Larval host specificity and proboscis morphology of fruit piercing moths

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ABSTRACT

The neonate larvae of *Othreis materna* (L.) fed only on the leaves of *Tinospora cordifolia* (Willd.), whereas the larvae of *O. fullonia* (Clerck) completed their life cycle on the hosts *viz*., *T. cordifolia, Tiliacora acuminata* Miers. and *Diploclisia glaucescens* (Blume) from neonate stage itself and it could not feed on *Cocculus hirsutus* (L.) Diels. and *Erythrina indica* (Lam.). Except *T. cordifolia* and *E. indica* the larvae of *O. homaena* reared on *C. hirsutus*, *T. acuminata* and *D. glaucescens* completed the life cycle. The larval duration was lesser when reared on *C. hirsutus* than the *T. acuminata* and *D. glaucescens*. The neonate larvae of *Rhytia hypermnestra* (Stoll) fed only on *T. cordifolia* with successful survivability. The proboscis of male and female of *O. materna*, *O. fullonia*, *O. homaena* and *R. hypermnestra* had three sclerotised oblique blades with sharp edges, six erectile barbs arranged in two rows near the tip which was sharply pointed. The total length of the proboscis of *O. materna* measured 13.90 mm and the sclerotised tip was very short measuring 1.21mm in male whereas it was 14.30 and 1.27 mm in female, respectively. The proboscis length of male *O. fullonia*, *O. homaena* and *R.hyperm nestra* was measured to be 15.25, 13.40 and 15.15 mm, respectively whereas in female it was 17.50, 14.70, 15.60 mm. The sclerotised tip of male moth measured 1.34, 1.30 and 1.27 mm, respectively and in female 1.49 mm in *O. fullonia* and 1.34 mm in both *O. homaena and R. hypermnestra*.

Key words: Fruit piercing moth, Menispermaceae, larval host specificity, *Othreis materna*

INTRODUCTION

The fruit piercing moths of *Othreis* sp. are unique noctuids. The adult moths of either sex have special sclerotised structures at the tip of their proboscis with which they are capable of drilling a hole through the hard rind of pomegranate and sucks the juice (Susainathan, 1924a; Hargreaves, 1929; Bhumannavar and Viraktamath, 2001b and Mohite *et al*., 2004). The larvae of fruit piercing moths feed on plants belonging to the Menispermaceae family especially the creepers *viz*., *Tinospora*, *Tiliacora*, *Cocculus* etc. The adult moths prefer these host plants for egg laying and larval feeding (Bhumannavar and Viraktamath, 2001a; Denton *et al*., 1999 and Swamiappan, 2001). Eventhough the fruit piercing moths causes severe damage in orchards very fragmentary information is available on the larval host specificity and their proboscis morphology and feeding mechanism of fruit piercing moths.

MATERIALS AND METHODS

Host specificity of *Othreis* spp. and *Rhytia hypermnestra*

The larvae of *O. materna*, *O. fullonia* and *R. hypermnestra* were found feeding on the natural vines of *T. cordifolia* in and around guava orchard in Agricultural College and Research Institute (AC & RI), Madurai campus whereas *O. homaena* on the *C. hirsutus*. Likewise in Coimbatore also the larvae of *O. materna* and *O. fullonia* were collected from *T. cordifolia* and *O. homaena* from *C. hirsutus*. Hence, to test the larval host specificity or host acceptance twenty five newly hatched larvae of each species of *Othreis* and *R. hypermnestra* were provided with fresh and tender leaves of four Menispermaceae plants *viz*., *T.cordifolia*, *C.hirsu tus, T. acuminata, D. glaucescens* and one Fabaceae plant *E. indica* in separate plastic containers (250ml). The mouth of the container was covered by muslin cloth and secured by the rubber band. Fresh leaves were provided every 24 h. The plant species on which most of the released larvae survived to second instar was considered as a natural host. The host plants not fed by the neonate larvae were considered as non-hosts. To find out whether older larvae of *Othreis* spp. and *Rhytia* feed on non-host plants, ten neonate larvae were reared on their natural host upto completion of first, second and third instars which were then shifted to non-hosts for subsequent instars.

Proboscis morphology

The proboscis morphology of the siphoning mouth parts of the moths was observed to study the sclerotised structures present at the tip and the extent of sclerotization for further grouping of moths into primary fruit piercers

and secondary fruit piercers. The proboscis of the moths thus collected were removed with the help of a pair of fine forceps and placed in 10% cold potassium hydroxide for 12 – 24 h for maceration of tissues depending on the sclerotization. This treatment invariably separated the two stylets of siphoning mouth parts. Stylets free from sticking food material and other dirts were washed in water. Cleaned proboscis was stored in glycerin for further study. Temporary and permanent slides were prepared with the help of glycerine and DPX mountant, respectively for taking microphotographs. Observations were made on the number of highly sclerotised blades, spine like teeth and erectile barbs. The total length of the proboscis and the sclerotised tip were measured for both the sexes of all the species of fruit piercing moths using a ocular and stage micrometer fixed in a Meopta Research Microscope and expressed in millimeters (mm).

RESULTS AND DISCUSSION

Larval host specificity of primary fruit piercers

The neonate larvae of *O. materna* fed only on the leaves of *T. cordifolia*, they did not feed on leaves of other Menispermaceae plants and *E. indica* under free choice tests (Table 1). The larvae reared on *T. cordifolia* upto 3rd instar were transferred to other Menispermaceae plants also failed to survive. No larva survived successfully on *E. indica*. The results of the present investigations were in agreement with the observations of Susainathan (1924a), Ayyar (1944) and Bajpai (1955) who reported that the larvae of *O. materna* fed only on leaves of *T. cordifolia*. Bhumannavar and Viraktamath (2001c), Swamiappan (2001) and Mohite *et al.* (2004) studied the biology *O. materna* on *T. cordifolia* and *Tinospora sinensis* (Lour.)Merr. Srivastava and Bogawat (1968) who reported that larvae of *O. materna* fed only on *T. cordifolia* and did not survive on *Cocculus*, *Erythrina* and *Caesalpinia*. Fay and Halfpapp (1993) identified two larval host plants of *O. materna viz.*, *T. cordifolia* and *Tinospora smilacina* Benth. in Sierra Leone. Now it is confirmed that larvae of *O. materna* is host specific, monophagous in nature and feed only on the plants coming under the genus *Tinospora*.

The larvae of *O. fullonia* had completed their life cycle on the hosts *viz.*, *T. cordifolia*, *T. acuminata* and *D. glaucescens* from neonate stage itself whereas it could not feed on *C. hirsutus* and *E. indica* (Table 1). The larvae reared on *T. cordifolia* could complete the life cycle in shorter period than the *T. acuminata* and *D. glaucescens*. It confirmed that the larva of *O. fullonia* was a generalist feeder and its performance was in favour of *T. cordifolia* than the *T. acuminata* and *D. glaucescens*. The larvae reared upto third instar on *T. cordifolia* which were then transferred to *C. hirsutus* and *E. indica* had failed to feed on them. Bhumannavar and Viraktamath (2004) studied

Table 1. Survival rate of larvae of fruit piercing moths on different host plants

Species	Host plants	Family	No. of larvae reared	Number survived	Per cent survival
Othreis materna (L.)	*Tinospora cordifolia*	Menispermaceae	25	25	100
	Cocculus hirsutus	Menispermaceae	25	0	0
	Tiliacora acuminata	Menispermaceae	25	0	0
	Diploclisia glaucescens	Menispermaceae	25	0	0
	Erythrina indica	Fabaceae	25	0	0
O. fullonia (Clerck)	*T. cordifolia*	Menispermaceae	25	25	100
	C. hirsutus	Menispermaceae	25	0	0
	T. acuminata	Menispermaceae	25	25	100
	D. glaucescens	Menispermaceae	25	25	100
	E. indica	Fabaceae	25	0	0
O. homaena (Hubner)	*T. cordifolia*	Menispermaceae	25	0	0
	C. hirsutus	Menispermaceae	25	25	100
	T. acuminata	Menispermaceae	25	25	100
	D. glaucescens	Menispermaceae	25	25	100
	E. indica	Fabaceae	25	0	0
Rhytia hypermnestra (Stoll)	*T. cordifolia*	Menispermaceae	25	25	100
	C. hirsutus	Menispermaceae	25	0	0
	E. indica	Fabaceae	25	0	0

Table 2. Proboscis dimensions of primary piercers of fruits

Species	Sex	Total length of proboscis (in mm)	Length of sclerotised tip (in mm)
		Mean ± SD	Mean ± SD
Othreis materna (L.)	Male	13.90 ± 0.84	1.21 ± 0.08
	Female	14.30 ± 0.86	1.27 ± 0.07
Othreis fullonia (Clerck)	Male	15.25 ± 0.53	1.34 ± 0.03
	Female	17.50 ± 0.70	1.49 ± 0.07
Othreis homaena (Hubner)	Male	13.40 ± 0.30	1.30 ± 0.03
	Female	14.70 ± 0.44	1.34 ± 0.05
Rhytia hypermnestra (Stoll)	Male	15.15 ± 0.26	1.27 ± 0.03
	Female	15.60 ± 0.14	1.34 ± 0.02

the biology of *O. fullonia* on *T. cordifolia*, *C. hirsutus*, *Anamirta cocculus* (L.), *T. acuminata* and *D. glaucescens*. Their findings are strong support to the present results.

Except *T. cordifolia* and *E. indica* the larvae of *O. homaena* reared on *C. hirsutus*, *T. acuminata* and *D. glaucescens* completed the life cycle (Table 1). The larval duration was lesser when reared on *C. hirsutus* than the *T. acuminata* and *D. glaucescens*. The larvae of *O. homaena* reared upto third instar on the *C. hirsutus* which were then transferred to *T. cordifolia* and *E. indica* were found failed to survive on them.

The neonate larvae of *R. hypermnestra* fed only on *T. cordifolia* with successful survivability but failed to feed on *C. hirsutus* and *E. indica* (Table 1). The late fourth instar after feeding upto third instar on *T. cordifolia* which were then transferred to *C. hirsutus* and *E. indica* also failed to survive. It shows that the *R. hypermnestra* are specific feeder, monophagous only on *T. cordifolia*. Fay and Halfpapp (1993) reported that the larvae of *R. hyperm nestra* fed only on the leaves of *T. smilacina* in Australia and *T. sinensis, Tinospora banzigeri* Forman and *Tinos pora crispa* (L.) in Thailand. Their findings confirm that the larvae of *R. hypermnestra* are monophagous, feeding only on the plants coming under the genus *Tinospora*. However, all the species tested on the *E. indica* were failed to feed on them indicating that the *E. indica* could not support the survival of larvae of fruit piercing moths.

Proboscis morphology of fruit piercing moths

Fruit piercing moths having sclerotised blades, serrations and erectile barbs at the tip of their proboscis which were used to group as primary piercers. The proboscis of male and female of *O. materna*, *O. fullonia, O. homaena* and *R. hypermnestra* had three sclerotised oblique blades with sharp edges, six erectile barbs arranged in two rows near the tip which was sharply pointed. Susainathan (1924b), Hattori (1969), Srivastava and Bogawat (1969), Banziger (1982) and Denton *et al.* (1999) provided evidence of the photographs of the proboscis of *Othreis* spp., *Adris* spp. and a few other prominent primary fruit piercers and they described the feeding mechanisms of fruit-piercers in detail.

The total length of the proboscis of *O. materna* measured 13.90 mm and the sclerotised tip was very short measuring 1.21mm in male whereas it was 14.30 and 1.27 mm in female, respectively (Table 2). Each sclerotised blade was found on the lateral side of proboscis and extending to the ventral side in a semicircular form on the outer surface of each stylet. When both stylets are held together the edges of blade coincide to form a continuous edge. The six erectile barbs were arranged in two rows (three barbs in one row) by the side of the three blades. The proboscis length of male *O. fullonia, O. homaena* and *R. hypermnestra* was measured to be 15.25, 13.40 and 15.15 mm, respectively whereas in female it was 17.50, 14.70, 15.60 mm. The sclerotised tip of male moth measured 1.34, 1.30 and 1.27 mm, respectively and in female it was 1.49 (*O. fullonia*), 1.34 mm (for both *O. homaena and R. hypermnestra*). In all the species the total length and sclerotised tip of proboscis were longer in female moths than the males. In the over all observations it is revealed that the length of proboscis with sclerotised tip was longer (17.50 mm and 1.49 mm, respectively) in the female of *O. fullonia*. Bhumannavar and Viraktamath (2001b) gave the detailed measurement on proboscis length and sclerotised tip of *Othreis* spp. and *R. hypermnestra*. They measured the total length of sclerotised tip of male *O. materna*, *O. fullonia*, *O. homaena* and *R. hypermnestra* were 13.88, 15.33, 13.44, 15.08 mm and 1.20, 1.37, 1.29, 1.26 mm, respectively whereas in female, it was 14.22, 17.72, 14.42, 15.58 mm and 1.28, 1.58, 1.33 mm (both *O. homaena* and *R. hypermnestra*) respectively. The results of the present investigation are in close conformity with the observations of Bhumannavar and Viraktamath (2001b). Proboscis morphology of *O. fullonia* and *O. materna* occurring at Guam, pacific islands were also documented by photographic presentation by Denton *et al*. (1999).

The feeding behaviour of fruit piercing moths was observed and the moths pierced the fruits with a forward and backward movement by twisting the head. By this movement the entire proboscis was inserted into the fruit and moved in all directions with the forward and backward movement thereby sucking the juice through food canal of the proboscis and by macerating the soft tissue around the point of insertion. Once drilled a hole it took nearly about 20-30 minutes to empty the contents around the point of insertion. If there is any disturbance during feeding the moth left the fruit without emptying the contents fully and made several holes to fulfill the feeding. The secondary fruit feeders do not possess the sclerotised structures and their proboscis are membranous with hairs and bristles incapable of piercing even soft skinned fruits.

The studies on larval host specificity of fruit piercing moths indicated that the Menispermaceae creepers were supported well for the survivability of the larvae, whereas presence of sclerotised blades and erectile barbs in the proboscis suggested that the moth can capable of piercing the hard skinned fruits. So, provision of physical barriers such as covering of orchards with nylon net during fruit ripening season can afford protection to some extend.

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