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A new report of the myrmecophilous root mealy bug *Xenococcus annandalei* Silvestri (Rhizoecidae: Hemiptera) - a devastating pest

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ABSTRACT: The obligate myrmecophilous root mealybug *Xenococcus annandalei* Silvestri belonging to the family Rhizoecidae and order Hemiptera was recorded on tender roots of a wide range of economically important crop plants and weeds at Idukki, Kerala, India. This is a new distributional report of the pest from South India. Both nymphs and adults are seen congregating the roots and rootlets and suck sap. Ant species *Acropyga acutiventris* Roger was always seen in association with these mealy bugs and helps in the spread of mealy bugs to the healthy plants. Ant nests are seen inside the soil and inside these nests mealy bugs are also seen. The present study identifies the mealybug and the associated ant. Host plants including crops and weed plants are described here. The cryptic habitat of the pest and its association with ants demands detailed examination of the planting materials along with correct management strategies so as to prevent the migration of the pest to other pest free area of the country.
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KEY WORDS: Root mealy bug, *Xenococcus annandalei*, *Acropyga acutiventris*, myremecophilous, host plants

INTRODUCTION

Mealybugs are major pests and vectors of many diseases of crop plants. They cause damage by sucking plant sap, by injection of toxins as well as exudation of honey dew resulting in sooty mould formation and reduction in photosynthesis. Among mealybugs, root mealybugs suck sap from the roots and rootlets of host plants resulting in slow growth, stunting, yellowing, lack of vigor and subsequently death of plants. These pests are often found in association with ants. Honey dew secreted by mealybugs is a rich source of nutrient for ants. The ants in turn protect the mealybugs from their natural enemies.

Most of the members of the family Rhizoecidae suck sap from the plant rootlets (Williams 1998), inhabit the soil, leaf litter or rotting logs and are frequently associated with ants. The members of this family were previously included in Pseudococcidae, and recently separated based on the morphology of adult males (Hodgson 2012), molecular sequences (Downie and Gullan 2004 and 2005) and endosymbionts (Gruwell *et al*., 2010). Two sub families, Rhizoecinae Williams and

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Xenococcinae Tang are included under this family. Tang (1992), divided Rhizoecinae into two tribes, Rhizoecini with the hypogaeic mealybugs and Xenococcini with the hypogaeic obligate myrmecophilous mealybugs which feed on the phloem of plant roots. These ant loving mealybugs exhibit a close symbiotic relationship with ants (trophobiosis) where ants give protection to mealybugs from predators and parasitoids and mealybugs in turn provide honey dew secretion which is a rich nutritive source for ants (Scott *et al*., 2011).

The root mealybug *Xenococcus annandalei* Silvestri was first reported from Barkuda Island in Odisha, India, during 1924, infesting roots of coconut palms *Cocos nucifera* L. and *Ficus obtusa* Hassk. and associated with the ant, *Acropyga acutiventris* (Silvestri 1924). First instar of *X. annandalei* collected from the roots of coconut was reported from Mysore in 1937 (William, 1978). Later Rajagopal *et al*. (1997) reported the occurrence of *X. annandalei*, severely infesting roots and rootlets of grapes at Bangalore. Apart from grape vine *X. annandalei* was also reported from roots of *Oxalis latifolia* Kunth., *Euphorbia hirta* L., *Blepharis mollinginifolia* Pers. and *Ageratum conyzoides* L. growing as weeds in the grape gardens. Williams (1998) stated that the previous reports of *X. annandalei* were based on a misconception and he reported that the specimens were actually *X. acropygae*. According to him the type species *X. annandalei* appears to be a local species confining only on Barkuda Island, Odisha, India. The pest was also reported from other parts of the world like Queensland and Northern Territory of Australia (Ben Dov, 1994), Papua New Guinea (Ben Dov, 1994, Williams and Watson, 1988), Hong Kong (Ben Dov, 1994, Williams, 1978), Malaysia (Ben Dov, 1994, Williams, 1978) and Vietnam (Ben Dov, 1994, Danzig, 1993). The pest has now been recorded in Kerala, South India, in Idukki district. The present study was under taken to identify the pest and the ant species associated with the crop plants and to gather information on the alternate host plants harbouring this pest.

MATERIALS AND METHODS

Mealybug specimens were collected during a visit to a farmer's field at Mannakkudi (6.796003^{0}N 77.126545^{0}E), during July 2012. About 50 cents of area was infested by the mealybugs. These mealybugs were always seen in association with ants. The field was a mixed plantation of clove (*Syzygium aromaticum* (L.) Merrill & Perry), cardamom (*Elettaria cardamomum* (L) Maton), coffee (*Coffea arabica* L.), turmeric (*Curcuma longa* L.) and ginger (*Zingiber officinale* Roscoe.). Mealybug samples along with ants were collected from the root zone of plants showing yellowing and wilting symptoms. Mealybug colonies were also obtained from the ant nests. Both the mealybugs and the ants were preserved separately in 70 per cent ethanol for further identification. Mealybug samples were sent to National Bureau of Agricultural Insect Resources, Bengaluru (NBAIR) and the ant specimens were sent to the Department of Entomology, University of Agricultural Sciences (UAS), Gandhi Krishi Vigyan Kendra (GKVK) Campus, Bengaluru for identification. Subsequent field visits were also made to Nedumkandam (9.8363^{0}N 77.1571^{0}E), Thannimoodu (9.828708^{0}N 77.171930^{0}E), Thopramkudi (9.8763^{0}N 77.0566^{0}E), Upputhara (9.6969^{0}N 77.0208^{0}E), Nathukallu (9.7870^{0}N 77.1087^{0}E) and Ettakkanam (9.698170^{0}N 77.019037^{0}E) areas of Idukki district to know the extent of infestation and also to gather information on the crop plants and weed plants harbouring the pest.

RESULTS AND DISCUSSION

The mealybug was identified as *Xenococcus annandalei* Silvestri by Dr. Sunil Joshi, Principal Scientist, NBAIR, Bengaluru and the voucher specimens were deposited at the Bureau. The present finding is the first report of the occurrence of *X. annandalei* in Idukki district of Kerala (Plate Ia). The pest was first observed at Mannakkudi and subsequently from Nedunkandam, Thannimoodu, Thopramkudi, Upputhara, Nathukallukallu and Ettakkanam regions in Idukki

PLATE I

a. Xenococcus annandalei close up view

b. Yellowing and wilting in *Laportia interrupta*

c. Root mealybug on jack root

district. At Mannakkudi, infested field was a mixed plantation of clove, cardamom, coffee, ginger and turmeric. The main weed species was Hen's nettle, *Laportea interrupta* L. Initial symptoms of yellowing and wilting was observed in some plants of ginger, cardamom, turmeric and also on the weed plant *L. interrupta* (Plate Ib). Shedding of leaves and drying was observed in infested plants of clove. A dense population of mealy bugs and ants were observed on the root zone of jack tree, *Artocarpus heterophyllus* Lam (Plate Ic), but symptom of infestation was not observed. Severely infested fields were observed in Thannimoodu, Thopramkudi, Upputhara and Nathukallu and Ettakkanam regions. Banana plants, *Musa* spp. at Thannimoodu showed drying of leaves and stunted growth (Plate IIa). Severe infestation of mealybugs resulted in shedding of leaves and complete drying of plants and these symptoms were observed in black pepper vines (*Piper nigrum* L.) (Plate IIb), tea (*Camellia sinensis* (L.) Kuntze) (Plate IIc), coffee, clove and cardamom. In cardamom, complete drying of the clumps were also observed (Plate IId). Severely infested field gave a sick appearance (Plate IIe) with completely dried plants of crops, weeds and even trees like clove, coral tree a popular standard of black pepper (*Erythrina indica* L.), wild jack (*Artocarpus hirsutus* Lam.) and nut meg (*Myristica fragrans* Houtt.), Congregation of both adults and nymphs of the root mealybug *X. annandalei* along with ants was observed on the roots and root lets of the affected plants.

Immature stages of *X. annandalei* are white in colour and the matured ones are cream coloured and these mealy bugs are always seen in association with ants. The ants were cryptic in habitat and identified as *Acropyga acutiventris* Roger by Department of Entomology, GKVK, Bengaluru. The ant nests are seen inside the soil from a depth of 5-20 cm. Exit holes with loose soil give an indication of the ant nest (Plate IIIa) and these ant nests had tunnels and chambers. The ant nest tunnels moved along the root system of host plants where more population of ants and mealy bugs can be seen. Ant colonies are densely distributed near the root zone of host plants. If there is any disturbance or food is exhausted, the ant will keep the mealybugs in between its mandibles and helps to migrate to more safer places or new healthy plants (Plate IIIb). Honey dew exudation by the mealybugs were also observed in the present study (Plate IIIc).

PLATE II

a. Root mealy bug infested banana

b. Completely dried black pepper

c. Completely dried tea plant

d. Completely dried clump of cardamom

e. Severely infested field

The present study identifies the presence of a devastating root mealy bug and the associated ant from the moist evergreen forests of Idukki district and these findings are in conformity with the findings of Anu and Sabu, 2007 where they reported the presence of the ant *Acropyga* sp. in the moist evergreen forests of Wayanad district. Biodiversity analysis of the litter ant assemblages in the Wayanad district was done in this study and they confirmed that the ant *Acropyga* sp. is present only in

PLATE III

a. Ant nest with exit hole

b. Ant carrying mealy bug in between mandibles

c. Honey dew exudation by *X. annandalei*

evergreen moist forest. There was no indication of the mealy bug species associated with the ant species. Earlier *X. annandalei* was reported only on two host plants (roots of coconut palms *C. nucifera* and *F. obtusa*) and was not a pest of economic importance (Silvestri 1924). This is the first report in which these insects are observed in a wide range of host plants.

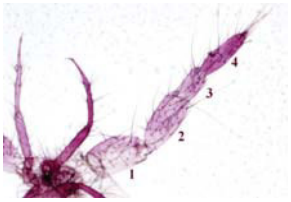
Diagnosis:

Adult females are 1.342 to 1.410 mm long and 0.576 to 0.615 mm broad. Body is broadly oval, with abdomen tapering (Plate IVa). Anal lobes not developed; positions of each lobe recognisable by inner ventral grooves, each apparent lobe with two long ventral setae and one long dorsal seta, forming a group of three. Anal ring formed of a crescentic sclerotized dorsal band without cells, bearing eight setae, each seta about as long as an anal lobe seta; anterior two pairs slender, posterior two pairs stout; posterior most pair of setae transferred to ventral surface. Antennae each four segmented, situated slightly onto dorsal surface, tapering, each about as long as body; articulation between first and second segments well developed, allowing each antenna to fold onto dorsum of body (Plate IVb). Legs well developed, each hind tarsus tapering to long slender claw (Plate IVc). Circuli round, each cupped in centre, two or three present in middle of each of abdominal segments II and III respectively, and sometimes a circulus present in middle of abdominal segment IV (Plate IVd). Body setae present on dorsum and lateral areas of thorax and are minute, slender and abundant. Setae on other areas of body are mostly long and stout. Sickle-shaped setae usually present, at least on thorax (Plate IVe), rarely absent. Eyes and ostioles absent. Pores and ducts absent.

Antenna well defined and the abdomen of the female tapers abruptly and kept in erect position. A special articulation is found in between the enlarged first and second antennal segments and hence the antennae can be folded back along the body. Instead of the mealy wax which is present on most of the mealybugs minute setae is found covering the abdomen. The legs are well developed and the insects move actively. These descriptions are in conformity with the findings of Williams (1978 and 1998).

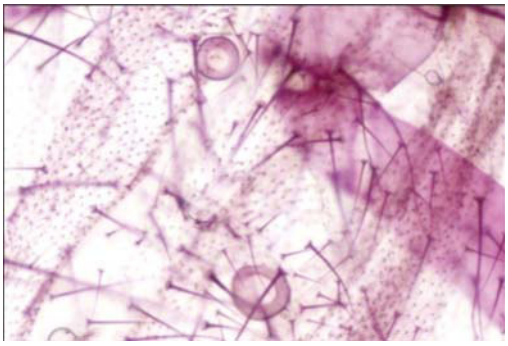
PLATE IV

a. Adult female *X. annadale*

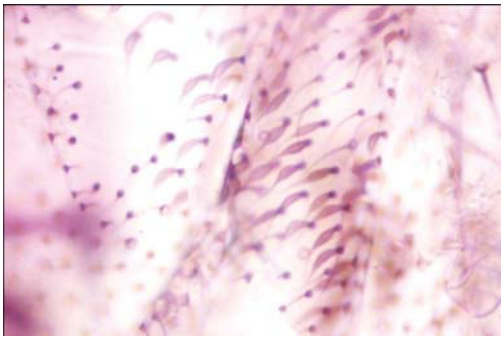


b. Antenna

c. Hind leg



d. Circuli



e. Sickle shaped setae on thorax

The mealybugs were attended by the ant, *A. acutiventris* that formed a mutualistic relationship with *X. annandalei*. The ants of the genus *Acropyga* are all hypogaeic (living entirely underground) and have a mutualistic relationship with root mealybugs (Weber 1944, Williams 1998). The ants help in transport of mealybugs from one place to another and also protect them from natural enemies. Honey dew excreted by the mealybugs is a rich nutrient source to ants.

Nature and extent of damage:

The pest was observed in a wide array of host plants belonging to 14 families and 18 species of which 17 species are new hosts. Economically important crop plants like cardamom (*E. cardamomum*, Zingiberaceae), black pepper (*P. nigrum*, Piperaceae), coffee (*C. arabica*, Rubiaceae), cocoa (*Theobroma cacao* L., Malvaceae), tea (*C. sinensis*, Theaceae), nutmeg (*M. fragrans*, Myristicaceae), banana (*M.* spp., Musaceae), wild jack (*A. hirsutus*, Moraceae), jack tree (*A. heterophyllus*, Moraceae), ginger (*Z. officianale*, Zingiberaceae), turmeric (*C. longa*, Zingiberaceae) and mango (*Mangifera indica* L., Anacardiaceae) were infested with these mealybugs. Yellowing followed by wilting was the general symptom observed on these plants; severe infestations led to complete drying of plants. The infestation was also observed on coral tree (*E. indica*, Fabaceae), garden croton (*Codiaeum variegatum*. L., Euphorbiaceae) and also weed plants like hen's nettle (*L. interrupta* L., Urticaceae), black night shade (*Solanum nigrum* L., Solanaceae), Ficus (*F. obtusa* Euphorbiaceae) and coat buttons (*Tridax procumbens* L., Asteraceae). During the rainy season high population of mealybugs were seen on the upper soil layers (5-15 cm depth) and during cold and dry weather the pest was generally seen in the deep layers of soil (up to 60 cm depth). The cryptic habitat of the pest and its association with ants warrants thorough examination of planting materials along with proper management measures in order to prevent the spread of the pest to other pest free zones of the country. Systematic monitoring of the crop fields is highly essential to diagnose the problem in the early stage itself. Since

the pest is in a highly protective environment and its association with ants makes the pest management more challenging. As the pest is polyphagous causing extensive damage, integrated pest management strategies are to be developed for the management of the pest.

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