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The role of thrips in pollination

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The article reviews the role of thrips in the pollination of members of Asteraceae, Solanaceae and Fabaceae. Several features such as the highly synchronized phenology of flowering with the life cycle of thrips, modification of flowers to facilitate pollen transfer by thrips and definite pattern of host succession that help maintain the population of thrips are reported. We argue that these features represent strategies in plants favouring a strong association between the thrips and the plants.

THE efficiency of thrips-flower association for pollination depends on the dynamics of pollen transfer through thrips. Thus availability of pollen and nectar as reward, pollen-stigma interaction, pollen wall architecture, mechanism of pollen attachment to thrips are the critical factors in thrips-flower interactions. Synchronization of anthesis and nectar availability with the development of the pollinator as well as behavioural aspects of thrips, play an essential role¹. Generally thrips are considered as pure pollinators because unlike bees and butterflies they carry pollen grains of only one plant species. Active involvement of thrips in pollination is well documented by Anand² and Billes³ on cacao, Odland and Porter⁴ on *Capsicum annum*, Hagerup⁵ and Carlson⁶ on onion, Syed⁷ on oil palm, Appanah and Chen⁸ on *Dipterocarpus* and Kirk⁹ on *Echium plantagineum*. Indian work on thrips pollination biology was initiated at the Entomology Research Institute, Madras and are documented in the contributions of Ananthakrishnan and coworkers¹⁰⁻¹², Velayudhan and Annadurai^{13,14} and Gopinathan and Varatharajan¹⁵ on a few species of Asteraceae, Solanaceae and Fabaceae.

Asteraceae

Synchronization of flowering periodicity with the developmental phase of the pollinating thrips appears to be controlled by the population build-up of thrips, eventually leading to dispersal. This is established in

our studies on thrips pollination of *Tridax procumbens*, *Wedelia chinensis*, *Synedrella nodiflora*, *Vernonia cinerea*, *Ageratum conyzoides* and *Cosmos bipinnatus* (all Asteraceae). Our studies have also established the relation between the host succession, population build-up of thrips and possible implications for their associated evolution.

For instance, the succession patterns of the host plants *Wedelia*, *Synedrella* and *Ageratum* and their flowering periodicities enable *Microcephalothrips abdominalis* to maintain their populations throughout the year. The continued availability of hosts with ample intra-floral resources facilitates thrips to build their populations.

The adaptive nature of the pollinator to the flower appears impressive in *M. abdominalis* which has a 9-12 day life cycle. Oviposition in this species coincides with the emergence of the petals of the disc florets of *W. chinensis* in its late bud stage, so that the larval emergence, anthesis and nectar production in the flowers are all synchronized. The disc florets of Asteraceae are protandrous and when their stigmas emerge through the staminal columns they carry pollen grains also on their lower surfaces. The nectary is located at the base of the style with minute stomata-like apparatuses, which are distributed diversely in different species, with the guard-cells containing plenty of starch grains¹⁵. Nectar secretion coincides with pollen maturation, maximal secretion occurring when the stigmas are receptive, providing an opportunity for fertilization by the foraging insects with mature pollen on their bodies. Pollen loads were heavy with *Frankliniella schultzei* carrying 120-180 grains. Pollen loads of different species range from 25 to 200 in the adults and the larvae, the adults having an increased load due to greater surface area such as wing fringes, abdominal setae, as well as the antenna.

Incidentally, a limitation of the food reward in the flowers encourages the foragers to visit other plants. Species living in the heterogamous capitula spend lesser energy for their migration due to corymbose arrange-

ment of the heads¹⁶. Thus, as visualized by Heinrich and Raven¹⁷, a balance exists between the nectar/pollen availability and the incidental calorific reward of a flower on the one hand, and the energy expenditure by the pollinator on the other. Experiments to measure the role of *Thrips hawaiiensis* in the pollination of *C. bipinatus* revealed that 50–65% seed-setting is contributed by thrips only, about 70–90% seed setting rate was obtained under natural conditions where the pollination was effected through a combined effort of thrips, bees and butterflies.

Solanaceae

Flowers of *Solanum melongena* harbour both *F. schultzei* Trybom and *Ceratothripoides cameroni* Priesner with the former being more abundant and frequent. The solanum type of flower is very conducive for the development of thrips, since the adults can penetrate the flower during the bud stage itself and the larvae can emerge even prior to the opening of the flower. Flowers of *S. melongena* are all oligandrous with most of their anthers enlarged and showy, providing the inhabitants and other visitors with excess of pollen and moderate quantity of nectar. The larvae hatching from eggs placed near the nectaries confine themselves to their respective flowers till they became adults and show active movements, more often towards the stigma. The cloud of pollen, resulting from poricidal dehiscence of the anthers gets scattered all over the flower and also on to the various parts of the body of thrips. The larvae of *F. schultzei* are more efficient pollen carriers than the adults (Figure 1 a–c). The peak receptive period of the stigma coincides with the exudation of a sticky fluid which helps adherence of the pollen. Hence, self-pollination occurs due to the random movement of thrips. The continuous build-up of population of thrips in a flower leads to inter-specific and intra-specific competition, resulting in the dispersal of thrips; this enhances the chances of cross pollination as in Asteraceae. The synchronized events occurring in the life cycle of the pollinator and the development of the flower is a vital factor in thrips pollination of *S. melongena*. Studies on the pollination potential of the thrips species in other solanaceous plants like *S. torvum*, *S. xanthocarpum*, *S. trilobatum*, *S. nigrum* and *Capsicum frutescens* indicate that the larvae of *F. schultzei* have a higher pollen-carrying potential than the adults in all the stages of floral development. Maximum pollen attachment on the bodies of the larvae is on the lateral sides of the abdomen and the last abdominal segment, while in the adults of *F. schultzei*, the maximum number is along the fringes of the thoracic wings. In some species, pollination by thrips alone accounts for 93% of the flowers pollinated. In solanaceous flowers,

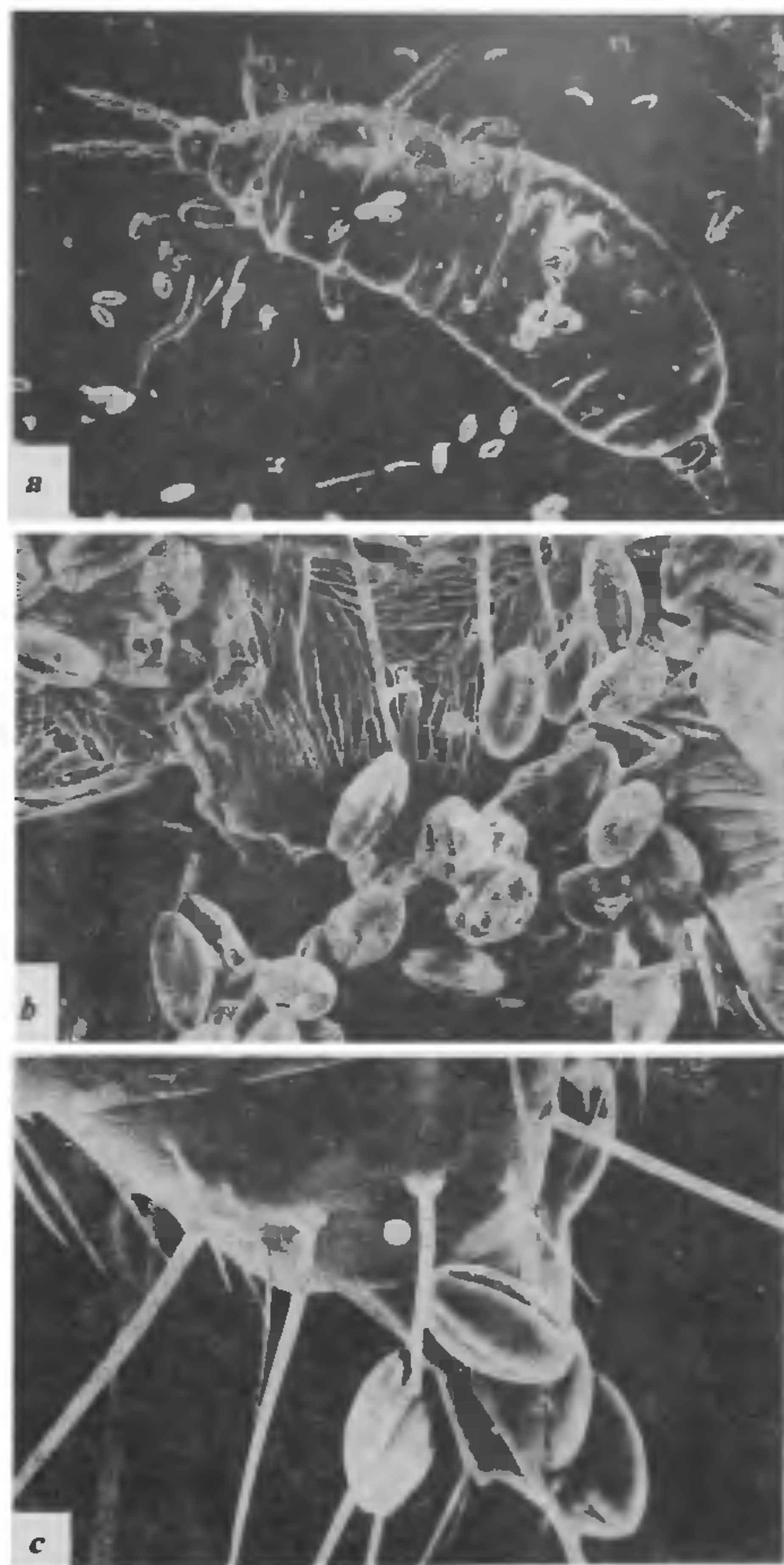


Figure 1 a–c. Scanning electron micrographs. a, Larva of *Frankliniella schultzei* with pollen grains of *Solanum melongena*. b and c, Portions of the body of the adult showing pollen grains.

the stigma occurs at a higher level than the anthers, and transfer of pollen from the anther to the stigma is mainly done by thrips larvae which move only within one flower. Cross pollination to a modest level also takes place through adults that are drifted by wind or that make short flights from one flower to another.

Fabaceae

Megalurothrips distalis and *F. schultzei* are the primary vector species occurring in larger frequencies with

smaller number of *Haplothrips gowdey* within the flowers of *Dolichos lablab*. The flowering phenology of *Dolichos* and the life cycle of thrips synchronize with each other: anthesis occurs between the fifth and the ninth day after the flower development; nectar secretion commences and the stigma becomes receptive from the 7th to the 12th day; duration of the life cycle of the pollinator is 12–18 days. Initial infestation of the flower by *M. distalis* occurs between the 3rd and 5th day of the bud, with the adults feeding on the fleshy regions of the standard and keel petals. They oviposit essentially along the basal regions of the keel petals. After an incubation period of 4–5 days, larvae emerge coinciding with the maximal secretion of nectar. Following flower shedding, older larvae move towards soil for pupation and adults emerge after 3 days to reinfest a new inflorescence. *D. lablab* blooms during October–June; the peak of flowering season is between December and early March, and coincides with population build-up of thrips. This increase in the population seems to be due to dispersal of thrips among crops such as *Cajanus indica*, *Sesbania aegyptiaca*, and *Vigna catjang* which incidentally harbour the same species of thrips and also flower during the same period. Weeds like *T. procumbens* (Asteraceae), *Ruellia tuberosa* (Acanthaceae), *Ipomaea* spp. (Convolvulaceae) serve as perennial reservoirs for thrips, especially for *F. schultzei*. Emasculated buds in the second and third row from the tip of the inflorescence set to pods when thrips were released. This confirmed interfloral movements of larvae and adults of thrips and suggested their possible role in cross fertilization.

Fabaceous flowers are generally considered self-fertile. But when thrips get associated with them, both the plants and thrips are benefited mutually: the thrips obtain the food reward, and the plants benefit by transfer of pollen grains. In spite of their small size, thrips help in realizing 50–70% viable seeds indicating their pollination potential.

In thrips-pollinated *Lantana camara* flowers, the

presence of thrips is only within yellow flowers and are totally absent from orange and scarlet flowers. The colour changes from yellow to shades of red, scarlet and mauve tend to guide the yellow flower thrips. Pollination also triggers the biogenesis of anthocyanins that mark the carotenoids and flavonoids in the petals of *Lantana*¹⁸.

Sabah oil palm pollination by *T. hawaiiensis* provides an interesting instance. The populations of this species were higher in the male inflorescence than in female flowers and each male inflorescence harboured a maximum of 1000 individuals per spikelet. The very high density on male inflorescences appears to be an adaptive factor for effective pollination⁷.

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