

Role of *Syrphus serarius* Wied. as a pollinator in Darjeeling Hills, West Bengal : palynological assessment

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Pollen analysis from the gut content of *Syrphus serarius* (hoverfly) shows that the members of 16 plant families are regularly foraged and pollinated among which 7 members are economically important. The most preferred 5 families in order of magnitude (in terms of pollen mean recovered from gut) are Caryophyllaceae, Sambucaceae, Asteraceae, Crassulaceae and Brassicaceae.

Key-words - Darjeeling Hill, Palynology, Pollinator, *Syrphus serarius* Wied., West Bengal.

INTRODUCTION

IN angiospermous plants the normal functional reproductive unit is flower which provides a vital link between plant breeding systems and the pollinating agents, viz., insects, forming an integral part of the evolving biological systems. The pollinator and the floral organization develop a closely knit entity. Among insects, bees, butterflies and moths are major pollinators. Other insects like flower flies and thrips also play important role in pollination. The syrphids or hover flies are common visitors to flowers, frequently hovering above the blossom. Some resemble honey bees (e.g. *Syrphus* spp.); others look like bumble bees or like wasps. The syrphids may be the most important fly pollinator because they tend to continue their work under poor conditions when most bees are inactive. Also like bees, they feed on pollen as well as nectars. Consequently these flies may be important pollinators in areas where plants frequently bloom during inclement weather (Richards 1978). Four species of *Syrphus*, viz., (*Syrphus serarius* Wied., *S. albostriantus* Fla., *S. quinquevittatus* Brum. and *S. cinctellus* Zett. are known so far from Darjeeling Hills.

MATERIAL AND METHOD

The plants blooming in Lebong, Ghoom, Jalapahar, Pabong and Lath Pancher areas of Darjeeling district during March to May were thoroughly surveyed. The fly flower bearing plants were isolated and the herbarium sheets of flowering twigs were prepared. The reference slides of pollen grains from fly flowers were prepared following usual acetolysis technique (Erdtman 1960).

During the study period, only the hover flies (*Syrphus serarius*) among the other flower foraging insects were sampled with the help of insect net and preserved in the vials containing 70% alcohol immediately after their capture and names of the respective foraging plants were labelled on the vials. The colours, shapes, form of corolla, scents of foraged flowers, span of foraging, resting patterns of flies on flowers and foraging time of the day were also noted.

Among the preserved hover flies, only *Syrphus serarius* adults were carefully dissected to isolate the gut. The guts of four flies foraging on different plants of the same species were opened and microslides were prepared following acetolysis technique for the study of pollen grains found in the

gut content. The prepared microslides were studied and number of pollen grains were counted under the high resolution compound microscope (Olympus BX 50). The pollen types recovered from gut content were identified with the help of prepared reference pollen slides.

OBSERVATION

Out of 1052 angiospermic species, 353 species were obtained in full bloom. *Syrphus serarius* was found foraging on 26 species (Table 1), seven belonged to Asteraceae, three to Brassicaceae, two each to Caryophyllaceae and Rosaceae and one each to the rest of the twelve families (Table 2). Out of 26 species, sixteen were cultivated plants.

A wide range of foraging time span during the day time was noticed. It ranged from 8.30 a.m. to 5.15 p.m. and the most suitable time for foraging was from 8.30 a.m. to 11.30 a.m.

The colour of the fly flowers were varied viz., yellow, white, violet, pink, blue and red among which white, yellow and pink flowers were frequent (Table 1). Flowers of diverse shapes were foraged by the flies among which 4-5 pointed star shaped cruciform and caryophyllaceous corolla were preferred in most of the cases (Text figs. 1-8).

A variable time span of foraging was noticed for different plant species. Thirteen species were noticed where the foraging span ranged from 5-30 seconds and the rest for 30-50 seconds at a time. The average higher foraging span was noticed in the members of Asteraceae, Brassicaceae, Onagraceae, Crassulaceae, Rosaceae, Papaveraceae, Caryophyllaceae and Sambucaceae (Table 1).

The gut content analysis of *Syrphus serarius* shows 26 pollen types referable to 16 families (Table 1, 2). The pollen grains of the flowers (from which the flies were captured) were represented in the gut content in higher frequency along with the pollen grains of other flowers which were not seen foraging by the flies at the time of collection (Table 1). The present study shows that among the sixteen families only five show higher mean pollen load above 100 (Table 2).

DISCUSSION AND CONCLUSION

The pollen analytical data from the gut content of *Syrphus serarius* reveal the highest representation of the members of Caryophyllaceae (*Silene pendula* and *Gypsophila repensi rosa*) followed by *Sambucus canadensis* (Sambucaceae); *Calendula officinalis*, *Cineraria grandiflora*, *Erigeron karwinskianus*, *Centaurea cyanus*, *Eupatorium adenophorum*, *Chrysanthemum leucanthemum* and *Bellis perennis* (Asteraceae); *Sedum multicauli* (Crassulaceae) and *Brassica nigra*, *Cardamine hirsutum* and *Iberis gibraltarica* of Brassicaceae (Table 2).

The features of the caryophyllaceous members possibly served as attractants to *Syrphus serarius* (Kugler 1955) are : i) flower shape approximates to that of a disc with 5-pointed margin, ii) bright coloured (light - deep pink), iii) nectariferous, nectars are present at the base of outer stamens or concealed at the base of calyx tube or on filaments as in *Silene* (Fahn 1987). *Sambucus canadensis* (Sambucaceae) is a plant having no nectars in flowers. The possible attractants may be sweet scent, greenish white petal colour and very high pollen productivity. Although the flowers of *Sambucus* are small, they are massed together in an umbellate inflorescence. It is interesting to note that with decreasing size of the individual flower there is often a parallel tendency for the flowers to become grouped into compact but conspicuous inflorescences which may themselves at times mimic single flower to attract the fly visitors (Jaeger 1961).

In the members of Asteraceae, the disc florets are pretandous and hence when the stigmas emerge through the staminal column they carry pollen grains along their lower surface; the nectar encircles the base of the style (Fahn 1952, 1953, 1987) which possesses minute stomata, the secretion of nectar coincides with the pollen maturation, maximal secretion occurring when the stigmas are receptive, providing an opportunity for fertilization by the flies with mature pollen on their bodies. These relationships seem to

Table 1. Showing field data viz. colour, scent, foraging span, etc.

Plants on which hover fly (<i>S. serarius</i>) foraged	Nectariferous (N) or polliniferous (P)	Colour of flower	Form of corolla	Shape of flower	Scent	Date of collection	Family	Foraging time	Foraging span
<i>Calendula officinalis</i> *	N	Yellow chrome	Tubular	5-pointed star	Mild sweet	31.3.98	Asteraceae	1.30 P.M.	36.66 sec.
<i>Cineraria grandiflora</i> *	N	Violet	do	do	do	30.4.98	do	9.30 A.M.	44.00 sec.
<i>Erigeron karwinskianus</i>	N	Disc floret-yellow Ray floret-white	do	do	do	14.3.98	do	11.00 A.M.	15.83 sec.
<i>Centaurea cyanus</i>	N	Ray floret-violet Disc floret-white	do	do	Mild sweet	17.4.98	do	1.30 P.M.	26.66 sec.
<i>Eupatorium wadenophorum</i>	N	White	do	do	No scent	27.3.98	do	10.30 A.M.	11.00 sec.
<i>Chrysanthemum leucanthemum</i> *	N	Ray floret-shite Disc floret-yellow	do	do	do	19.5.98	do	1.00 A.M.	22.00 sec.
<i>Bellis perennis</i>	N	do	do	do	do	31.3.98	do	1.30 P.M.	33.00 sec.
<i>Brassica nigra</i>	N	Yellow	Cruciform	4-clawed	Oily	22.3.98	Brassicaceae	10.30 A.M.	34.00 sec.
<i>Cardamine hirsutum</i>	N	White	do	do	No scent	27.3.98	do	11.00 A.M.	16.00 sec.
<i>Iberis gibraltaria</i>	N	White	do	do	do	30.4.98	do	1.30 P.M.	11.00 sec.
<i>Clarkia pulchella</i> *	N	Deep pink	4-clawed	4-clawed	do	16.5.98	Onagraceae	8.30 A.M.	35.00 sec.
<i>Polygonum chinensis</i>	N	White	5 partite	5 partite	do	3.5.98	Polygonaceae	12.45 P.M.	18.00 sec.
<i>Sedum multicauli</i>	N	Yellow	Stellate	5-pointed star	do	13.5.98	Crassulaceae	2.00 P.M.	48.00 sec.
<i>Spiraea nipponica</i>	N	White	Rosaceous	do	Mild sweet	31.3.98	Rosaceae	11.30 A.M.	13.00 sec.
<i>Rosa rugosa</i> *	N	Light pink	Rosaceous	do	do	9.5.98	do	9.30 A.M.	36.83 sec.
<i>Torenia peduncularis</i>	N	Whitish violet	Campanulate	Bell shaped	No scent	16.4.98	Scrophulariaceae	10.30 A.M.	11.66 sec.
<i>Papaver rhoeas</i> *	P	Deep red	4 Partite	Round	do	31.5.98	Papaveraceae	9.30 A.M.	46.66 sec.
<i>Silene peridula</i> *	N	Light pink	Caryophyllaceous	5-clawed	do	30.4.98	Caryophyllaceae	11.00 A.M.	50.00 sec.
<i>Gypsophila repens-rosa</i> *	N	Deep pink	do	do	do	16.5.98	do	8.30 A.M.	48.33 sec.
<i>Primula melacoides</i>	N	Light pink	5 Partite	do	do	27.3.98	Primulaceae	11.30 A.M.	22.00 sec.
<i>Nemophila melacoides</i>	N	Sky blue	Rosaceous	Round	do	1.4.98	Hydrophyllaceae	1.30 P.M.	11.00 sec.
<i>Hydrangea macrophylla</i>	P	Whitish blue	5 Partite	do	do	22.5.98	Saxifragaceae	9.30 A.M.	6.33 sec.
<i>Colchicum autumnale</i>	N	Pink	Bell-shaped	Bell-shaped	Mild sweet	30.5.98	Liliaceae	5.15 P.M.	6.33 sec.
<i>Sambucus canadensis</i>	P	Greenish white	Ovate	5-pointed star	do	21.5.98	Sambucaceae	8.30 P.M.	38.00 sec.
<i>Oxalis corniculata</i> **		Yellow	5 Partite	do	do	22.5.98	Oxalidaceae	Not detected	Not detected
<i>Magnolia campbellii</i> **		Pink	Magnoliaceous	Round	do	22.5.98	Magnoliaceae	Not detected	Not detected

**Not found to be foraged by flies in the field but represented in the gut content of flies.

*Cultivated Taxa:

have a co-ordinating mechanisms (possibly hormonal in nature) between the events culminating in pollen maturation and those leading to nectar secretion (Shuel 1961). In the present survey, most of the asteraceous members had 5-pointed star shape, white ray florets and yellow disc florets except in *Centaurea cyanus* (violet ray and disc florets). The different coloured disc and ray florets show an extraordinary resemblance to a single flower which attracts the visitors (Jaeger 1961). Among the seven asteraceous members, five viz., *Calendula officinalis*, *Cineraria grandiflora*, *Centaurea cyanus*, *Chrysanthemum leucanthemum* and *Bellis perennis* possess larger florets. It is striking that larger the florets, greater will be the number of stomata on the nectary, resulting in the attraction of more visitors (Ananthkrishnan 1992). It is estimated that the pollen production in a single disc floret ranges from 5536 to 5716 and in a capitulum from 2,10,350 to 2,17,208. A considerably high amount of nectar is secreted through the minute stomatal opening present at the apex of the nectary near the stylar base (Gopinathan and Varatharayan 1983).

Table 2. Showing pollen load range and pollen load mean \pm S.D.

Families	Pollen load range	Pollen load mean \pm S.D.
Asteraceae	128.16-216.80	179.11 \pm 49.899
Scrophulariaceae	6.50-15.83	10.12 \pm 4.3414
Papaveraceae	79.200123.83	98.17 \pm 20.1221
Caryophyllaceae	153.25-285.52	200.67 \pm 58.8000
Primulaceae	14.52-29.00	22.34 \pm 6.0320
Hydrophyllaceae	9.75-16.66	2.89 \pm 3.4656
Saxifragaceae	21.33-36.33	28.49 \pm 6.1425
Liliaceae	2.93-6.50	4.66 \pm 1.7173
Sambucaceae	178.66-216.50	197.74 \pm 16.3554
Polygonaceae	55.78-101.66	80.69 \pm 19.5899
Crassulaceae	145.16-176.16	160.87 \pm 12.7110
Rosaceae	14.41-32.50	24.44 \pm 8.1173
Oxalidaceae	1.53-3.50	2.19 \pm 90.19
Brassicaceae	98.75-128.16	118.05 \pm 13.7502
Onagraceae	19.16-34.00	26.62 \pm 6.4871
Magnoliaceae	1.85-3.18	2.45 \pm 0.6576

The flowers of *Sedum multicauli* (Crassula-ceae) are smaller but the flies consider them rewarding possibly due to its bright yellow petal colour, 5-pointed star shape and nectar in the nectary where each carpel is provided with a nectar secreting scale.

The members of Brassicaceae possibly attracted the flies due to their characteristic shape (4-clawed), white to yellow flower, characteristic fragrance due to the oil gland and nectaries between the stamen bases (Fahn 1952, 1953, 1987).

Although the mean pollen load of the members of Rosaceae recovered from the gut of *Syrphus serarius* was not higher, their floral adaptations, deserve special mention as the adult female fly oviposit at the base of the petals of *Rosa rugosa* (Rosaceae). Light pink colour, sweet scent and nectar; a cushion shaped or ring like nectar secreting disc present between the stamens and carpel (Fahn 1953, 1987) possibly-attracted the visitors.

Hover flies also can perceive certain colours like honey bees. In open flat in florescences, white, yellow and greenish flowers are normally preferred by flies and the newly emerged flies are not attracted by any colour (Kugler 1956; Sareen *et al.* 1989; Finch 1991). Many flowers can reflect ultra-violet rays whose wave length is 400 A°. This capacity has been noted in yellow flowers such as *Brassica* spp., in the red flowers of poppy (*Papaver* spp.) and in the blue flower of *Nemophila menziesii* (Jaeger, 1961). Although these UV rays cannot be visioned by the human eye, they are nevertheless clearly perceived by the flies (Jaeger 1961). Kugler (1956) showed that the flies prefer and react positively to a shape with several points. In the present survey 4-5 angled/pointed star shaped flowers with white, greenish white, yellow, pink and violet colours were proved to be the most rewarding for *Syrphus serarius*.

The foraging time span of *S. serarius* varies from species to species. The flies spent more time in the members of Papaveraceae, Caryophyllaceae, Sambucaceae, Asteraceae and Crassulaceae, as the flowers were found rewarding either for nectar (Caryophyllaceae, Asteraceae and Crassulaceae) or

pollen (Sambucaceae, Papaveraceae) or both. The number of foraged asteraceous members is higher in comparison to the members of other families (Table 1). This may be due to preferential propagation of the members of Asteraceae.

From the above account it is clear that *Syrphus serarius* may be designated as an efficient pollinator who fulfilled the following criteria: a. although diverse in foraging preference it shows consistency to some rewarding plant families (Table 2), the flies foraged in such a manner that they could come in contact with the essential floral organs, c. wide range of working hours (8.30 a.m. to 5.15 p.m.), especially during inclement weather conditions of Darjeeling Hills.

A considerably large population of *Syrphus serarius* during the present study period along with the aforesaid features suggests them to be an efficient pollinator. Further the larvae of *Syrphus serarius* have been found to predate over the aphid colonies growing on *Rosa rugosa* and *Brassica nigra*. Thus, if cultivation of the aforesaid plants is practised then the aphid infestation on two economically important plants viz., *Rosa rugosa* and *Brassica nigra* could be minimized biologically.

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