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First report, occurrence, biology, ecology and control of fig psylla *Homotoma indica* (Hemiptera: Homotomidae) from Kolhapur region, India

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ABSTRACT

Ficus carica Linnaeus is an important horticultural crop in India. _Homotoma indica_ sp. n. (Homotomidae: Hemiptera) is reported and described for the first time from India as a new pest of Fig _Ficus carica_ L. Its incidence was noticed from March to October on _F. carica_ with overlapping generations. Its life cycle was completed within 85 days. Both nymphs and adults caused inverted saucer shape to leaves by sucking cell sap and affected the crop yield adversely. The pest was predated by _Menochilus sexmaculatus_, lace wing, anthocorid bug and mirid bug and controlled by spraying the crop with 0.03 % Malathion / Azadirachtin or 0.02% phosphamidon.

Key words: _Ficus carica_, _Homotoma indica_, occurrence, description, biology, ecology, control.

Introduction

Ficus carica Linnaeus is one of the oldest known fruit. Its native is believed to be Asia Miner from which it has been spread to almost most of the part of the world (Butani, 1979). At present, the fig is extensively cultivated in California, USA, Europe and Afghanistan. However, in India, commercial cultivation of this crop is not yet well developed in spite of high demand to its dry fruits. The fruits of fig are nutritious food with high sugar content 45-50%, low in acid content and good source of vitamin –A (Hayes, 1966). Its high laxative properties are also known (Butani, 1979). It has been cultivated from Karnataka, Uttar Pradesh, Gujarat and Maharashtra on small scale. *F. carica* is attacked by more than 20 insect pests including sucking types.

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Homotoma indica sp. n. (Homoptera: Homotomidae) has been reported for the first time feeding on *F. carica* from Maharashtra, India. From India 2 species of psyllids, namely *Dinopsylla grandis* Crawford and *Pauropsylla depressa* Crawford have been reported by Butani (1979) on *F. carica*.

Review of literature indicates that, Psyllids have been studied by Bosslli (1929), Dobreanu & Manolache (1962), Butani (1979), Hodkinson & white (1979), Halperin *et al.* (1982), Hollis & Broomfield (1989), Burkhardt (1994), Amrine & Manson (1996), Burkhardt (2005, 2011), Sharma (2008), Sathe (2009), Jerinic –Prodanovic (2011), Sidhu *et al.* (2011) and Niranjanadevi & Ganapathy (2015). There are about 124 species of *Cacopsylla* described from the world (Burkhardt, 2011), some species of *Homotoma* (Psyllidae) have been reported on fig from Serbia.

Material and Methods

The nymphs and adults of *H. indica* were collected on anjeer *F. carica* fields during the morning hours 7.00 to 8.00 AM from geographically and climatically different regions of Kolhapur, India namely, Kolhapur, Radhanagari, Hatkanangale and Chandgad. The adults were collected from the host

plants with an aspirator, the larvae of different instars and eggs were collected together with leaves and fruits of *F. carica*. The collected insect material was fixed in 70% ethanol, later dehydrated with different grades of ethanol, cleaned in xylene and mounted in DPX or Canada balsam on slide. The slides of body parts like antenna, legs, wings, head, thorax and abdomen have been prepared. Measurements of body parts were taken in millimeter. The eggs and different instars of *H. indica* were collected along with leaves where they were laid and developmental period of eggs and different instars have been noted by spot observations. During the study period, 2014-2015 seasonal occurrence of different stages of life cycle with hibernating stage of *C. indica* were noted. Natural enemies like parasitoids and predators of Psyllids have also been noted by spot observation by one man one hour search method from the fields of Kolhapur. The sex ratio of psyllids have also been recorded by noting sexual character, ovipositor and abdomen body size. The crop was treated with 0.03% Malathion, 0.02% phosphamidon and 0.03% Azadirachtin and mortality was noted.

Results

Results recorded in the table 1 and 2 and figs. 1 to 10 indicated that *H. indica* has been noted first time from India. It is widely distributed in all study spots viz. Hatkanangale, Kolhapur, Radhanagari and Chandgad. However, their occurrence intensity was noted from high temperature and low rain fall study spots specially, Hatkanangale and Kolhapur.

In the field condition, eggs started hatching from mid-March. The first and second instar nymphs were found settled from under surface of young leaves from March to April- May. The third instars were noted in May and fourth in July. The infected leaves showed a shape of inverted saucer. The nymphs were found settled along the margins of veins of the leaves and started sucking the cell sap from tender leaves from under surface. Adults were also noted sucking the cell sap from the undersurface of the leaves by injecting beak into tender leaves. They secreted honey dew like substance and created sooty moulds on leaves which interfered with the respiration, photosynthesis, growth and finally the yield of the crop adversely. The fruits turn more soft, discolored and disfigured. The infected fruit showed darkening and necrosis which affected the quality and marketability of the fruits. Both nymphs and adults were found feeding on the cell sap from under side of leaves (Fig.-3). Specially, the nymphs were associated with veins in a very typical manner, in a row (Fig.-7).

The eggs over wintered on the terminal buds and lenticels of fig shoots from November to March. Eggs hatched in to nymphs in March or April. The nymphs showed five instars.

Figure-1. Map of India showing occurrence of *H. indica*

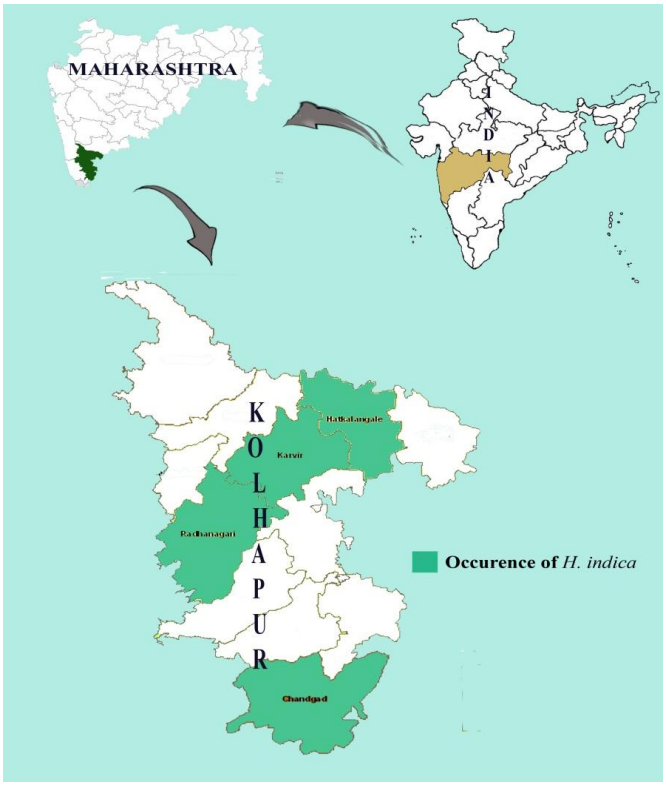


Table-1. Duration of instars of *H. indica* in fields on *F. carica*

Sr. no.	Nymph instar	Duration	Total time (days)
1.	Ist	15March-27 March	13
2.	IInd	27 March- 09 April	14
3.	IIIrd	10 April- 24 April	15
4.	IVth	25 April- 11 May	17
5.	Vth	11 May- 25 May	15

The duration and time required for development of each instars were recorded in table 1. However, mixed instars were noted on the crop, showing overlapping generations. The occurrence of *H. indica* nymphs in mixed instars on leaves of *F. carica* are noted in table 2.

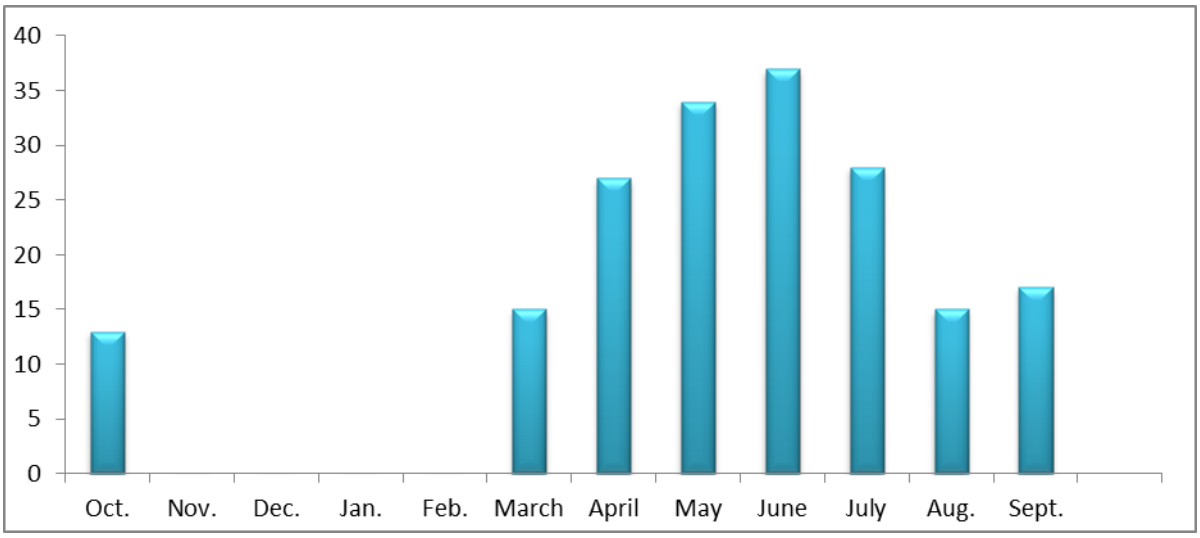
Diagnosis:

H. indica deposited oval shaped eggs in small groups on tender leaves or bud-shoots of *F. carica.* The eggs were light yellow in colour when freshly laid, later; they became darker at the time of hatching. Under favorable conditions eggs hatched within one week. In the field, adult female laid eggs

Table-2. Occurrence of *H. indica* on *F. carica*

Average no. of nymphs on single leaf											
Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug	Sept
13	-	-	-	-	15	27	34	37	28	15	17

Figure-2- Occurrence of *H. indica* on *F. carica*



on tender buds or leaves of *F. carica* either in September or October. There were five instars in the nymphal stage. The first instar nymph was slender bodied, light yellowish with bright red eyes and dark brown legs. In first, second, third and forth instar nymphs were with hairs and bristle like processes densely arranged on the back as like first instar. The thoracic part of nymph was much wider than abdomen. Abdomen was tapered. The body length and width of first, second, third, fourth and fifth instars were 0.7 mm and 0.11 mm, 1.7 mm and 0.22mm, 2.10 mm and 0.75 mm, 3.25 mm and 0.95 mm and 3.00 mm and 1.11 mm respectively. The nymphal stage lasted for 2.5 months and overlapping generations were noted in the field condition. Life cycle completed within 85 days at favorable condition.

Adult Female:

Body was light greenish yellow, 2.75 mm long and 1.00 mm broad. Antenna was not densely setose but with light colour and with three blackish bands. Terminal tip was with black band, similarly, third and fourth segments were with black bands. Antennal terminal segments contained two prominent setae and one lateral seta on penultimate segment, black banded segments were with short single seta on each side of segment. Antennae were without dense setae. Wings were slightly angulate towards apex and with membrane transparent. Veins were without dense hairs. Legs were with black spots on claws, basal basistarsus was blackish and with 2 spurs. Instars in general, were elongated and with abdomen tapered. Fifth instar was not roughly triangular but elongated hairy and with light green colour. Males measured for 2.50 mm long and 1.00 mm wide.

Figure-3- *C. carica* damaged leaves.

First instar was light yellow with brownish red eyes and with black band to anal tip and dark band on legs. The body was covered with densely arranged setae. Second to fourth instars were also

light green yellow coloured showing above features but larger in size. The fifth instar was with a pair of wing pads with relatively more green colour. Nymphal shape was not broadly triangular but more or less elongated. On the body and margins light coloured densely arranged setae were present. Antennal tip was black and pointed.

Figure-4- *C. carica* damaged fruits.

Figure-5. *H. indica* adult.

Figure-6. *H. indica* under Compound Microscope.

Figure-7. H. indica nymphs on leaf.

Remarks:

According to Hallis & Broom field (1989) *H. indica* resembles with *Homotoma ficus L*. by having following features:

i. Antennal tip with two prominent setae.
ii. Antennal tip black.
iii. Black spot on claw
iv. However, it differs from above species by having following characters,
    1. Antennae with three black bands including large terminal. (Only terminal black band present in *H. ficus*).

2. Antennae not densely hairy, single sita only on black banded segments of antenna (densely setose antenna was noted in *H. ficus*).
3. Wings less angulate at proximal than *H. ficus*.
4. Wings were less membranous than *H. ficus*.
5. Nymphs were more or less slender bodied in *H. indica* while in *H. ficus* fifth instar was more or less triangular in shape.

Figure-8. H. indica nymph (5th instar) under Microscope

Figure-9. Ant with *H. indica* nymphs

Figure-10. *M. sexmaculatus* (predater)

Control measures:

Preventive control:

Collection and destruction of nymphs and adults from infected leaves of *F. carica.*

Biological control:

1. Young instars of *H. indica* were predated by a lady bird beetle *Menochilus sexmaculatus* (Coleoptera: Coccinellidae).
2. First and second instars were predated by lace wings.
3. Nymphs of *H. indica* were predated by Anthocotid bug and mirid bug.

Chemical control:

H. indica nymphs and adults were controlled by spraying the crop with 0.03% Malathion or o.02% Phosphamidon or 0.03% Azadirachtin.

Discussion

Several workers (Boselli, 1929; Loginova, 1968; Burckhardt, 1994; Gencer et al., 2007) reported that *Homotoma ficus* (L). completed only one generation during the year and over winters in the egg stage on host plant. From the region of Crimea, Longinova (1968) reported that the larvae start hatching at the beginning of April and adults emerged in mid-June while, in costal part of Georgia the development of *H. ficus* was about two weeks later. However, from the Montpellier region of France, larvae hatched from the eggs during February and March. But, in the Turkey the larvae hatched at the beginning of April and eclosion of adults occurred in May (Jencer *et al*.,

2007). In the present study eggs hatched in March and nymph were noticed from March or April.

According to Longinova (1968) the adults of *H. ficus* stayed on fig crop for about 7 to 10 days after eclosion and then migrated to other crops especially conifers, Oak, Horse-chestnut, hawthorn and date. However, Gencer *et al*., (2007) reported adults on fig from May until the end of September in Turkey and egg laying was noted in October. No migration of *H. indica* to other crops was noted in Kolhapur region of India.

H. ficus was originally distributed in the Mediterranean region and the Middle East. However, it was introduced together with its host plant in other countries outside the original distributional range. It has been reported from Great Britain (Hodkinson and White, 1979), Switzerland (Buvekhardt and Muhlethaler, 2003), costal region of Slovenia, Croatia and Montengro (Seljak, 2006), U.S. A., California (Gencer *et al.,* 2007) and region of Belgrade and Movisad in Serbia (Jerinic-prodanovic, 2011).

According to Hollis (2004) Homotomidae is one of the smaller families of Psylloidea which includes about 80 species feeding on the plants of Moraceae and mainly the genus *Ficus* (Hollis and Broom freld, 1989). *H. ficus* was reported feeding on *F. carica* from warm regions of western Palaercic (Burckhardt, 2011).

According to Sutton (1984) *Cacopsylla peregrena* (Foerster) (Psyllidae) was univoltine and over wintered in a stage in bark crevices of hawthorn branches. The nymphs of which hatched in spring and settled on buds and then migrated to tender and expending leaves near the shoot apices. Lal (1934) recorded several species of *Crataegus* as hosts on which the pest developed successfully from egg to adult. The prominent species he recorded were *C. laevigata* (Poir) and *C. monogyna* Jacq., the latter was common in British Hedgerows. Although psyllid developed only on *Crataegus* species, the tendency of adult to disperse to other trees resulted in erroneous conclusions regarding host plant relationships (Lautrer, 1976).

The colonization preference and population trends of larval fig psylla *H. ficus* were studied in the Bursa, north western Turkey, from March 2000 to July 2001 by Gencer *et al*., (2007). They reported that *H. ficus* over wintered in egg stage on terminal buds and lenticels of shoots. Larval emergence occurred on 30th and 11th March 2000 and 2001, respectively. Degree- day (DD) accumulation since 1st January indicates that the emergence of first larvae averaged 47 DD based on the larval developmental threshold of 10.9^{0}C. Although the population trends of *H. ficus* larvae were affected by temperature and rainfall, there was only significant relationship between larval abundance and temperature. The first instar larvae significantly preferred the bottom and the inside stipule of leaves. The second instar larvae distributed not only on expanding green tissue but also on both the upper and lower surface of leaves corresponding to the fig bud development period. Third and fourth instar colonized significantly greater on the bottom of leaves compared with the stipule and upper surface. They noted a significant linear relationship with fig phenology and cumulative larval counts.

The emergence and development of larvae were synchronized with the phenology of host plant as in other univoltine insect or psyllid species such as *Euphyllura phillyreae, Haplocampa flava* (L.), *Rhagoletis cerasi* L. and *Arytainilla spartiophila* (Foerst) (Kovanchi *et al*., 2000). Moreover the population fluctuation of other psyllid species, *Hereropsylla cubana*, was related to tree growth cycle (Geiger and Gutierre, 2000). The emergence of *H. ficus* larvae was found to be highly correlated to fig phenology. Therefore, the timing of the larval emergence in the field can be predicted with high degree of accuracy using a linear fig phenology observation model.

According to Hall *et al*., (2012) the Asian citrus psyllid *Diaphorina citri* Kuwayama (Psyllidae) is an important pest of citrus which transmits phloem-limited bacteria (*Candidatus* Liberibacter group) strongly implicated in huanglongbing (HLB; citrus greening disease) which is world's most serious disease of citrus. The role of *H. ficus* as vector for viral disease is not studied up to date.

Nutritional resource manipulation is typical in insect plant gall interactions in psyllids. Galls as a physiological sinks providing insects with essential nutrients needed for their growth and development. The first instar nymphs of *Pauropsylla depressa* Crawford (Psyllidae) initiated gall formation on *Ficus glomerata* Roxb. during its feeding stage for secreting saliva rich in proteins and lytic enzymes (Dsouza and Ravishankar, 2014). The present form *H. indica* is cell sap sucker and there is no record of formation of gall by this insect. Butani (1979) reported two psyllids namely, *D. grandis* and *P. depressa* on *F. carica* from India as leaf gall formers. However, from Kolhapur region no leaf gall forming psyllid was recorded. Mangat and Sing (1960) studied the biology and control of citrus psylla *D. citri* wherein they reported 4-20 days egg hatching period and nymphal period was 10-36 days depending on climatic conditions. According to Atwal (1976) *D. citri* was distributed throughout the oriental region and recorded on all species of citrus as most destructive psyllids and also reported on number of other plants of the family Rutaceae.

Control of insect pests on horticultural crops with the help of pesticides is not without danger (Sathe, 2004, 2009, 2014, Sathe *et al.,* 2014). Therefore, judicious use of pesticides is the need of the day (Sathe, 2003) Natural, ecological and biological control strategies are very good options for pest management as ecofriendly measure (Sathe 2015; Sathe and Oulkar 2013, Sathe *et al*. 2014, 2015). In the present study, four species of natural enemies have been reported. Their mass propagation and use against *H. indica* will add great relevance in pest management. However, the pesticides 0.03% Malathion, 0.02% phoshamidon and 0.03% Azadirachtin suggested in the text would prove worth for control of *H. indica.*

According to Qureshi and Stansly (2010) a single round of spray chloropyriphos (2.8 Kg a. i. ha) reduced adult *D. citri* 10 folds over six months compare to untreated trees while, Dadmal *et al*., (2002) recorded highest mortality of citrus psylla by using dimethoate on citrus crop. The highest mortality in psyllids by chloropyriphos was due to its residual effect, contact action and more penetration potential in to the plant tissues and subsequent translaminar action (Sharma, 2008). The increase in fruit yield was noted by increased doses of chloropyriphos 20 E C. and tryzophos NOEC 0.06% (Sidhu *et al*., 2011).

In the present study 0.03% Malathion, 0.03% Azadirachtin, 0.02% phosphamidon were used and found suitable. Azadirachtin acted as antifeedant and ecofriendly for controlling *H. indica.*

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Conflict of Interests:

The authors declare that there is no conflict of interests regarding the publication of this paper.

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