CHAPTER-I

INTRODUCTION

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The economic development of any country mostly depends on agriculture, which provides basic ingredients and the raw material to the mankind. Agriculture in India has always contributed lot in shaping the Indian economy, hence Indian economy is sometimes described as agricultural economy. In the last decade the world has witnessed very rapid unfolding of the enormous potential of the field of biotechnology and its applications in the areas of agriculture. This has aroused unlimited hopes and expectations in mankind. The advent of recombinant DNA technology resulting in transgenic plants and animals. Other types of biological manipulations such as, cell and tissue culture, embryo transfer technology etc. have opened up new challenges.

Technological progress particularly over the recent years has opened up new possibilities for producing more food, fodder, fibre and other agricultural commodities from less land. Recent advances in biotechnology must be taken into account in the planning of agriculture. In spite of the very creditable increase in our food production during the last few decades, it is no cause for complacency, when one realizes that even today 40% of the existing population is undernourished. However the progress through research is very well reflected in terms of increase in production & productivity of various important crop commodities. Indian population is likely to touch 1 billion mark by the end of the century, then our requirements would be of about 230 ml of food grains, 9 ml of edible oils, 13 billions bales of cotton and 11 million bales of jute and mesta. In general we need to view our achievements in research.

There are several significant achievements in different crops relating to breeding either genetically higher in productivity or possessing resistance to various biotic & abiotic stresses.

India is the first in the world to commercialize hybrid cotton. H_4 was the first such interspecific hybrid, followed by other Varlakshmi DCH-32, etc. Today the country's earning is around Rs. 4500 crores of foreign exchange, through the export of raw cotton (Paroda 1993). In wheat, high yielding dwarf varieties suiting consumers preferences, helped India to achieve "Green Revolution". In sorghum excellent hybrids namely, CSH-1, CHS-5, CSH-6, CSH-9, etc. have proved their superiority under rainfed condition. New Kharip hybrids CSH-10, CSH-11 and SPH-468 and rabi hybrids CSH-12 R and CSH-13 R are also prominent varieties. India is also first country to develop hybrids in pearlmillet, castor and more recently pigeon pea. The hybrids have been commercially exploited in number of crops such as maize, sorghum, sunflower, cotton, tomato, etc.

In general, Indian agriculture is predominantly characterised by cultivation of wide variety of food & non food crops (Sing & Sadhu, 1986). Plantation crops are high value commercial crops of great economic importance and they play a vital role in the country's export trade. Plantation crops occupy 82% of the total cropped land and they generate an income of about Rs. 16000 million (Ramchandan, 1993). These crops open considerable avenues for employment and systematic labour. Government has identified a few important crops from horticulture & oil seeds for their problems and it is felt that, there is an urgent need to concentrate on R & D efforts on these crops. In the past our increase in the food production was possibly mainly due to increase in area under cultivation and production of new and hybrid varieties. However, the expected yield of crops is not achieved so far, because of the damage caused by the pests. The insect pest problem is chronic for several crops and also a major cause for decreasing the yields.

A pest is an organism that inflicts economic damage to agricultural crops or products or to human resources in the process of their multiplication. It is estimated, annual crop losses cost more than Rs. 6000 crores, of which insects contribute 20% (Paroda 1993). The introduction of exotic high yielding varieties have also increased the pest problems. In general, the insect pests damage stems, leaves, flowers, fruits and roots of crops by feeding upon them. Many times we have to sacrifice the crops due to the severe attack by insects and lack of application of control measures.

Most prominent & established control measures are chemical, mechanical, cultural, biological, radiational, genetical, etc. However, hormonal control, behavioural control, attractants, repellants, pheromones, allomones, kairomones etc. are also the components of integrated pest management. Chemical control gives quick result but has many side effects such as :

(1) health hazards,

(2) air & water pollution,

(3) physical & physiological changes in soil,

(4) killing of beneficial insects,

(5) disturbance in natural balance & ecological cycles,

(6) development of resistance in pests,

(7) Pest resurgence,

(8) Secondary pest outbreak,

(9) Stimulation to the reproductive potential in certain pests, etc.

The above factors suggests to find out an alternative for the pesticidal use. In this contest biological control is "living weapon" over chemical control. Biological control is defined as "the action of parasitoids, predators and pathogens in maintaining other organisms density at a lower average than would occur in their absence (DeBach 1964). Coppel & Mertins (1977) defined the biological control as "the use or encouragement by man of living organisms or their productions for the population reduction of pest insects." In general, parasitoids & predators are important parameters of biological control. The term "parasitoid" was firstly used by Reuter in 1913 to describe life history, intermediate between that of predators & true parasites. Parasitoids kill their hosts in the process of their development, thus they are entomophagous. But the adults are free living. Parasitoids are widely scattered in the orders strepsiptera, Hymenoptera, and Diptera. They are also recorded from the Lepidoptera and Hemiptera.

Though biological control is a modern technique it has many records in ancient times of it's use. Apanteles (=Cotesia) glomeratus (L) was the first parasitic insect reared from caterpillars of cabbage white butterfly; Pieris rapae Boisduval in 1502. The 18th century literature also contains the descriptions of the wasps and files emerging from other insects. Linnaeus suggested for the first time that the ichneumonid parasitoid, Ichneumonid aphidium can control the aphids on some plants. In 19th century, Darwin suggested various parasitic insects to control number of economic pests. (Coppel & Mertins, 1977). About 110 pest species have been controlled by biological means in 60 countries, inolving more than 225 projects (DeBach, 1964). Likewise, Simmonds (1970) reported 11 species of pests that have been controlled by biological means in several countries.

In 20th century various workers viz; Jonson (1957), Huffaker and Stinner (1971), Greathead (1971), Rao (1961), Rao et al (1971), Sailer (1971), Haegan and Franz (1973), Coppel & Mertins (1974, 1977), Nagarkatti (1981), Nikam & Sathe (1983), King (1984 a,b) Lutterell et al (1985), Sathe & Nikam (1983, 1984), Yeargan (1985), Cossentine and Lewis (1966). Lingren et al (1988), Narasimhan and Chacko (1988), Sathe (1984, 1985, 1986 a,b,c; 1987, 1988, 1990, 1991 a,b; 1992 a,b), Sathe et al (1989) Sathe and Ingawale (1993) and Ingawale and Sathe (1994) have made significant contributions in the field of biological control.

In recent years, peoples have realized that, the insecticides will never permanently solve the pest problem. Hence, world organizations like CILB, CIBC, CAB, IOBC and USDA etc. came forward to fillip the workers in the biocontrol of insect pests. These organizations provide effective services to world agriculture to co-ordinate and administer agricultural informations, identification, bio-control programmes and other services. In USA commercial production of parasitoids seems to be popular. There are at least 50 commercial insectaries, which annually produce 3000 million Trichogramma Spp. for control of various Lepidopterous pests. In Soviet Union, more than 10 biological factories are engaged in mass production of Trichogramma Spp. and producing about 5000 million parasitoids per season. Besides, about 15 species of parasitoids have been mass rared and released in about 10 million hectares for control of variety of pests in USSR. Similarly, in Netherland 32 million Opius Spp. are produced annually for the control of olive flies (Manjunath 1992).

Common Wealth Institute of Biological Control (CIBC) has installed first centre in India at Bangalore in 1957 to work on biological control. Since then a large number of centres have been established and are actively engaged in doing research on biological control of insect pests. Noteworthy among them are the centres at Gorakhpur (U.P.), Solan (H.P.), Hyderabad (A.P.) Shriganganagar (Rajasthan), International Crop Research Institute for the Semi Arid Tropics Patanchery (A.P.), Tamil-Nadu Agricultural University Coimbatore, Shivaji University Kolhapur; Vasant Dada Patil Sugarcane Institute Pune, Dr. Babasaheb Ambedkar Marathwada University Aurangabad, Bio-control Research Laboratory Chengalpattu (T.N.) and some other agricultural Universities.

CIBC, Bangalore has made extensive survey for natural enemies of Aphids, Rhinoceros beetle, etc. Rao et ai (1971) reviewed several exotic natural enemies that have been introduced for pest control. In India, commercial production of bio-control agents was began only in 1981. The parasitoids that are presently available commercially include various species of Trichogramma for control of sugarcane boreres, cotton boll worm, codling moth, etc. The parasitoids are also available for coconut black-headed caterpillar and Filth Flies in India (Manjunath 1992).

The order Hymenoptera is extremely important from the view of biological control of insect pests. Many parasitic wasps have been extensively used in bio-control programmes. The most important parasitic families of this order includes Braconidae, Ichneumonidae, Chalcidae, Trichogrammatidae, Eurotomidae, etc. Among the parasitic families of Hymenoptera, Braconidae ranks very high. It is also one of the largest families of the Animalia. The braconids attacks mainly Lepidopterous, Coleopterous, Dipterous, Hemipterous and rarely Hymenopterous insects.

Taxonomy is unique among biological sciences in it's dominant concern with diversity. The more important is the establishment of intraspecific diversity occuring in different populations of given species. In recent years, there are several reports on the existance of variants which react differently under different conditions, causing setbacks in applied research programmes. Biological control is one of the several areas of biological applied research which depend heavily on taxonomy. There are many instances where biocontrol programmes have failed due to the incorrect species identity. Keeping in view, all above facts, the present topic was selected. It is estimated that, there are about 2,50,000 species of parasitic Hymenoptera in the world, of which only about 60,000 species have been described (Gupta, 1988). According to Kerrich (1960) Hymenoptera contain 5 lakhs of parasitic wasps. The family braconidae alone consists more than 40,000 species (Achterberg, 1988). From USSR territory more than 1100 species have been reported (Tobias, 1976).

From Oriental region only 1/10 of the species have been described. Hence our knowledge on oriental braconidae is megre. As far as Indian braconids are concerned, no comprehensive volume has ever been published except Bhat and Gupta (1977). The workers of 18th century viz. Brulle (1846), Smith (1861), Cameron (1891, 1900, 1905-7, 1910 a,b,c, 1911, 1912) have described a large number of genera and species of the oriental braconidae and also provided key to separate genera and subfamilies of bracondiae. Subsequently workers like Bingham (1901), Ayyar (1920, 1921, 1926-28) Wilkinson (1927, 1928 a,b, 1929, 1930, 1932 a, b, 1935), Watanabe (1934-1937) Beesan and Chatterjee (1935), Chatterjee (1941), Lal (1939, 1942), Narayanan (1936) Mathur (1942) and Bhatnagar (1948) revised many subfamilies and genera of oritental braconidae. Later Rao and Kurian (1950), Gupta (1957) Narayanan and Subba Rao (1960), Rao (1953, 1961), Rao and Chalikwar (1970 a,b,c, 1971), contributed to braconidae in the form of fragmented research papers. In 1961 Rao provided a key for the oriental species of genus Apanteles (Braconidae) and Nixon (1967) to the Ultor group of Apanteles with some new descriptions of species. While Papp (1986, 1987) contributed to glomeratus group of Apanteles. Recently Chalikwar, et al (1984) Sathe and Inamdar (1988, 1989 a,b, 1991). Sathe et al (1989, 1990) have made significant contributions on Indian braconids. Irrespective of efforts made by various workers, taxonomy of braconids received very less attention even today, and the present work will add relevance.

The members of the family bracondiae are recognized by groove between first and second tergite of abdomen. Hind wing has a long submedial cell, several times wider than the medial cell; 2nd recurrent vein is absent, Propodeum sculptured as a rule usually with more or less clear space.

The subfamily Microgastrinae has it's special importance since the members frequently determine the population densities of large number of insect pests of micro and macrolepidoptera, Coleoptera and Hemiptera, etc. The microgastrines are readily recognized by 16 jointed flagellum and the spiracle of laterotergite I. Considering the usefulness, Mason (1981) gave Plesiomorphic characters for the microgastrinae,

(1) Vannal lobe of hindwing large & delimited by a notch.

(2) Intercubitellan (2r-m) present.

(3) Interradiellan (r) present.

(4) Larval palpi developed as 1 jointed sclerotized appendage .

Microgastrinae was considered to include the three genera, of which Foerster (1862) split Microgaster Latreille i.e. Microgaster, Microplitis and Apanteles with the addition of Adelius Haliday (1833), Mirax Haliday 1833 and Dirrhope Foerster 1851. The genus Fornica Brulle was also added to Microgastrinae. Nixon (1965) made a correct analysis in excluding Adelius, Paradelius, Dirrhope and Oligoncurus. He suggested three tribes,

(1) Cardiochiles and it's close relatives;

(2) Mirax and

(3) The traditional genera Microgaster, Microplitis and Apanteles.

Recently, Mason (1981) concluded that there are no strong enough synapomorphic characters to group Mirax, Cardiochiles and Microgastrini under one subfamily. Hence, he made three subfamilies i.e. Cardiochilinae, Miracinae and Microgastrinae.

Mason (1981) further split Microgastrinae into 4 tribes viz. Apantelini, Cotesini, Microgastrini and Microplitini. The tribe Apantelini represents the following characters -

(1) Ovipositor sheath almost always (97%) longer than half the hind tibia and always hairy throughout, sheaths are short, they are uniformly hairy and arise from the valvifers.

(2) Tergite I usually longer than broad and often with a median broad groove on the apical half, tergite II usually wider than long and shorter than tergite III.

(3) Propodeum often with a partial to complete areola; the bounding carinae often reduced so that, the areolet has the appearance of a 'U' or 'V' and sometimes the propodeum is entirely carinate.

In the tribe Apantelini Mason visualized 15 genera namely *Apanteles*, *Dolichogenidea*, *Micropotes*, *Semionis*, *Dasylagan*, *Sendaphne*, *Promicrogaster* and the new genera *Pelicops*, *Teremys*, *Erulonyx*, *Ilidops*, *Pholetesor*, *Alphonomelon* and *Papanteles*.

The tribe Cotesini is represented by the characters -

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

(2) Tergites extremely variable, 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.

(4) Metanotum often lacking setae on the sublateral lobes, 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.

Mason (1981) included 17 genera under this tribe, namely, Cotesia, Parapanteles, Glyptapanteles, Protapanteles, Larissimus, Protomicroplitis, Parenion, Buluka and Dolichogaster and the new genera, Distastris, Deuterixus, Exix, Nyereria, Rasivalva, Venanides, Venanus and Wilkinsonellus.

Since the above two tribes are very much economically important, hence in the present study attention was concentrated on the same. Inamdar (1990), Dawale (1991), Ingawale (1991), Sathe and Inamdar (1988, 1989 a,b), Sathe et al (1989, 1990), Sathe (1992), Sathe and Ingawale (1995), etc. have exposed some new fauna of these two tribes in the form of their thesis and publications, from Western Maharashtra. Since there is lot of scope to work on taxonomy and the braconids are widely utilized in biological control, the present work was undertaken and completed. In the present text four new species of the genus Cotesia of tribe Cotesini and six new species of the genus Dolichogenidea of tribe Apantelini of subfamily microgastrinae have been described for the first time. A distributional record of the above species have also made. The present data will be helpful for making the parasitoid-host index, ecological studies and biological control of insect pests.