

Sensillar Dynamics in Thrips-Flower Interactions of Arid and Semi-arid Tree Species

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Abstract : Extensive survey was carried out in order to study the thrips-flower interactions of some introduced/native tree species of arid and semi-arid areas. The behavioural response involved in feeding are modified according to the sensillary structures and functions of the antennae and mouth parts. Though no work in this direction has been undertaken forestry thrips, an analysis of diverse type of olfactory sensilla on the antenna of different species would appear important and measures have to be adopted to protect the forest tree species from flower thrips.

Key words : Flower thrips, sensilla trichoidea, basiconica, chaetica, host selection.

Host selection and feeding specificity by a particular insect is based on the overall sensory input. Thrips (Thysanoptera) are no exception since the contact receptors on the antennae and mouthcone play a very useful role in the host plant recognition by them. It was clearly seen that orientation towards the particular host by the insect was greatly affected when experimental insects were introduced to various treatments such as antennal ablation, maxillary coating, excision of antenna and maxilla as well as blinding of eyes without imposing severe damage (Murugesan, 1990). Successful host plant utilization by phytophagous insects unquestionably depends upon the properly co-ordinated interaction between the insect and the plant (Dethier, 1974). As indicated by a number of workers, the behaviour involved in host plant selection can be divided into several components as chemical, visual and tactile, etc., each of which occurs as a result of insect's prior response in the chain of responses. The behavioural responses involved in feeding are modified according to the structures and functions of the mouth parts, an-

tenna, etc., with the existence of variation in plant quality. This is because individuals that avoid plants of low quality show food preference on plants of high quality (Murugesan, 1990). It has long been recognised that phytophagous insects can be highly selective with respect to the plants they consume and continue feeding culminating in cessation of feeding and locomotion (Kogan, 1977). For their success and survival, the phytophagous insect has to locate the habitat and orient towards the respective food plant and finally accept the plant before commencing the feeding. The behavioural events leading the herbivore to find a suitable plant from a distance to feed or oviposit depends on the pathways of plant emitted chemicals and coding of these patterns by the CNS. Insect can perceive numerous chemical compounds in plants through the development of highly developed chemosensory system and this enables the insects to be the successful exploiter. Though no work in this direction is available for forestry thrips, an analysis of diverse type of olfactory sensilla on the antenna of different species would appear important

in paving the way for further studies. There is, therefore, a need for an understanding of feeding diversity, morphological variations of the types of sensillary structures on the antenna, mouthcone and genital portion of flower-infesting thrips of arid and semi-arid tree species which is of paramount importance.

Materials and Methods

Extensive survey was carried out from November 1995 to March 1996 in different areas of Jodhpur (Rajasthan), viz., Mandore, Chopasni and Pali sites in order to study the thrips-flower interactions of some introduced/native tree species of arid and semi-arid areas such as *Ziziphus mauritiana* Lamk (leguminosae), a native tree species of Jodhpur, *Parkinsonia aculeata* L. (leguminosae), *Moringa oleifera* Lam. (leguminosae), *Cassia siamea* L. (leguminosae) and *Prosopis cineraria* L. (leguminosae). Field collected individuals were preserved in 70% alcohol and permanent slides were prepared for identification studies.

In order to study the sensory morphology, mouthparts and antennae, scanning electron microscopic studies were made. Specimens were washed in 30% acetone and dehydrated in acetone series, transferred to amyl acetate and dried using a Critical point drier (CPD). The dried specimens were fixed on aluminium stubs using a double adhesive tape and coated with gold using ion coated for 3 to 4 minutes before being observed with SEM under 15 KV emission current and for the micrograph, NOVA FP4 125 A5A film was used.

Results and Discussion

Feeding diversity and damage profiles

Thrips are popularly depicted as fringe wing insects (Fig 1). There are about 5000 species the world over, some of which are known to cause serious economic damage,

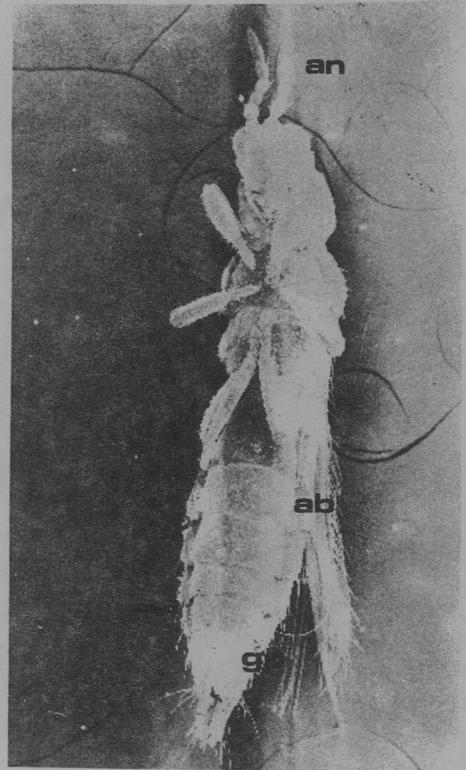


Fig. 1. Whole mount of *Thrips* sp. an - antenna, ab - abdomen, gp - genital and sa - sensilla portion.

both by feeding and acting as vectors of bacterial, fungal and viral diseases. The phytophagous species are confined to various parts of the plants, stem and flowers. The menace of thrips as serious crop and horticultural crop pests, particularly in view of their increasing tendency to be polyphagous, has come to be recognized in recent years. This is especially true in relation to forest tree species. *Thrips palmi* and *Scritothrips dorsalis* have been on the rampage in India and South-East Asian countries, apart from others like *Retithrips syriacus*, several species of *Frankliniella*, *Thrips*, *Taeniothrips*, *Megalurothrips*, *Caliothrips* and *Haplothrips* (Ananthakrishnan and Gopichandran, 1993). There

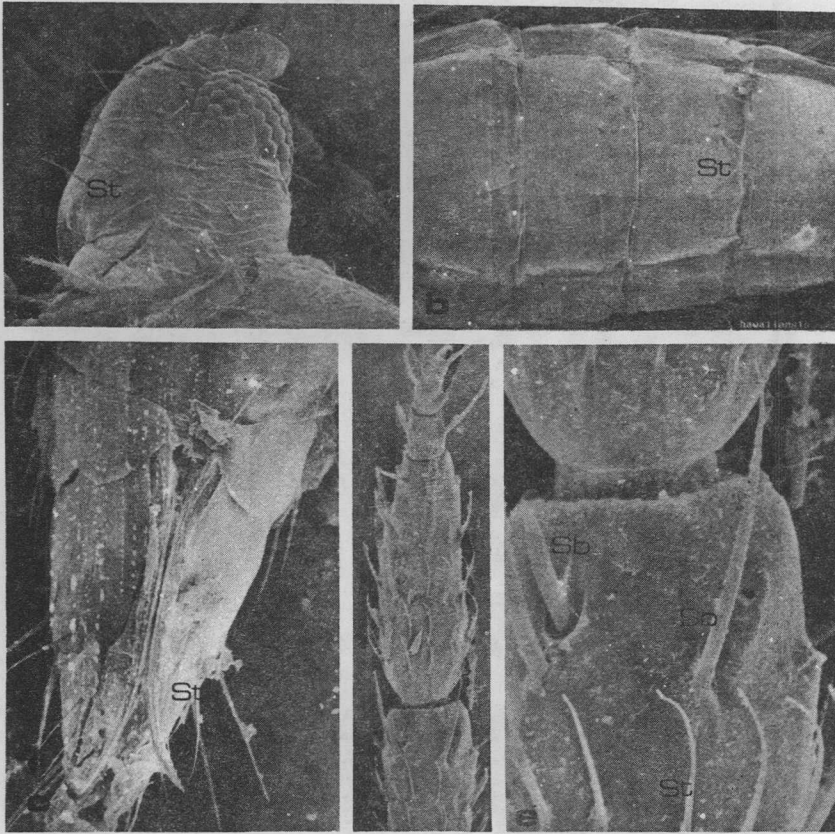


Fig. 2. Scanning Electron micrographs of *T. hawaiiensis* (a-c) distribution of sensory hairs on mouthcone, abdomen and genital portion. (d-e) variation of sensory hairs distributed on antenna. St : Sensilla trichoidea, Sb : Sensilla basiconica without collar and with collar.

is an urgent need for an understanding of thrips-flower interaction of forest tree species of arid and semi-arid areas. The oligophagous and phytophagous species create a potential for frequent host shifts, pest species rapidly colonising on plants that are cultivated extensively, as well as on plant species harbouring different species in different regions (Strong *et al.*, 1977). Extensive survey was carried out from November 1995 to March 1996 in different areas of Jodhpur (Rajasthan), viz., Mandore, Chopasni and Pali sites in order to study the thrips-flower interactions of some

of the introduced/native tree species of arid and semi-arid areas such as *Z. mauritiana*, a native tree species of Jodhpur, *P. aculeata*, *M. oleifera*, *C. siamea* and *P. cineraria*. These trees are nitrogen fixing species and are grown on almost any soil type. Some of them are attractive fuel wood and fodder trees for moderate tropical areas and now planted successfully for ornamental and fuel wood purposes, are found throughout the arid and semi-arid tracts (Hocking, 1993). These are being tried extensively for wasteland reclamation in poor and eroded sites with sandy,

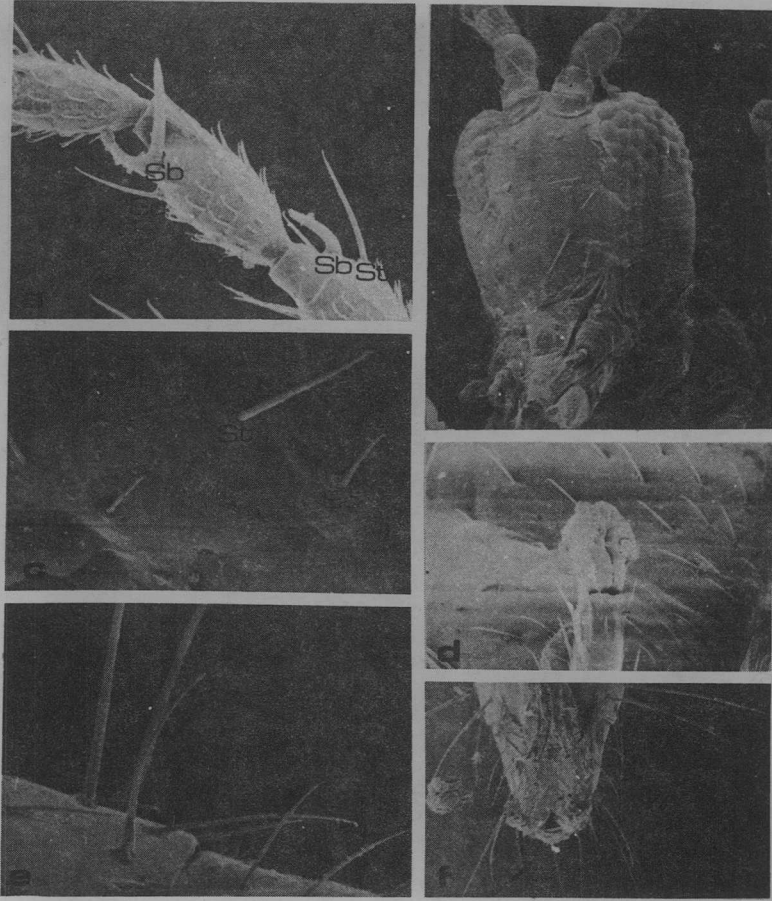


Fig. 3. Scanning Electron micrograph of *M. distalis* (a-f). Variation in the distribution of sensory hairs of antenna (a), mouthcone (b), higher magnification of mouthcone (c), abdomen (d), higher magnification of abdomen (e) and genital portion (f).

rocky or clay soils and for afforestation of degraded forest lands. *M. oleifera* has many medicinal applications, especially flowers are being used as a tonic and diuretic. Owing to this, the intricacies involved in thrips host plant interactions appear very relevant and give exhaustive information about the feeding behaviour of thrips.

Flower thrips, *Megalurothrips distalis*, *Thrips hawaiiensis*, *Thrips tabaci*, *Frankliniella*

dampfi, *Dendrothrips bispinosus* and *Thrips* spp. were observed infesting flowers of *M. oleifera*, *P. aculeata*, *C. siamea*, *Z. mauritiana* and *P. cineraria* (Murugesan and Kumar, 1996). *T. tabaci* is found to cause considerable damage to *C. siamea* in the field condition, the damage is evident as flowers become dry, wrinkled and fade away due to heavy infestations. All parts of the flowers are infested and several adults and larvae are found inside each flower. *M. distalis* have a particular af-

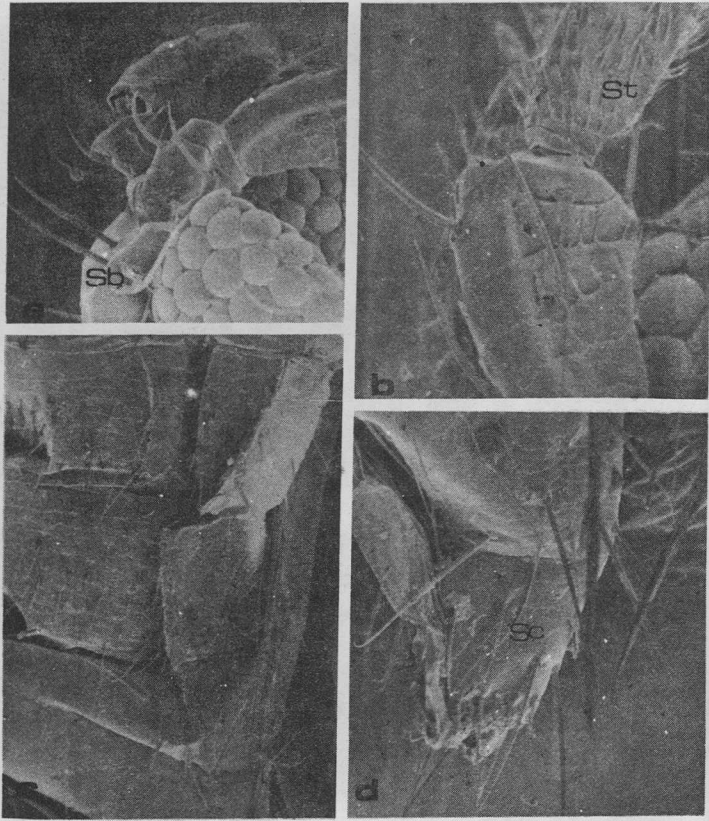


Fig. 4. Scanning Electron micrograph of *D. bispinosus* (a-d) distribution of sensilla basiconica, trichoidea and chaetiua on mouthcone, antenna, abdomen and genital portion.

finity for the flowers of moringa. Heavy infestations by these species in flowers of *M. oleifera*, *P. aculeata*, *Z. mauritiana* and *C. siamea* were observed to cause weak growth, drying and premature shedding of flowers resulting in the prevention of pod setting. *T. hawaiiensis* causes considerable damage in the bud of *P. aculeata*, with the result that flowers become smaller as the petals shrink (Murugesan and Kumar, 1996). In view of this, measures have to be adopted to protect the tree species of arid and semi-arid areas, from flower thrips. The flower thrips, *M. distalis* is reported for the first time on *Mangifera indica* (mango) (Rama Subbarao and Tham-

miraju, 1994). Ananthakrishnan (1973) reported the flower thrips *M. distalis*, *Franklinella dampfi* and *T. tabaci* on *Pongamia glabra* (ponga), *Medicago sativa* (lucerne fodder crop), *Anacardium occidentale* (cashew), *Gomphrena glabosa* (gomphrena), *Cocos nucifera* (coconut) and *Nepelium litchi* (litchi) as alternative host plants. He further reported, the flower thrips *M. distalis*, *F. dampfi*, *T. hawaiiensis* and *T. tabaci* on *Pongamia glabra* (ponga), *Punica granatum* (pomegranate), *A. catechu* and *Papaver somniferum* (poppy) and evaluated the damaging profiles as result in laceration of the tissue, the green tissue turning brown. The injury to their ovary and young

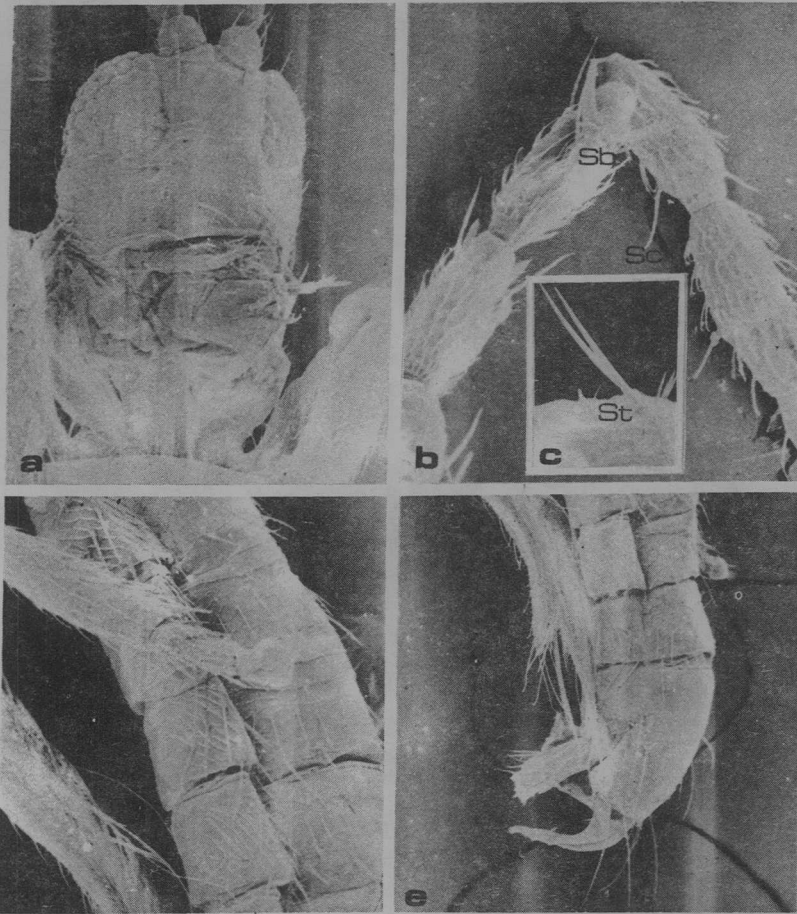


Fig. 5. Scanning Electron micrograph of *Thrips* sp. (a-d) distribution of Sensilla basiconica, trichoidea and chaetica on mouthcone, antenna, abdomen and genital portion.

Pods persisted as scabs on the fully developed pods. In relation to fruit crops, attack by this species results in the drying of floral nectaries and as a result of the feeding on the fruit and fresh flowers, it promotes distortion and atrophy (Ananathakrishnan and Gopi-chandran, 1993; Sharga, 1933) indicated that 17% of the florets of wheat and 38% of spikelets in oats are damaged by *Limothrips cerealium*. *Anaphothrips obscurus* feeding on oats resulted in 36% sterility (Hewitt, 1914).

Sensillar dynamics

Thrips are well equipped with different types of sensillary structures on various parts of their body such as antennae, mouthparts, abdomen and genital portion (Figs. 2-5) which can easily be utilized to recognize their host plant. These sensory organs can perceive the gustatory, tactile and olfactory stimuli emitted by the host plant. The inputs from the multiple receptors and multimodal activities like vision, gustation and olfaction provide the insects

with a wealth of information reflecting the complexity of its environment. The asymmetrical piercing and sucking mouthparts of the thrips, viz., *T. hawaiiensis*, *M. distalis*, *D. bispinosus* and *Thrips* sp. (Figs. 2, 3 and 5a) consist of a mouthcone comprising paired paraglossae and maxillary stylets which vary in structure between families and species (Ananthakrishnan, 1971). Paired labial and maxillary palps located on the mouthcone appears to be sensory. Distribution of sensillae on the mouthcone are similar to those found in the aphids, leafhoppers and psyllids. Damage to the tissue of host plants on account of feeding infringes on perception of host chemicals through the sensillae which govern the feeding behaviour. Recent observations by Hunter and Ullman (1992) indicate that the mechanism of thrip feeding is principally based around the likely selection of feeding sites in response to mechanical and chemical cues from the plant surface. The sensory structures involved in the perception of odour stimuli which are located in the antennae, mouthparts and genital portion of *T. hawaiiensis*, *M. distalis*, *D. bispinosus* and *Thrips* sp. are characterised based on the Scanning Electron micrographs.

The mouthcone of all four species have uniformly been covered with sensilla trichoidea, which are straight or strongly curved, since the surface area is small and appears to function as olfactory chemoreceptors. The antennae and abdomen are densely covered with sensilla trichoidea. Sensilla basiconica are stout, short, with collar, without collar and minute sensillae distributed all along the length of antennae are involved in the olfaction. Sensilla chaetica, arising from a bulbous base with sharp pointed ends, serve as mechano-receptors. However, the distal tip of the terminal segment of the antennae bears a field of sensilla basiconica with two types of sensilla, one group with sharp and pointed ends and other with blunt ends. This

sensilla appears to be campaniform sensilla and it acts as gustatory receptor (Fig. 2d).

The various steps involved in the feeding behaviour like host finding, recognition, acceptance occur rapidly and thus is difficult to distinguish, each step requires a particular sensory input, often involving sensilla remote from the antennae and mouthparts, and the sequence may be interrupted by unsuitable stimulants at each stage. The ability of any insect to find suitable hosts depends not only on its sensory capacities and the characteristics of the plant, but also on insect's mobility and patterns of dispersal (May and Ahmed, 1983). Olfaction from the large number of receptors at the tip of the antennae, abdomen and genital portion plays a major role in location of food. In the case of *T. hawaiiensis*, *M. distalis*, *D. bispinosus* and *Thrips* sp. both visual as well as olfactory cues appear to play an important role in host selection. Ananthakrishnan and Gopichandran (1993) have shown in leaf-disc experiments a better orientation of the individual with intact antenna than individuals with one or both antennae amputated. *Retithrips syriacus* shows a preference for castor, eucalypte, rose, *Hemidesmus* and *Arachis* in the order mentioned, when offered simultaneously. Chemoreceptors of insects form a complicated and suitable sensory system that enables them to differentiate between any natural stimuli of seemingly great diversity (Schoonhoven, 1977). An overall view analysis of the host plant range of the four species studied showed sensory modalities in the sensillary structures of the antennae, mouthparts and genital portion. Behavioural evidence suggests that sensilla on the antennae and mouthparts may also be concerned in the perception of chemical of plant origin in several insects. Olfaction has been shown to play an important role in feeding (Dethier, 1974). Therefore, knowledge of the existing role in thrips-host interactions at the sensory level is pivotal for

learning the evolutionary and ecological strategies of the herbivores which will further strengthen the present method of control.

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