at

night.P. bhairavi belongs to the tribe Cotesiini and subfamily **genus** Microgastrinae, of family Braconidae. The. Parenion is very small, described by Noxon (1965). Only the type species from Now Guninea bears a name, but there are other species in New Britain and New Caledonia (Mason, 1981). In India, the species was reportea on Diacrisia obliqua Walkar, from Maharishi for the first time by Sathe and Tnamdar (1989) P. bhairavi is a solitary, end larval parasitoid of D.obliqua (Lepidoptera:
Arctiidae) .It attacks early instars of the caterpillars. The Bihar hairy caterpillar, D.obliqua belongs to the family Arctiidae of order lepidoptera. It is sporadic pest and is widely distributed in the oriental region.lt is very serious pest in Bihar, Madhya Pradesh, Uttar Pradesh and Pan jab as a polvphagous pest Caterpillars feeds on leaves and soft portion of stem and branches of cow pea C. malshri belongs to tribe Cotesiini and subfamily Microgastrinae of the family Braconidae. Glyptapanteles is one of the segregates of the old "Apanteles" including 5 to 10 % of the species in temperate regions and up to 25% in the tropics, probably 1000 species or more. Under Glyptapanteles most of the species in Wilkinson's group A or Nixon's species group vitripsnais octanorius, pallipes, siderion, demeter and triangular are included.

The genus is less well represented in dry climates. It is an important parasitoid of the Diampnd-back moth, p. xylostella in Pune, Maharashtra.

The Diamond-back moth, P. xylostella belongs to the family Plutellidae of order lepidoptera. It is of European origin but now occurs whenever cabbage is grown. Though originally recorded in

England as pest of turnip, the pest is worldwide but serious on cauliflower and cabbage. It also feeds on many other cruciferous, solanaoeous liliaceous plants. The pest is most serious when

it appears on the early crop in August-September, Diamond shaped three three yellowish spots are on the back of the fore wings, hence it named the Diamond-back moth. Behavioural studies like mating, oviposition, and host age selection have been worked out in A. prodeniae by Santhakumar **(1989),**

In the present chapter biological and biometrical studies are made on three parasitoids viz. P. bhairavi, G. malshri and A. prodeniae. In addition, emphasis has been paid on behavioral studies like mating, oviposition, host age selection etc. and adult nutritional requirements in P. bhairavi and malshri. The present study will be helpful in mass rearing of above parasitoids.

Material and Methods:

The cultures of parasitoids and their hosts were maintained under laboratory condition as per the rocedure given in material and methods. To study the life history and morphology of immature stages of parasitoids, 3 days old D.obliqua larvae, 5 days old P. xylostella larvae and 4 days old S. litura larvae were exposed to mated females of P. bhairavi, G. malshri and A. prodeniae respectively in test tubes (size 19 X 2.5 cm). With help of camel hair-brush parasitized larvae separated in containers for further development. Parasitoid eggs and larvae were collected after 12 hr. intervals, dissecting parasitized host larvae in normal saline solution till sufficient number was obtained to determine development of parasitoids. Instars were identified by observing the size of head capsule mandibles (Short, 1959, 1970). Parasitoid eggs and larvae measured with a calibrated ocular micrometer in a compound microscope. Larval stages were mounted in Hoyer's solution on microscopic slides for morphological studies. To determine the shape ind size of the larval mandibles, the larvae were boiled in 10h KOH solution for 45 sec. clearing but not completly removing the obscuring tissue. After being washed in distilled water and
were mounted on slides. The head capsules and mandibles were measured with a calibrated ocular micrometer in a compound microscope.

To study the cephalic structure of last larval instar, the heads removed and immersed in 10% KOH solution for 24 hr. After being washed in distilled water for 5 min, the heads were mounted in a drop of glycerin in the cavity of a monoconcave slide. Observations on head structure were also made from the remains of the last instars found inside the

cocoon. Prepupae and pupae were obtained from the parasitoid cocoons for measurement and observation. The cocoons were opened longitudinally along one side by using micro dissecting scissor/blade. All drawings were made with a DPX/Camera Lucida. To determine the mating, newly emerged (male and female) pair was caged in plastic container and observation was noted. Twenty pairs of each parasitoid species were observed for their mating. For oviposition, Ilnd instar host larvae were exposed to parasitoid species. Along with the host larvae, leaves of Cow pea/cabbage were also exposed to parasitoids for observing the oviposilional behaviours.To determine the effective age of host for maximum parasitization, larvae ranging in age from 1 day to 10 days were exposed to individual newly mated female of respective species of parasitoid in glass cage for a period of 24 hr. After exposure, the larvae were separated into containers for further observation. Daily records of the exposed larvae and the parasitoids emerged from cocoons were noted. The results obtained were tested by regression analysis to find out its significance. The effect of different food sources on the longevity of adult parasitoids was studied by placing newly emerged males and females in glass cages (Fig.I and II) and supplying them with water, 10% honey, 20% honey and 50% honey. In control, the adult parasitoids
were starved.

Perenion bhairavi Sp Nov. C Fig.135) :

Egg (Fig. 136): slightly tapering to one Eggs are elongated translucent, end, and randomly deposited
stalked, in the hemocoele of the host larvae. The newly deposited eggs are white and thin walled. The one end is somewhat rounded. The chorion is smooth, thin and transparent. The ovarian eggs are smaller than the newly laid eggs. The ripe eggs are white, thin walled and typically hymenopfceriform. At deposition, the egg contents are homogeneous. However, as development proceeds, a deep yellowish zone appears along

the central part and outline of the embryo is marked. After oviposition, the egg has greatly increased in size. The total measurements of 25 eggs, averaged 0.4 mm long (range 0.21 - 0.45 mm) and width 0.15 mm (range 0.10 - 0.17 mm). Its cephalic end has broadened. The cells surrounding the embryo increase in size as the embryo develops. Egg hatching period is 3 days.

Larva: There are three larval instars out of which the first occupies the greatest part of the larval life and other two instars extends for a relatively short period.

First Instar (Fig. 137) : The first instar larva found free in the body cavity near the periphery, usually at posterior part of host body, 5th or 6th abdominal segment with the head directed toward the head of its host. The larva shows a caudal vesicle at the posterior end. The body of first instar consists of broad quadrate head, 3 thoracic and 7 abdominal segments. The last abdominal segment is about twice as long as any of the other segment of the abdomen. Subsequent larval movements cause the chorion to split open wider and soon, it envelopes only the abdomen and is ultimately shed caudal. Newly hatched larvae are surrounded by a serosal cell mass. A tracheal system was not apparent. The head of the first instar larva consist of a large segment, about 2-3 times the size of the thoracic segments. It bears a pair of antero - lateral labral processes, the labium, the labrum and two antero- ventral, sharp pointed mandibles with broad bases. These mandibles are increasingly darker and more sclerotised at their distal ends. The bases of the mandibles are supported by rod-like structure. Newly hatched 25 larvae averaged 0.6 mm (range 0.3-0.7 mm) in length and 0.15 mm (range 0.132-0.lf mm) in width. These dimensions and the general appearance of the larvae did not change until first 2 days. The caudal horn of early stage has evolved to a large conspicuous, bladder like vesicle. The function of this vesicle, which is a caudal projection of the proctodaeum, is not completely understood. The body length of 25 individuals averaged 1.32 mm (range 1.20 - 1.36 mm) and width was 0.23 mm (range 0.19- 0.25 mm). In 25 individuals, mandibles averaged 0.032 mm (range 0.029-0.335 mm) and 0.012 mm

(range 0.009 -0.016 mm) in length and width respectively. Length of vesicles measured in 25 individuals averaged 0.20 mm (range 0.17 - 0.23 mm) and width 0.28 mra (range 0.25 - 0.30 mm). The vesicle is transparent and somewhat rounded in shape. The head capsule averaged 0.080 mm in length (range 0.077-0.083 mm) and 0.068 mm frange 0.065-0.072 mm) in width. The first instar lasts for 5 days.

Second Instar (Fig. 138) : The larval body in the second instar was cylendrical with a well developed head followed by 3 thoracic and 10 abdominal segments, all clearly separated from one another. The body is creamy white and consits of a narrow head. The anal vesicle is prominent and often flattened poster dorsally. The central portion of the body occupies with the large apparently blind mid-intestine. The paired salivary glands are very conspicuous, forming series of loop that fill the major portion of the body cavity, at back abdominal segments. The tracheal system comprises two longitudinal trunks which extend into the head giving off some short branches, as posteriority they run almost the entire length of the larva, giving of one dorsal and one ventral branch in each of the 10 abdominal segments. The longitudinal trunks are connected just behind the head by a dorsal commissure. The tracheal system does not extend into the anal vesicle. Spines or setae were not apparent on the Larval body. The spiracles could not see in this stage. The average length and width of the body measured in 25 were 2.20 mm (range 2.10 mm - 2.33 mm) and 0.39 mm (range 0.31- 0.46 mm) respectively. The head capsule length and width of 20 individuals averaged 0.30 mm (range 0.20-0.40 mm) and 0.18 mm (range 0.16 - 0.20 mm) respectively. The vesicle is transparent and slightly bilobed. The vesicle consits of a single layer of columnar cells (Fig. 143). The average length and width of the vesicles measured in 25 individuals were 0.48 mm (range 0.45-0.58 mm) and 0.46 mm(range 0.40-0.54 mm) respectively. The length of 20 mandibles averaged 0.080 mm (range 0.067 - 0.092 mm) and width 0.035 mm (range 0.021 - 0.043 mm). The second instars stayed for 2 days.

Third Instar (Fig. 139) : The third and last instar is hymenopteriforms and appeared on the 10th day after oviposition and lasted for 2 days. The body of the larva is creamy white and opaque. Larva showed the head and 13 well defined segments. It tapered slightly toward both the ends. In early stage. anal vesicle is present, later, the structure gradually descreases in size and finally disappears in mature form. The head is small compaired to the rest of the body and is apparently telescopic. The digestive system consits of mouth, a slender oesophagous,a large mid-intestine that is apparently closed at its posterior end, and the anus. Two large silk glands have occupied much of the body cavity. They were coiled, tubular, and pearly-white. These silk glands surround the digestive tract and unite at the second abdominal segment to form a common duct which extends ventrally to the pharynx and open on the floor of the mouth. The tracheal system (Fig. 144) is similar as found in Ilnd instar except seven pairs of spiracles are present on the half of the larval body, while one pair is in the meso-thorax. The mature parasitoid larvae emerged from the host by cutting the larval body with the help of mandibles due to which larva killed immediately. The remains of the host body was almost found attached to the parasitoid cocoons. The body length and width in early third instar observed in 25 individuals averaged 3.90 mm (range 3.72 - 4.0 mm) and 1.42 mm (range 1.33 - 1.50 mm) respectively. In 25 head capsules measured, mean length and width were 0.895 mm (range 0.80 - 0.91 mm) and 0.685 mm(range 0.682- 0.690 mm) respectively. In late instars the vesicle was absent. The mandible (Fig. 145 b) length tnd width observed in 25 individuals averaged 0.1 mm (range 0.82 - 1.5 mm) and 0.065 mm (range 0.034 - 0.073 mm) Respectively. The third instar lasted for 2 days. The head is well developed into a dorsal epicranial part and a ventral buccal region. (Fig. 145 a). The epicranial part consists of a frons with two lateral rudimentary antennal sockets and a clypeus. Two dark brown sclerotized, bifid mandibles occur, each with a broad proximal base tapering distally to a sharp point. The broad base articulates dorsally with the anterior pleurostomal process and ventrally with the posterior pleurostomal process. A strongly curved hypostoma with a ventrally directed sclerotised hypostomal spur lies behind each maxilla. The maxillary palp is oval and prominent. The labium is encircled by the labial

sclerite. The labial sclerite is supported by a lateral stipital sclerite on each side. The labium has two oval labial palpi, a silk press and silk duct opening.

Biometry: Biometry studies of different instars of P. bhairavi showed that there is an increase in the length and width of larval form as well as in head capsule and mandible with respect to age. (Table 1). The results obtained clearly indicated that there exists (length-P <C0.E0, width-
P < 0. 30), correlationship between the age of the larval instar and the size which was tested with regression analysis (r=1.30 for length and r= 0.13 for width). The statistical results are tabulated in the Table No. 1,2,3.

Cocoon (Fig. 140) : The third ecdysed larva begin to weave the cocoon from the posterior end of its body. The larva doubles up and attaches a thread to the substrate close to its own body. It pulls out a short thread which forms a loop in the shape of an inverted ' U'. It continues the same until it has formed a series of loop around the ventral half of its body. Then larva reverses the direction and attached the loop to the tops of the first series and makes the frame work around its own body. When the frame becomes loosened, the larva move back and forth with the head and the silk fails to pull out properly. Even it is rigid enough to draw the thread, the frame may sag away from the body and develop as a long curved strip, never reaching the proper height for completion. Larva rounds off the top and by bending backward extend the frame downward in the form of a hood, when it extends the frame to ventral full-height side of its body. It then crawls into the hood and reverse its direction so that large posterior portion of the body is held in the hood. Reaching back to where it left off, it continues the looping process down the other side until the oval, basket like frame is completed. Then it presses out the sides and spins a tight wall on the inside alternating between two movements; first back and forth straight longitudinal motions placing the threads in parallel series and second transverse progressing loops like an elongated figure '8'. Finally the cocoon is lined by a thin pellucid sheet composed of flattened strands running in various direction. Cocoon is

faint-yellow coloured, densely spun, cylindrical and rounded at both ends. The average length of 50 cocoons was 4.20 mm (range 3.84 - 4.50 mm) and width was 1.80 mm (range 1.60- 1.90 mm).

Prepupa : The prepupa appeared on the 13th day after oviposition and lasts for one day. Initially prepupa is indistinguishable from a last instar, but soon differentiated by the appearance of a constriction in the middle portion of the larval body and by the fact that future pupal structure, such as segmentation of the abdomen. The mean length of 20 mature prepupa was averaged 4.02 mm(range 3.89 - 4.2 mm) and width average 1.58 mm (range 1.52-1.80 mm).

Pupa (Fig. 141) : As like other hymenoptera the pupa is of the exarate type. It is enclosed with Pink yellowish oval cocoon. It's creamy white initially (141a) except for the blackish eyes and brown ocelli. As the development proceeds, the entire pupa gradually darkens: (141b). The pupal stages were found on the 14th day after oviposition and lasted for 6-7 days. Pupa is somewhat shorter and wider than the prepupa. The Pupal appendages are loosely apprised to the body t he female pupa can be readily distinguished from the male by the presence of the developing ovipositor. The mean length and width of 25 pupae were averaged 4.00 mm (range 3.80- 4.10 mm) and 1.76 mm (range 1.72-1.79 mm) respectively.

Emergence: The adult emerge from the cocoon by cutting off at one end circular cap, which is pushed aside and usually remains attached. After the emergence adults spent a brief time for cleaning their body. Then they flew away, usually males emerged before the females. Data on the proportions of the sexes emerged from their hosts indicate that the sex ratio, male: female is favors of males 1: 0.636.0.

Adult (Fig. 142) : Female of P. bhairavi measured 5.20 mm in length from the tip of the head to the tip of the abdomen. The length of the ovipositor averaged 0.44 mm. The head and thorax of female are black with an antennae and legs partially faint – black colored, Flagellomers mostly with two ranks of placodes, propodeum coarsely reticulate and median longitudinal carina is strong but not complete, it bifurcated; median groove of first tergite is absent, ovipositor sheath is with hairs, areolet open (2r-m absent); head circular moderately pubescent; antenna 16 segmented', fore-wing faint yellow in colour, haylines dark-yellow; abdomen is dark blackish brown, tergite I sub parallel sided and much longer than wider, without median groove; ovipositor dark brown; ovipositor sheath with few hairs, shorter than ovipositor.

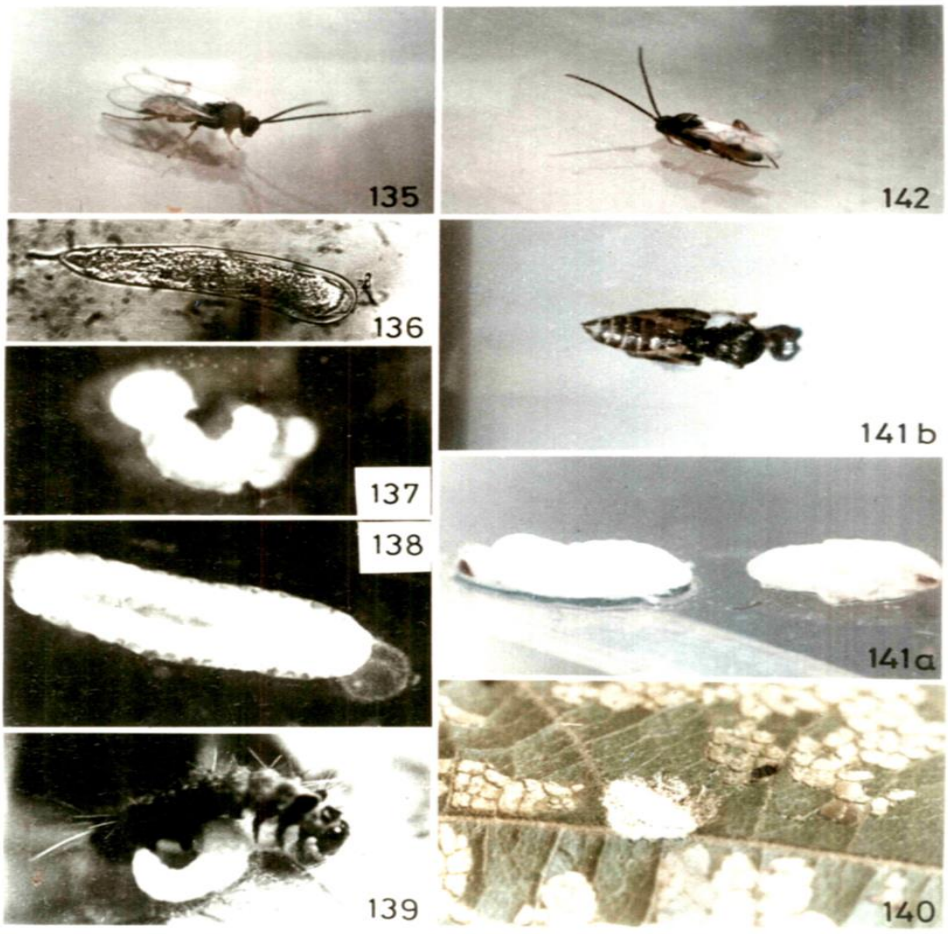
Mating: The copulation observed freely under laboratory conditions when newly emerged pair (male and female) placed in a container. The males become highly excited in the presence of female. Prior to mating, the male fanned its wings rapidly, and walked toward the female. Usually the male had to make several attempts to catch up with the female. When succeed/ the male suddenly mounted the female, and if there is no resistance, copulation takes place. The copulation lasts for 48". During mating, both individuals remained stationary. After separation the excited male started pursuing other females and copulated with many. The females have been observed to mate only once in rapid succession.

Preoviposition: During the Preoviposition, female can take their food, 50% honey v/hen provided. Females after contacting the host larvae with their antennae do not respond as they moved away from the host larva. The preoviposition period lasted for 12 hr.

Oviposition: Almost immediately after the introduction of leaf and larva, the female started actively searching for host. On reaching the cow pea foliage, she walked about tapping the surface with her antennae and ovipositor, nervously. Further, she stopped walking and began making circular movements by tapping the surface. If damaged leaf came in contact the female exdted more. Thus the damaged part of leaf plays important role in inducing oviposition. The female continued to examine the infected leaves, until she located the host larva. By contacting the host, she quickly inserted the ovipositor and deposited an egg in the larva, which requires 3 seconds. Female oviposite 1-3 eggs in each host larva.

Host Age Selection: The results tabulated in Table No. 4, 5, 6 shows that 3 days old larvae were the most suitable for maximum parasitization. At this age 50% parasitization was noted. The percent parasitism was decreased beyond the host age, 3 days and was absent in 1 day old and 8-10 days old. The results obtained by linear regression analysis indicates that there exists a significant ($p< 0.10$) correlation between the host age and percent parasitism ($r=0.07$).

Longevity: The results (Table 7) shows that, without food or with water, the mortality of both the sxes were recorded in about 1 to 2 days, In general, males lived longer than females, the males lived longest, 8.33 days and the females, 7.22 days when provided with 50% honey. With supply of 10% honey the longevity, observed in male 4.60 days and in female 4.13 days whereas with 20% honey the longevity was not increased so significantly, the males lived for 5.40 days and females for- 5.30 days.



Parenion bhairavi Sp.nov. Fig.2: Adult Male (135), Egg (136), First Instar (137), Second Instar (138), Third Instar (139),Cocoon(140), Pupa (141a 8 b), Adult Female(142),

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