Pollination Biology of *Sopubia delphinifolia* G. Don

Kavitha GR, Thriveni MC*, Vijay CR, Shivamurthy GR
Department of Studies in Botany, Manasagangotri, Mysore-570 006
thrivenimc@gmail.com

Abstract: The floral biology and pollination mechanism of *Sopubia delphinifolia* G. Don a cross-pollinated entamophillous species is described. Pollination is aided by the zygomorphic symmetry, floral arrangement on the inflorescence, position of anthers and anther lobes, their dehiscence, production of large quantities of pollen grains and nectar. Presence of one sterile and one fertile anther lobe in each anther lead to the operation of lever mechanism. Pollen is shed through a ventral pore in the anther, which extends backwards simulating longitudinal dehiscence. Mellitivorous and pollenivorous insects carry out pollination. The operation of lever mechanism assisted by poricidal dehiscence in a taxon of Scrophulariaceae is being reported here for the first time. [Report and Opinion 2010;2(6):62-66]. (ISSN:1553-9873).

Key words: Floral biology; mellitivorous insects; pollenivorous insects; lever mechanism; nototribic

1. Introduction

Pollination is one of the prerequisites for fertilization and seed set in angiosperms (Faegeri and Pijl, 1979). The pollination ecology of a large number of taxa of the Scrophulariaceae has not been investigated. Pollination mechanism in different species of *Pedicularis* from different regions of North America has been described by Macior (1968a, 1968 b, 1969, 1970, 1971, 1973, 1974). Koeman – Kwak (1973) reported pollination by short tongued bumblebees in *Pedicularis palustris.* Meidell in *Melampyrum* (1944) and Kwak in *Rhinanthus* (1979) observed pollination by honeybees and bumblebees. The present study was undertaken, as there was no information available on the pollination mechanism in *Sopubia delphinifolia* G. Don a potent parasitic weed on grasses and cereal crops.

2. Materials and methods

Field studies were conducted during the blooming period from November to January in Manasagangothri campus and Chamundi Hills of Mysore for three years. Phenological data of the species was collected. Observations were made from 8 A.M. to 5 P.M. with an air temperature ranging from 18-28 degrees centigrade for a number of days at each site of collection during suitable weather for the flight of insects. Insects alighting but not foraging on the flowers were not collected. Careful observations were made on the foraging behaviour of the insects which were trapped by hand sweep method with suitable nets and were identified by the Common Wealth Institute of Entomology, London. Pollen carried by foragers was removed from various body parts and identified by comparing with the pollen collected directly from the taxon. Unopened flower buds of 50 plants were bagged in polythene covers, allowing them to complete blooming and then determining the number of fruits produced. These were compared with the insect pollinated plants. The seeds of bagged plants were tested for the germinability by using petri plate culture method. Flowers were dissected out to study the presence / absence of adaptations if any for self-pollination.

3. Observations

Sopubia delphinifolia is a root hemiparasite of the tribe Rhinanthoideae of Scrophulariaceae. It is commonly found growing on grasses with a potential to parasitize cereal crops (Shivanna & Rangaswamy, 1976; Kulasekaran, 1987). The plant is profusely branched and the flowers are sub-sessile and obliquely attached to the racemose inflorescence axis (Fig. 1A). They are purplish, zygomorphic, sympetalous and hypogynous. The corolla is bell shaped, the two posterior lobes form the upper lip and the three anterior lobes constitute the lower lip forming the landing platform for the visiting insects. The corolla is wide enough for the pollinators to creep in. The four epipetalous stamens are didynamous. The anthers of the two pairs abut each other (Fig. 1B). Each anther is dithecous and one of the lobes is sterile while the other is fertile. The sterile anther lobe is acuminate and acts as a lever (Fig. 1C). The stamens are arranged in two pairs facing inwards and adhere together. The pollen is shed through a small ventral pore which extends backwards simulating longitudinal dehiscence of the anther lobes, (Fig. 1D). The slightly flattened stigma protrudes out of the corolla tube and the style is hairy.

Nectar foraging workers of *Bombillidae systoechus* and pollen foraging workers of *Apis cerana, Pithitis binghami* and *Pseudapis oxybeloides* regularly visited the flowers

Before the nectar foraging insect creeps in to the corolla tube, it examines a number of flowers from outside, flying from one to another and hovering like a syrphid in front of the flower mouth without touching it (Fig. 2A). Sometimes it sucks the nectar while in flight. Later, using the lip as a platform, it creeps into the flower touching the stigma first and then the anthers. It thrusts its head into the mouth of the corolla in search of nectar (Fig 2B). While doing so it pushes the acuminate sterile anther lobes in its path. This activates a lever mechanism causing the fertile thecae to swing down and hit the back of the visitor. The pollen is liberated through the downwardly directed ventral pore of the fertile anther lobe and is sprinkled on to the abdomen and head of the visitor.

The stigma is independent of this mechanism. In old flowers the mature stigma project in front of flowers so that pollen-carrying insects brush against the stigma while entering the flower.

The insect repeats its attempts to obtain nectar from a number of flowers, during which process pollen carried on its back gets brushed away by the stigma of flower visited thus effecting cross pollination.

Pollen foragers, as they alight on the lower lip, brush first the stigma and then anthers. As the insect creeps and pushes its head into the flower, the sterile acuminate anther lobes are pushed upwards and backwards activating a lever mechanism causing the fertile anther lobe to swing downwards bringing pollen in contact with the abdomen of the insect. Insects visiting for pollen work the flowers upside down, (Fig. 2C) collecting pollen directly from anthers. They also happen to scrape the pollen directly from anthers with their legs. They take up a hanging position under the anthers and by vibrating wings they render pollen grains to fall out of the anthers on to the insect. Pollen falling from the anthers is deposited on the head (Fig. 2E) and ventral surface of the thorax as well as the abdomen. (Fig. 2D).

Most of the pollen is groomed / combed from the body and transferred to corbiculae formed on hind legs of the insects (Fig. 2F) but much of it on the front face of the abdomen remains as such and pollinates other flowers.

Flower buds of each of the two populations were covered with finely perforated polythene bags to exclude pollinators. Self-pollination failed to occur in these flowers and no fruits developed thus demonstrating that cross-pollination is the only method of pollination in *Sopubia delphinifolia.*

4. Discussion

Floral structure of *Sopubia delphinifolia* imply its adaptation to cross pollination by insect vector .The insect visitors of the following study are mellitivorus and pollenivorous. The insects visit flowers frequently in the early morning and their visits decreased with increase in intensity of light and temperature. At times the insects resumed their visit to the flowers in the evening, but less frequently. Hence these are early morning pollinated plants as classified by Percival (1965). Insects visit flowers during tolerable intensity of light and a temperature between 16°C to 32.5°C.

The lower lip of the zygomorphic corolla forms the flat landing platform for the insect visitors. The bell shaped corolla mouth is sufficiently wide for pollinators to creep in. Anther and stigma lying under the upper lip are protected against rain and they touch the back of the insect that forces its head down into the tube. Zygomorphism of the corolla is coupled with the lack of a fifth median stamen, which would have been in the path of visitors and also obstruct the position of the style. *Sopubia delphinifolia* never discharges its pollen from its ventral pore of the anthers until the insect comes in contact with the acuminate, sterile anther lobe, which activates a lever mechanism causing the fertile thecae to swing down and hit the back of the visitor depositing / sprinkling pollen grains. The operation of lever mechanism is being reported for the first time in this taxon of Scrophulariaceae. Bumblebees also vibrated their wings as they foraged. Cross pollinated plants nototribic mechanism. Pollen deposited on any other region of the visiting vector is groomed / combed by its legs and transferred to the corbiculae present on the hind legs. An insect vector entering the flower brushes first against the stigma and later establishes contact with the anthers. As the insect searches for nectar and sucks it, its back comes in contact with the stamens and sigma, which lie against the upper side of the corolla tube. Floral arrangement on the inflorescence affords easy forage of each flower and the forager visits only a few flowers of the inflorescence before flying to another. This is similar to what has been reported by Macior (1969) in *Pedicularis.* The visitor moves from older flowers at the base to younger flowers at the tip of the inflorescence.

Cross-pollination is the only method of pollination in *Sopubia delphinifolia.* In the event of failure of cross-pollination no viable seeds are formed.

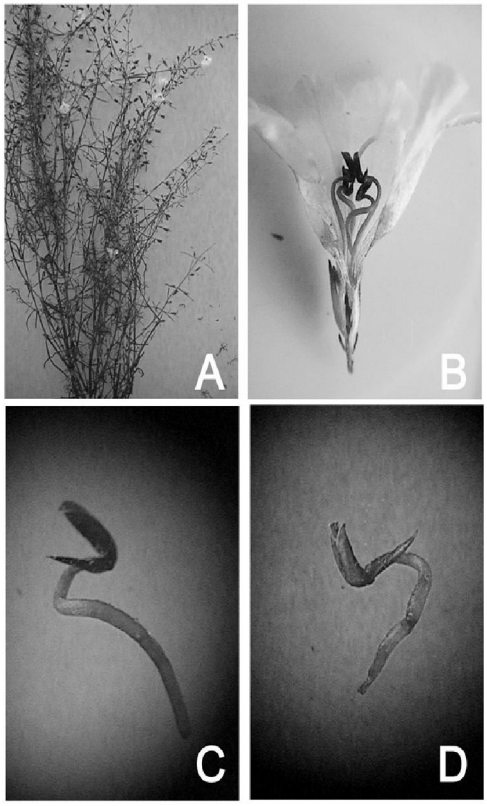

Fig. 1. Arrangement of flowers and floral parts in *Sopubia delphinifolia*.
A. Arrangement of flowers on the inflorescence X 0.5.
B. Arrangement of stamens and style X 3.
C. Stamen with one sterile and one fertile anther lobe X 3.
D. Fertile anther lobe with apical pore extending downwards X 3.

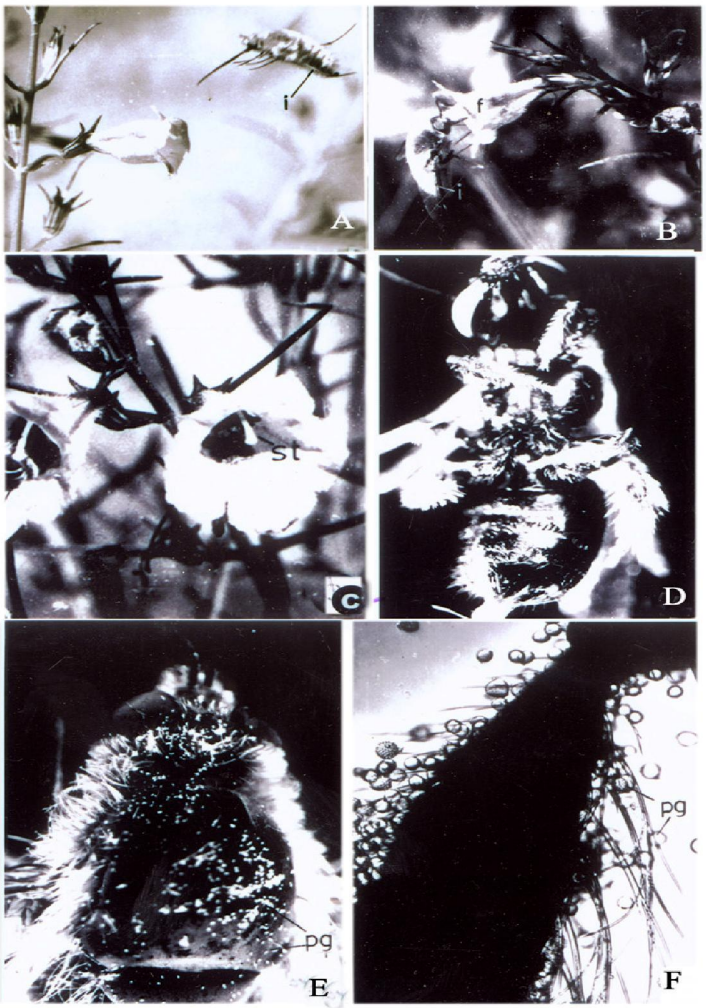

Fig. 2. Pollination by mellitivorous and pollenivorous species.
A. Insect sucking nectar without pollinating the flower X 2.
B. Nectar foraging worker effecting pollination X 2.
C. Pollen foragers working upside down X 3.
D. Head and ventral surface of insect dusted with pollen X 16.
E. Insect head covered with pollen grains X 16.
F. Leg of pollen forager covered with pollen grains X 100.

Acknowledgement
The authors are thankful to the Common Wealth Institute of Entomology, London.

Correspondence to
Thriveni MC
Research Scholar
Dept. of Studies in Botany
Manasagangotri
Mysore-570 006
Karnataka, India.
M-9480734888
Email-thrivenimc@gmail.com

5. References

[1] Faegeri K, Van Der Pijl. The principles of Pollination Ecology. 3rd ed Pergamon press Oxford 1979.

[2] Koeman – Kwak M. The pollination of *Pedicularis palustris* by nectar thieves (short tongued bumblebee) Acta Botanica Neerlandica, 1973; **22:** 608- 615.

[3] Kulasekaran MD. Studies in Parasitic Angiosperms, Thesis University of Mysore 1987.

[4] Kwak MM. Effects of bumblebees visit on the seed set of *Pedicularis*, *Rhinanthus* and *Melampyrum* (Scrophulariaceae) in the Netherlands , Acta Bot. Neerl. 1979; **28:** 177-196.

[5] Macior LW. The pollination ecology of *Pedicularis groenlandica,* American Journal of Botany. 1968a; **55:** 927 -932.

[6] Macior LW. Pollination adaptation in *Pedicularis canadensis,* American Journal of Botany. 1968b; **55:** 1031 -1035.

[7] Macior LW. Pollination adaptation in *Pedicularis lanceolata* American Journal of Botany 1969; **56:** 853 –859.

[8] Macior LW. The pollination ecology in *Pedicularis* in Colorado. American Journal of Botany 1970; **57(6)**: 716-728.

[9] Macior LW. Co-evolution of plants and animals, systematic insights from plant insect interactions, Taxon 1971; **20:** 17 –28.

[10] Macior LW. The pollination ecology of *Pedicularis* on Mount Rainier, American Journal of Botany 1973; **60:** 863-871.

[11] Macior LW. Behavioral aspects of Co-adaptations between flower and insect pollinator, Annals of Missouri Botanical Garden 1974; **61:** 760 –769.

[12] Meidell O. Notes on the pollination of *Melampyrum pratense* and the honey stealing of bumble bees and bees, Bergen Meuseum Arbok .Maturvitensk rekke 1944; **11:** 1-12.

[13] Percival MS. Floral Biology. Pergamon Press, Oxford, 1965.

[14] Shivanna KR, Rangaswamy, NS. Seed germination and seedling morphogenesis of the root parasite *Sopubia delphinifolia* G. Don, Z. Pflanzenphysiol 1976; **80:** 112-119.

6/1/2010