INTRODUCTION

All the flies are not enemies of the human race and some of them are natural and true friends of man in his struggle against other harmful insects. One of such true friends are syrphids. Of such dipterans flies, the syrphids are very important in natural control and thus exhibit great economic importance. A number of species of Syrphidae, for instance, live on aphids (common plant lice) and are often responsible for keeping their numbers drastically down. Aphid-eating syrphid larvae are brightly coloured, green or yellow and they move over infested twigs like leeches. They do not usually have far to go to find the aphids, since the mother syrphid will have taken care to lay her eggs close to an aphid colony. The nursery is thus next door to the larder. The great majority are predaceous upon aphids though a small number attack Chelmidae, dactylopine Coccidae, Cercopidae and Lepidopterous larvae (Ghorpade, 1981). Campbell and Davidson (1924) have
presented studies upon the food habits of a number of aphid-feeding species occurring in California. There experiments have revealed that up to 400 aphids are consumed by a single larva during its development. Thus due to their own reproductive powers and voracious appetite they may almost completely exterminate an infestation of countless millions of aphids which are serious pests of many of the major crops. It has also been observed that the aphid population on cereals and bursssel sprout increase when their syrphid predators are excluded from the habitat (Pollard, 1969; Chambers et al., 1983).

The species of this large, well known family, Syrphidae, exhibit a considerable range in habits. Some being aquatic and feeding upon decaying animals and vegetable matter and others occurring in decaying wood. Some acting as scavengers like, genus Volucella which lives in the nests of social bees and wasps therein feed upon diseased larvae and pupae in the nests; larvae of Microdon are found in the nests of ants presumably in a commensal capacity. The larvae of relatively small proportion of the flower-flies live in or on plants, sometimes doing damage to the root stocks of Narcissus,
Hyacinth and Iris.

These extremely interesting flies also show the mimetic capacity with other bee and wasp models and are abundantly found feeding on pollen and nectar along with the bees and are second to bees in importance as flower pollinators of some major crops. Just as the females of many blood sucking species require blood for ripening their eggs, many nectar-drinking flower flies like syrphids have to eat pollen for the same reason and possess a mouth that is especially constructed for pulverizing it (Linsenmaier, 1972).

From an aesthetic point of view this entirely beneficial family is perhaps the most attractive of all from the beauty and diversity of form and colour represented among its members. Something like three thousand species were known from all over the world whereas only sixty seven from India (Lefroy, 1909). Brunetti (1923) divided this family into seven subfamilies, Syrphinae, Vollucellinae, Eristalinae, Milesinae, Chrysotoxinae, Microdontinae and Cerinae. Many of the subfamilies have been studied intensively, some of them are being explored while several of them still remain in a state of neglect. Most of the taxonomic studies, as in other groups, have been carried out on the basis of
only external male genitalia. Verall (1901) observed that the parts of genitalia are unsymmetrically twisted to right and attempted to draw the various parts in several cases but without much clarity. Berlese (1909) gave nice illustration of the genitalia of *Eristalis tenax*. Bazin (1914) in his studies of syrphidae of Congo, described the exposed parts of the genitalia. Since Metcalf's (1921) work on the morphology and taxonomic value of the male genitalia of Syrphidae, the study of their structures has gradually become an almost standard method for estimating the taxonomic status for the identification of the specimens. Fluke (1951) made a detailed study of the male terminalia of the Nearctic, Neotropical and Western Palearctic species of *Syrphus*, *Epistrope* and related genera. He also figured the male terminalia of 126 species and arranged these into generic, subgeneric and species groups 'based largely on the genitalia'. Glumac (1958) studied the structure of male genitalia of Syrphidae and discussed its significance in phylogenetic classification. Lundbeck (1961) made variable observations on the conditions of the segments of the post-abdomen. Nayar (1965) gave a detailed account of the genitalia of
Syrphus balteatus.

Very few reports have come across who have included female genitalia. The female genitalia of Syrphidae are still largely unknown. The general opinion has been that these structures are simple and greatly similar in different species and that they would not have any great taxonomic importance, at least on lower taxonomic levels. Some rough characters of the post-abdomen and spermathecae have sometimes been described for different groups (Borisova, 1981, 1982, 1985) and few notes concerning Syrphidae are included in papers concerning other groups of Diptera (Herting, 1958; Henning, 1973).

Nayar (1965) gave some account of the external genitalia of female Episyphus balteatus but was unable to demonstrate the important structures within segments. Thompson and Torp (1982) applied the characters of segment eight in the female for distinguishing two species of Orthonevra. It seems that only Shatalkin (1982) and Hippa (1986) have realized the wide taxonomic importance of the copulatory structures within the segments of female genitalia.

Some of the intricate taxonomic problems need the help of supplimentary studies relating to the internal
systems, the physiological characteristics and the broad chemical components of the concerned species. As far as the family Syrphidae is concerned the only notable contribution pertaining to the internal organs is by Nayar (1965, 1966) who has made observations on the digestive, nervous and reproductive systems of Syrphus balteatus belonging to subfamily Syrphinae. A persual of the conclusions of his work brings out striking differences in the male and female reproductive organs as compared to rather less variable nervous and digestive system and project these organs as highly promising structures which could be helpful for establishing the prevalent taxonomic criteria based on external morphology and for their use in solving such problems as defy solution on the basis of features from external morphology. Undoubtedly, the work of Nayar (1965) on the male and female reproductive systems of representative of Syrphinae provides important basic information and the type of variations which are useful as a good starting point for taking up additional studies on more representatives of other subfamilies.

The other studies pertaining to syrphids have been
on their diurnal activities, mating strategies and other behavioural aspects (Gruhl, 1924; Parmenter, 1944; Schneider, 1948; Blickle, 1959; Kikuchi, 1963, 1965, 1965a; Nayar, 1965; Nielsen, 1966; Campan, 1973; Waldbauer and Sheldon, 1975; Maier, 1977, 1978; Svensson and Janzon, 1984). Periodic activity a characteristic of most natural populations is a behavioural adaptation that can reinforce or maintain reproductive isolation and can reduce competition, hygrothermal stress or predation pressure. Activity rhythms of economically, genetically and medically important Diptera have been extensively studied in nature (Nielsen and Greve, 1950; Mitchell and Epling, 1951; Dyson Hudson, 1956; Haddow, 1961; Bidlingmayer, 1974).

Kikuchi (1962, 1965, 1965a), Nielsen (1966) and Schneider (1958) discussed the effect of various meteorological factors on syrphid activity but collectively they concluded little except that some species avoid direct sunlight near the middle of hot days. They did not investigate biotic variables, for example, pollen and nectar availability, which strongly influence syrphid activity.
patterns. As syrphids utilize these resources (flowers) as sites for the sexual rendezvous and pollen, it is a requisite for normal ovarian development (Maier, 1978; Schneider, 1948). Keeping these objectives in mind some behavioural studies have also been taken up during the tenure of present work.

The subfamily Eristalinae which is of worldwide distribution having representatives in every quarter of globe had been selected for the present studies. In several of the genera, the species are very closely allied and moreover often subject to considerable variation, which makes a keen study of allied species a sine qua non for their certain identification.

Amongst the subfamily Eristalinae the sexes are separate with distinct sexual dimorphism. The females have characteristic telescopic ovipositor and dichoptic eyes, the males have holoptic eyes and complex male genitalia. The organs specialized for copulation and oviposition vary greatly even between species and because they are readily visible, have been adopted by taxonomists as prime features for distinguishing between related species.
The 'lack of fit' of copulatory organs may be a major barrier to hybridization and thus may effectively separate species that are still genetically compatible. Except Keuchenius (1913) who have worked on *Eristalis* sp. and Nayar (1965) who worked on *Syrphus* sp., there is absolutely no work on internal reproductive organs on syrphids whereas there is extensive work on the reproductive organs of other dipterans (Parks and Larsen, 1965; Ulrich, 1966; Boulard, 1968; Cummings and King, 1969; Ronquillo and Horsfall, 1969; King, 1970; Wulker and Winter, 1970; Lauge and Bordan, 1971; King and Akai, 1971; Tokuyasu et al., 1971; Wetzel, 1971; Chia and Morrison, 1972; Mahowald, 1972; Rockstein, 1973; Anderson and Telfer, 1975; Huebner et al., 1975; Bast and Telfer, 1976; Abu-Hakima and Davey, 1977; Kessel and Ganion, 1979; Huebner and Injeyan, 1980, 1981; Koepee et al., 1980; Berry, 1982; Junquera, 1983; Yamauchi and Yoshitake, 1984; Verma and Ishikawa, 1984).

As syrphids visit the crops for pollen, nectar or mating, there are great chances of their being exposed to various pesticides used in the fields. Because many factors
both physiological and biochemical, influence the amount of insecticide required to kill a particular insect, it is virtually impossible to predict the degree of toxicity which a particular compound might exhibit toward one species on the basis of its action toward another (Winteringham, 1969; Riviere, 1970; Asakawa, 1971). Moreover, there is extreme commonality among all living systems and to adversely affect the pest species exclusive of all others is currently a seemingly impossible task. Many biochemical mechanisms vital for the survival of an insect pest, for example, are equally essential for the survival of non-pest or non-target species which may be economically important like syrphids, which themselves help in pest eradication.

Visualizing the importance of syrphids it was provocative to analyze the toxic potentialities of the new class of insecticides, the carbamates which are nerve poisons and as such are potentially damaging to all animals whose nervous system depend upon a proper balance of acetylcholinesterase for normal nerve impulse. The toxicity of carbaryl to honeybees is perhaps the best known example of carbamate adversely affecting a non-
target species (Anderson and Atkins, 1958; Johensen, 1961; Shaw and Fisehang, 1962; Ibrahim et al., 1967; Stevenson, 1969), considering that in some major crops honeybees are responsible for more than 75% of pollination (Wafa and Ibrahim, 1957) and perhaps syrphids are second to them. It is clear that any compound highly toxic to these insects would definitely be undesirable. Henceforth, to assess various toxic aspects of carbamate insecticides, carbaryl and carbofuran were selected which are known potent contact toxicants (Kuhr and Dorrough, 1976).

An attempt has also been made in the present investigations to demonstrate the various morphological and seasonal variations in context to macromolecular synthesis and peak availability of the flies in relation to temperature and humidity.