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# Comparative Efficiency of Thrips in Relation to Other Foraging Insects in the Pollination of *Cosmos bipinnatus* Cav. (Compositae)

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Evaluation of the comparative efficiency of thrips pollination in *Cosmos bipinnatus* (Compositae) in relation to other flower-visitors like butterflies and bees, are made. The flower-recognition capacity and pollen-carrying efficiency of the primary species, *Thrips hawaiiensis,* total pollen production, viable seed production and the mode of nectar secretion sugars and free amino acid composition of the nectar of *Cosmos* are also discussed in relation to pollination by thrips.

**Key Words:** **Thrips, Pollination,** *Cosmos*

## Introduction

*Thrips hawaiiensis* is a recognised polyphagous anthophilous tropical species, sizable populations of which occur in a wide variety of horticultural plants. But their role as efficient pollinators is evident from the observations of Mathur and Mohan Ram (1978) and Syed (1979). Recently, Ananthakrishnan (1982) has discussed in detail the role of thrips in pollination, in terms of adaptive significance of the pollinator and the flower, with particular emphasis on some Compositae. In the present study, attention is focussed on the comparative efficiency of thrips, in relation to other foraging insects such as butterflies and bees, in the pollination of *Cosmos bipinnatus*.

## Material and Methods

Periodical observations were made to study the timings of insect visits. In order to assess populations as well as flower preference by thrips species, the flowers were categorised into the following stages: (a) late bud stage, where the sterile ray floret corollas have just opened; (b) ray as well as disc florets of the first two rows opened, where generally maximum amount of nectar and pollen is available, and (c) seed setting stage. Insects with pollen grains were captured and killed in 70% alcohol. The pollen grains were isolated from the insect bodies and then identified. Anthers were crushed in glycerine and the number of pollen grains was estimated using a haemocytometer. The starchy and non-starchy pollen grains were distinguished by IKI method (Jensen 1962). Field experiments were conducted to find out the efficiency of pollination in terms of seed production by different pollinators. In the first set of experiments, buds of *Cosmos* were covered with polyethylene bags so as to prevent the visits of insects, enabling study of the chances of self-pollination. In the second set up, thrips alone were introduced into the flower at a stage when the ray petals and the first row of disc florets were opened and the flowers were covered with bags as in the earlier experiments. Both the sets were maintained till the seed setting stage.

Studies on pollination were carried out from two different angles, viz., direct involvement of *T. hawaiiensis* from the surrounding weed host *Lantana camara* L. (Verbenaceae) and experimental introduction from *Couroupita quianensis* Aubl. (Lecythidaceae) flowers which harbour very large populations of *T. hawaiiensis*. The flower recognition capacity of *T. hawaiiensis* was assessed by culturing different stages of *Cosmos* inflorescence in sucrose solution under laboratory condition. The individual cultures were grouped together and kept inside a plastic tray partly filled with water, and covered by a polyethylene bag with minute pores to facilitate aeration. While setting up cultures, care was taken to avoid the presence of thrips in the flowers. Thrips were then introduced into the late bud stage of *Cosmos* flowers. After an interval of two hours (the minimum period for thrips movement between the flowers), flowers from the above culture were examined under a binocular dissection microscope.

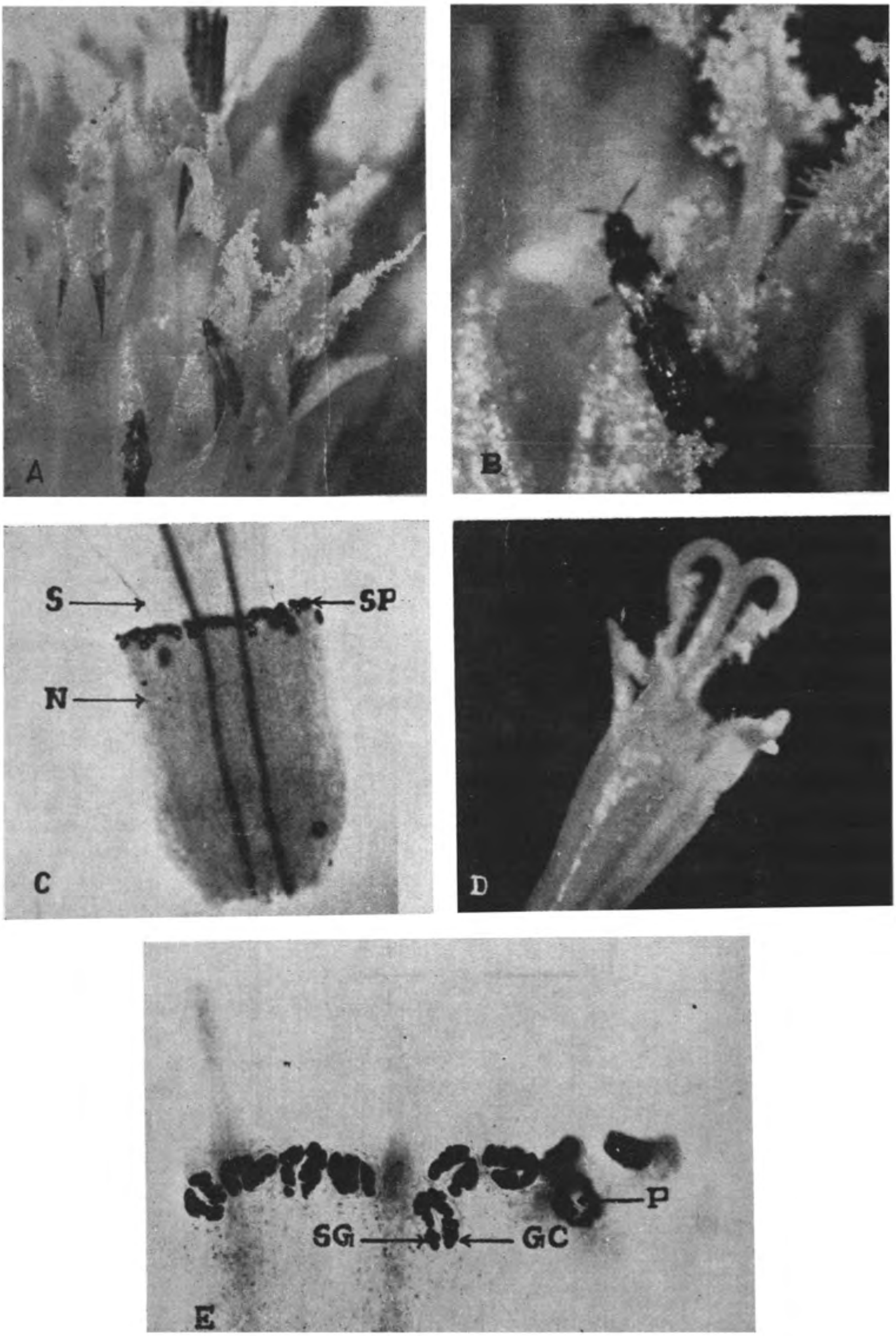
**Observations**

Various insects such as bees, butterflies and thrips visit the inflorescences of *Cosmos* during different times of the day. Field observations showed that thrips were the only insects present throughout, while the visit time of bees is generally between 7.00 and 13.00 hrs every day with the frequency decreasing gradually from 11.00hr onwards. In the case of butterflies, the foraging period was between 9.00 and 14.00 hrs with frequency declining by 12 O' clock.

Infestation of thrips starts at stage 'a' of the flowers. Larval population gradually increases when almost all the disc florets open and stigmas become receptive. *T. hawaiiensis* lay their eggs inside the tissues along the lower parts of the corolla tubes normally, just above the nectary. In several cases the eggs are laid in a circular fashion around the corolla tube, most of them in contact with the secreted nectar.

Among the thysanopteran pollinators, *Thrips hawaiiensis* could be considered as the primary species usually with a population of 8–15 adults and 5–13 larvae per inflorescence followed by *Microcephalothrips abdominalis* with 4–7 adults and 6–10 larvae, and *Frankliniella schultzei* with 2–4 adults and 5–8 larvae per flower with occasional visitors like *Haplothrips gowdeyi*. The dominant species *T. hawaiiensis* occurred throughout the flowering season i.e., from mid-September to the end of December, while the other three species showed a successional pattern during different months of the blooming period, with *M. abdominalis*, *F. schultzei* and *H. gowdeyi* appearing in the months of October, November and December respectively.

**Figure 1 A-E, A & B,** Thrips with pollen grains attached on their body in *Cosmos* inflorescence (A—× 15; B—× 31); **C,** Nectary at the stylar base showing stomata arranged on the top (× 50); **D,** Single floret showing the well projected stigmatic lobes with pollen grains touching the lip region (× 25); **E,** Enlarged view of the stomatal pore on the nectary showing the starch grains inside the guard cells (× 500). **N,** Nectary; **P,** Pore; **S,** Style; **GC,** Guard cell; **Sg,** Starch grains, and **SP,** Stomatal pore


A
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Analysis of the pollen carrying efficiency of thrips revealed that the adults of *T. hawaiiensis* carried the maximum number (90–100) of pollen grains on their body followed by the larvae (50–80). Detailed observations on the thrips with pollen load indicated the presence of pollen grains on 9th and 10th abdominal segments facilitated by the presence of more number of setae than other body segments. Apart from this, the species were found to carry pollen grains in clusters on the legs. Pollen loads on the other three secondary species of thrips were considerably less than those on primary species namely *T. hawaiiensis*, both in terms of pollen carrying efficiency and its successional abundance. Examination of pollen grains collected by bees showed the presence of a mixture of pollen grains of both *Helianthus* and *Cosmos* suggesting the frequent visits by bees at the observation site, while *T. hawaiiensis* was always present in the flowers.

Receptivity of the stigma occurred when the stigmatic lobes became well-projected and tapering, often touching the lip of the corolla tube. Encircling the tapering region of the stigmatic lobes are long papillae which, gradually decrease in number and length towards the apex. The receptive region occurs along the inner sides of lobes towards the lower portion with closely arranged small papillae. The papillae at the tapering region carry copious amounts of pollen grains during the slow movement of the insect through the syngenesious another column which takes 70–74 hrs after the complete curling back and touches the lip of the corolla tube which has numerous small hairs on which pollen grains are dusted (figure 1,D).

Thrips in their attempt to get into the lower regions of the corolla tube in order to feed on the nectar, pass along the lips of the corolla where a large number of pollen grains are accumulated as a result of the shedding of pollen by the stigmatic lobes on the lip surfaces. Therefore, during this migration the forelegs and the ventral portions of the bodies of thrips become coated with pollen. Incidentally the wings and the setae along the dorsal sides of the thrips bodies also get coated with pollen since thrips brush against the hairs of the stigmatic lobes.

Visits of different groups of insects in the same flower which are almost adapted for the same type of food indicate the high production of food i.e., pollen and nectar. It is estimated that the pollen production in a single disc floret ranged from 5536 to 5716 and in a capitulum from 2,10,350–2,17,208 (table 1). Some starchy pollen grains occur in the outermost row of disc florets and their number gradually decreases towards the innermost row. The considerably high, nectar secretion is released through the minute stomatal openings present at the apex of the nectary near the stylar base (figure 1, C and E). The ellipsoid stomata lack subsidiary cells and remain always open. The guard cells are non-chlorophyllous and show the presence of starch grains (Gopinathan & Varatharajan unpublished.

Experiments on seed production revealed that flowers without insect visitors produced 25–30% seeds and the rate of seed setting was 50–65% in the thrips pollinated flowers 70–90% of seed set were observed in the natural condition where the pollination activity was contributed by a combined effort of bees, butterflies, and thrips (table 1).

Results of the experiment on the flower recognition capacity of *T. hawaiiensis* revealed that majority of thrips were confined to the open flowers (i.e., flower stage-b); a few thrips were present in the flowers which had just attained the senescent stage, and the flowers into which thrips were introduced at the beginning were devoid of thrips. Abundance of thrips in the fully open flowers of *Cosmos* showed the ability to recognise the particular flower stage for their development and multiplication.

**Table 1**

| Types of Study | Range | Mean ± S.E. |
|---|---|---|
| Pollen production per floret | 5536–5716 | 5620 ± 19.3 |
| Number of viable seeds produced under natural condition | 27–34 | 29.8 ± 0.79 |
| Viable seeds produced in cultures with thrips alone | 19–25 | 21.8 ± 0.58 |
| Viable seeds produced in cultures without insects | 9–11 | 9.6 ± 0.38 |

(Data collected from 380 florets : 10 flower heads)

## Discussion

The direct involvement of *T. hawaiiensis* in the pollination of *Cosmos* revealed geitonogamy whereas that by other foraging insects such as bees and butterflies showed xenogamy, resulting in maximum seed production. As far as the food reward to the three different insect groups foraging the inflorescence is concerned, thrips are the major beneficiaries because of their incidence inside the inflorescence throughout. On the contrary, the foraging period of bees and butterflies is restricted to specific timings. Thrips due to their abundance and greater food reward, lead a life of lesser intra- and inter-capitular migration resulting in geitonogamy.

The experimental results reveal that the ability of thrips to recognise the particular stage of the flower which is ready for pollination appears interesting, even though they are introduced from a different host plant. Synchronisation in terms of infestation by gravid females, their egg-laying sites where maximum nectar is freely available for the emerging larvae at the receptive stage of stigma, helps in the build-up of population in an inflorescence for more pollinators. Thrips can be considered as primary pollinators due to the exclusive presence of *Cosmos* pollen grains. Bees and butterflies are of heterogeneous type since they also carry pollen grains other than that of *Cosmos*.

## Acknowledgement

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