First report of *Phenacoccus saccharifolii* (Green) (Pseudococcidae: Hemiptera) on sugarcane in Tamil Nadu, India

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First report of *Phenacoccus saccharifolii* (Green) (Pseudococcidae: Hemiptera) on sugarcane in Tamil Nadu, India

**Abstract**

This is the first report of *Phenacoccus saccharifolii* (Green) on sugarcane in Tamil Nadu, though an earlier unreported isolated occurrence was observed by this team in the farmers’ fields at Pugalur, Tamil Nadu. It has now become a major threat to sugarcane cultivation across the State as the pest could often kill the infested canes either with or without the association of the fungal disease, *pokkah boeng*. Field observations revealed that the ratoon crop suffers more than that of the plant crop in the same locality. This species was found in large colonies, primarily between the -2 and the +1 leaf of the sugarcane plant, and hence, named as crown mealybug. Infestation leads to severe mottling in leaf whorl and death of central shoot. Furthermore, this is the first report of the occurrence of this mealybug on *Saccharum spontaneum* L., in the world. Well-developed colonies showed high activity of three encyrtid parasitoids viz., *Aenasius phenococci* (Ashmead), *Aenasius arizonensis* (Girault) and *Leptomastix dactylopii* Howard in the areas surveyed.

**Keywords:** Sugarcane, *Saccharum spontaneum*, mealybug, *pokkah boeng*, *Phenacoccus saccharifolii*
Introduction

Sugarcane, a long duration crop of 12-14 months and sometimes cultivated as a crop of 18 months (Adsali) in certain locations, is obviously subjected to the climatic vagaries across the seasons. At least 220 species of pests occur on sugarcane at different growth stages with their pest status dependant on agro-climatic zones. In India, the high incidence of insect pests and diseases is a critical issue in achieving higher sugarcane production. Though in general, cane borers and root grubs are significantly destructive, sucking pests are sporadic, seldom a problem of serious consequence necessitating neither intense monitoring nor alacritous management. Their damage is often viewed as a corollary of either climatic vagary or poor crop husbandry and rarely of both.

However, lately, sucking pests have undergone a major shift in pest status in sugarcane. Reports of change from minor to major pest status and occurrence in newer, previously unknown areas of incidence are on the rise. For example, the invasion of southern India by woolly aphid Ceratovacuna lanigera Zehtner in substantial scale and subsequent serious losses in 2004-2012 was in contrast to the innocuous status the pest had previously displayed in its native state West Bengal. Likewise, recently Phenacoccus saccharifolii (Green), a mealybug affecting the crown region of the sugarcane has made its appearance in newer areas of sugarcane cultivation. Of the six mealybug species infesting sugarcane in India, only Saccharicoccus sacchari (Cockerell) and Kiritshenkella sacchari (Green) are more common than Pseudococcus saccharicola Takahasi, Antonina graminis (Maskell), Dysmicoccus carens Williams and P. saccharifolii. But recently P. saccharifolii has emerged in devastating proportions in Tamil Nadu, where it has never been previously reported. Several species of Phenacoccus have recently either been recorded as invasive mealybugs in
India often expanding host range or area within the country or assumed to have reached serious proportions than its status in earlier records. Examples of such a phenomenon on other crops include *Phenacoccus solenopsis* Tinnsley on cotton, jute, cashew and other crops, *Phenacoccus madeirensis* Green on cotton, *Phenacoccus parvus* Morrison on Naga King Chili, China aster and *Phenacoccus manihoti* on cassava.

*Phenacoccus saccharifolii* was observed on sugarcane (*Saccharum spp.* hybrid cv Co 06022) plants for the first time in India, Tamil Nadu, Pugalur at 11° 04′ 26.43″ N and 78° 01′ 15.41″ E, as an isolated case in a single field and later in Coimbatore, Veerakeralam, Sugarcane Breeding Institute in pot culture and fields (cv. Co 86032) at 11° 0′ 21″ N and 76° 55′ 6″ E and 11°0′19″ N and 76°55′2″ E. Specimens were sent for identification from the Coimbatore collection, as these mealybugs were hitherto not observed on sugarcane in Tamil Nadu. Immediately thereafter, news a new mealybug infestation arrived from other parts of Tamil Nadu and surveys by the team from ICAR-SBI were undertaken. This paper discusses the outcome of studies on the mealybug at ICAR-SBI as well as the surveys carried out in commercial plantations.

**Materials and methods**

**Surveys**

Two surveys were carried out in villages of Tamil Nadu to assess the type, extent and causes of the mealybug outbreak. The first field survey was conducted in July 2021 in the sugarcane belt under the aegis of M/s. Salem Co-Operative Sugar Mills, Mohanur and the second one was in September 2021 in the area earmarked for Kothari Sugars (Kattur and Sathamangalam). Percent incidence was assessed in one of the surveys, based on the number
of clumps affected among 100 clumps sampled as 10 clumps each at 10 different spots. Damage was further assessed on a scale of 1-4 with any two of the conditions fulfilled.

Grade 1. Bare infestation: few mealybugs in the leaf blade; no mottling; one tiller or cane in a clump affected.

Grade 2. Visible infestation: no mottling; infestation in less than 25% of leaf length in the sampled leaf; scarce sooty mould; infestation in at least 25% of the total number of tillers or canes in a clump.

Grade 3. Prominent infestation: severe mottling; heavy sooty mould; 50% of leaf length occupied in the sampled leaf; 50% of total number of tillers or canes in a clump.

Grade 4. Population peak: leaf drying; heavy sooty mould; dead heart; aerial sprouting; 75% or more of the at least one leaf or leaf sheath is occupied by the colonies; infestation in 75% or more of the total number of tillers or canes in a clump.

In the pot culture of Co 86032, the initial population was observed. The specimens of the colony were packed in 70% alcohol and were sent for identification to ICAR-NBAIR, Bengaluru and TNAU, Coimbatore. The colonies were observed for their growth and development without any intervention. Samples were drawn at periodic intervals to observe the eggs, nymphs, male cocoons, and adults as well as natural enemies. The specimens were observed under microscope in the laboratory to collect details about the microscopic features. Damage potential, the pattern of colony spread and symptoms were observed. Activity of the predators on the mealybug was monitored. Regular incubation of infested leaves to observe parasitoid emergence and observations to note the predator activity were carried out periodically. The parasitoids and predators were identified by the authors based on the bibliographical survey\textsuperscript{15-22} and by comparison of pictures at the websites of research institutes.
and images in several research publications. Ant activity and other behavioural aspects of the colony were observed. The colony characters were observed in infested plants in pot culture and research farm in ICAR-SBI, Coimbatore. Data on the percent incidence on \textit{S. spontaneum} and \textit{Erianthus arundinaceus} clones that were maintained at ICAR-SBI were also recorded.

\textit{Observations in the laboratory:}

Specimens from the field were transferred onto 20 day old seedlings of sugarcane for observation on nymphs and adults. Studies on mating were made by rearing mature female on a sugarcane leaf bit in a cavity block or 5 ml capacity eppendorf tube or on 20-days old potted plants (Figure 1a-1f) and frequency of mating was observed by allowing unmated single male either once or multiple times. The colonies on leaves harvested from the field were observed under the microscope (Carl Zeiss Stemi SV 6) to study the morphological features of the nymphs and adults. The ovisacs were teased and observed for the eggs under the microscope. Photographs on morphological details of the mealybugs were obtained from a scanning electron microscope (FEI Quarta 250, Everhart Thornley Detector) with a tungsten heated filament under low vacuum and through slides made of the mealybug.

\textbf{Results and discussion}

\textbf{Identification}

The mealybug collected from ICAR-SBI was identified as \textit{Phenacoccus saccharifolii} (Green) from ICAR-NBAIR, Bengaluru and confirmed from TNAU, Coimbatore.

\textit{Outcome of surveys}

\textit{Mealy bug occurrence}
During the field surveys, irregular distribution of the mealybug was observed. Infestation based on the clumps was 10-40% of the sampled clumps. The scale of infestation as judged through the methodology mentioned was found to vary in the range of 1-4 with an average of 3.1 grading in the first survey done in July 2021.

In a field survey conducted during July 2021 in the sugarcane belt of Mohanur in the villages of Kidaram (11.0494° N, 78.1782° E), Kattuputhur (10.9961° N, 78.2163° E), Pettapalayam (11.0711° N, 78.1272° E), Muthur (11.0444° N, 77.7352° E), Periyakarasapalayam (10.7748° N, 77.3131° E) and Ellaimedu (11.0970° N, 78.0541° E) concomitant occurrence of the mealybug and pokkah boeng was observed in Kidaram on Co 0212, CoC 24, in Kattuputhur on Co 06022, in Pettapalayam on Co 06022 in ratoon crops. Heavy bud sprouting and restricted terminal growth were observed. In Kattuputhur, a plant crop of Co 11015 in an area of 2.5 acres was free of mealybug infestation. It could be observed that a ratoon crop of CoM 265 in Muthur, a ratoon crop of Co 06022 at Periyakarasapalayam, and a plant crop of Co 06022 were free of P. saccharifolii incidence due to insecticidal application.

Subsequent field surveys conducted during September 2021 in the area of Kattur and Sathamangalam of Tamil Nadu in 17 different fields located in the villages of Valadi (10.8763° N, 78.7575° E), Kothamangalam (10.0603° N, 76.6352° E), Mettupatti (11.6648° N, 78.3117° E), Alangudimahajanam (10.3611° N, 78.9796° E), Kattur (10.7930° N, 78.7445° E), Poovalur (10.9612° N, 79.6600° E), Peruvalanallur (10.9207° N, 78.8408° E), Aalampadi (11.4653° N, 79.6141° E), Annimangalam (11.3262° N, 78.7944° E), Thirumalapadi (10.9010° N, 79.0546° E) with the varieties CoV 09356 (Ratoon), Co 86032 (I Ratoon), Co 06022 (I Ratoon), Co 06022 (III Ratoon), Co 86032 (Plant crop), Co 11015 (Plant crop), Co 06022 (I Ratoon), Co 09356 (I Ratoon), Co 86032 (Plant crop), CoV 09356 (III Ratoon), Co 06022 (I Ratoon), CoV 92102 (I
Ratoon), CoV 92102 (III Ratoon), Co 0630 (I Ratoon), CoG 7 (Plant) Co 0212 (I Ratoon), Co 11015 (Plant), CoV 92102 (IV Ratoon), Co 11015 (Plant) also showed differential infestation levels of the mealybugs and *pokkah boeng*.

**Nature of infestation as influenced by management**

In general, ratoon crops suffered mealybug incidence higher than the plant crop and occasionally mealybug infestation and *pokkah boeng* i.e., in four out of 17 (23.59% probability) fields had combined plague of the pest and the disease, compounding the damage. The varieties Co 06022 and CoV 09356 (ratoons) had shown an alarming level of mealybug and *pokkah boeng* incidences. The infestation seemed to be fortuitous than by fortitude as the fields adjacent (PI 1110) to critically infested fields (CoV 09356) were noted to have escaped the mealybug infestation. The variety CoG 6 had suffered extreme damage by the coalition of mealybug and *pokkah boeng*. Severe incidence of the pest was also noticed in some of the farmers’ fields with the popular variety Co 86032 (Figure 2). Both crop stunting due to mealybug infestation as well as crop recovery due to application of control measures, usually an insecticide and sometimes by applying a fungicide in addition, could be seen. In some fields, prophylactic insecticidal sprays had also protected the crop from the onslaught of the pest.

**Incidence and nature of infestation on a new host, *S. spontaneum***

Based on the literature survey, it could be ascertained that this species, *P. saccharifolii* has never been recorded in Tamil Nadu in either *S. officinarum, S. spontaneum* or *E. arundinaceus*. During this study, its infestation on *S. officinarum* cultivars as well as *S. spontaneum* clones could be confirmed for the first time in Tamil Nadu (Figure 3) (Table 1). Of the total 25 genotypes of *S. spontaneum* observed, 11 genotypes were free of *P. saccharifolii* incidence.
The infestation ranged from nil to 64.29% (IND-21-2062) with a mean incidence of 17.99. Grading was found to be from nil to 3 (IND-21-2066) with an average grading of 1.18. Honeydew secretion was minimal and ant activity was nil. Parasitoid activity was sporadic. No incidence was observed on the *S. spontaneum* lines IND-21-2069, IND-21-2071, IND-21-2072, IND-21-2073, IND-21-2074, IND-21-2075, IND-21-2076, IND-21-2077, IND-21-2078 and IND-21-2081. Three clones of *E. arundinaceus* (IND-21-2061, IND-21-2608 and IND-21-2087) despite being in the vicinity of *S. officinarum* clones decimated by *P. saccharifolii* and low infestation on *S. spontaneum* clones, did not harbour the population.

It was interesting to note that there was no incidence of *P. saccharifolii* in *S. spontaneum* plants infested with other species of mealybugs. Further, unlike *S. officinarum* cultivars, no co-existence of other pests viz., aphids was noticed. It was interesting to note that *P. saccharifolii* was observed on *E. arundinaceus* in Andhra Pradesh which could not be observed in the present scenario. This is the first record of *P. saccharifolii* on *S. spontaneum* as there are only records of this pest on *E. arundinaceus*\(^23\) and *Sorghum halepense*\(^24\) as its hosts other than sugarcane *S. officinarum*\(^25\). It has been found in Andhra Pradesh\(^26\), Bihar\(^{24,25,27}\), Karnataka\(^26\), Madhya Pradesh\(^26\), Delhi\(^26\), Uttar Pradesh\(^28\), West Bengal\(^26\) in India. Besides India, the records of *P. saccharifolii* in other countries include only Nepal\(^24\) and Pakistan\(^26\).

*Observations on mealybug colony composition and description*

Each colony had all life stages with overlapping generations. The tubular ovisacs are long and loosely compressed. Microscopic examination showed that the egg masses are embedded in mealy threads of the ovisacs (Figure 4a). Fresh eggs were pale yellow and elongate (Figure 4b). The eggs were laid in batches in the same ovisac as clusters (Figure 1e). The prolifically emerging crawlers were yellow, highly active and move in groups (Figure 4c). The
morphological features could be seen clearly in Figures 5a-5i and 6. The SEM observations revealed that the antennae were eight segmented (Figure 5b, 5c). The legs were strong, and well-segmented (Figure 5d). The advanced nymphal instars are soft, yellow-bodied beneath the white mealy and powdery waxy coating (Figure 1). The waxy filaments are prominent all around the body with the protrusions along the flank more pronounced in males. Two pairs of long waxy filaments in the caudal region flanked by another pair of filaments were observed at the base of the abdomen. While males pass through a true pupal stage, the females moult into an adult without metamorphosis. Abundant tiny male cocoons arranged as pairs in overlapping rows in inverted “V” shape, formed linear white festoons (microscopic view: Figure 4d) along the vertical axis on the mostly the ventral side of the leaf but on both sides of leaf during an outbreak. The scurrying small and fragile adult males could be found active during the day. Male adults possess a pair of long white caudal filaments, white translucent wings with pinkish body (Figure 4e).

The relatively inactive stout females heavily coated with mealy wax filaments form the major part of a well-developed colony. The mature females spin ovisacs during the pre-ovipositional period of two days. Single or multiple mating are observed. Egg laying is intermittent and in defined batches due to which the ovisac is extended (Figure 1). As the female adult matures, the size of the ovisac grows linearly and often measures more than twice the size of its body (Figure 1). The ovisac covers the entire body with only the head region protruding and exposed. The female body is slightly lifted at an angle with the attachment to the leaf only by the mouth parts. The females often crowd together and overlapping their long ovisacs may lead to the striking appearance of the cottony bed (Figure 4f). The long body of the female becomes globular wide at the posterior end with the side projections of waxy filaments. The legs were prominent in all stages, but in mature females, they appeared to have shrunk in
proportion to the swollen body. Feeding by females leaves a distinct black necrotic scar on leaves (Figure 1).

*Observations recorded in pot culture*

Infestations occurred in most of the 650 potted plants. Leaf blades, leaf sheath and leaf whorls were found to harbour the pest in large numbers. In the field surveys too, infestation pattern was similar to that in the pot experiments. The mature females with their profuse mealy coating and long cottony ovisacs were found to be crowded prominently on the abaxial surface of the leaves. During an intense infestation, the population was found on the adaxial surface, mainly in the crown as well. The inner top portion of the leaf sheath at the leaf joint cupping the stem closely also harbours the pest. Young crawlers often reach the leaf whorl, and congregate around the unopened leaf (-2) to settle down for feeding. The young nymphs then move to opened leaves and develop on the leaf blade under the protection of mealy mesh of the matured nymphs as well as adult females.

Crinkling, necrosis and rotting of +1 to +3 leaves can be observed due to the high infestation of young plants (Figure 7a, b, c, d). The further attack leads to rotting of up to -2 leaf. Desapped leaves turned pale orange, yellow and then subsequently dry. Due to feeding, necrotic spots or mottling develop on leaves. As the population builds up, the entire crown is affected, thus we named it crown mealybug. Intense attack in the leaf whorl leads to rotting of central culm and/or meristem which is also known as dead heart. Loss of apical dominance induces tillering in young plants (tillering phase) or sprouting of aerial tillers in case of grand growth phase. Often, the leaves of the new tillers whether sprouted aerially or from the nodes at the ground level, are also infested and the whole sprouts wither away. Affected young plants seldom form canes. Young crops more specifically ratoons, are vulnerable to this pest.
No recent reports of the occurrence of this mealybug are found in India or elsewhere. In isolated instances during 1919 and later in 1941, \textit{P. saccharifolii} had been observed to be common on sugarcane in north India\textsuperscript{29,30} and later as, a minor pest in a compilation\textsuperscript{31}. The mealybug chiefly attacked \textit{E. arundinaceus} in south India, for example, Andhra Pradesh\textsuperscript{30}. Ali\textsuperscript{31} reported this mealybug to be a vector of spike disease of sugarcane caused by a virus but later it was disproved\textsuperscript{32}. Perhaps the infestation of this mealybug had predisposed the plant to the spike disease infection and thus may be indirectly associated with the disease. A similar situation was observed in Tamil Nadu, wherein the severely infested canes were frequently affected by \textit{pokkah boeng}. The concurrence of the mealybug and \textit{Pokkah boeng} made the plant recovery either impossible or slower.

It is rare to find a combination of sucking pests in the same niche in sugarcane. For example, whitefly (\textit{Aleurolobus barodensis} Maskell) and woolly aphid (\textit{Ceratovacuna lanigera} Zehntner) are not found together. The niche occupation can further be so specific in sugarcane that the two species of whitefly \textit{A. barodensis} and Neomaskellia bergii (Signoret) do not occur together on the same leaf and on occasions in an ecosystem entirely. A similar case of discrete site allocation is practised by the pink sugarcane mealybug \textit{Saccharicoccus sacchari} (Cockerell) and the yellow mealybug \textit{Kiritshenkella sacchari} (Green). Though they both occur on the sugarcane stalk, the former abound in the nodal region with the latter occupying the internodal region. But as an isolated case, colonies of \textit{P. sacchari} could frequently be found to coexist with any of the other sucking pests such as yellow sugarcane aphid, \textit{Melanaphis sacchari} (Zehntner) (Figure 8), giant scale \textit{Icerya pilosa} Green, sugarcane whitefly \textit{A. barodensis} and \textit{Dysmicoccus carens} Williams at different ratios with either the mealybug being predominant or the other(s).
In the pot culture, the population did not decline due to rains whether it was summer rains or monsoon rains. Perhaps the secured niche at the leaf whorl might have protected the crawlers which help to maintain the subsequent population levels. In general, extended dry rainless periods with clement weather favour mealy bug infestation and the rainy season decimate the attack. However, *P. saccharifolii* multiplication was profuse during summer rains as well as the monsoon period. This has earlier also been observed by Ali\textsuperscript{31}.

On *S. officinarum* cultivars, profuse honeydew produced by the mealybugs due to continuous and gregarious feeding, patronized ants (Figure 9). The ant species observed were *Camponotus compressus* (Fabricius), *Anoplolepis longipes* Jerdon, *Monomorium aberrans* Forel but mainly *C. compressus* which tended and aided in the dispersal of the mealybug by physical transportation. Copious honeydew secretion also led to extensive sooty mould *Capnodium* sp. growth mostly on the same leaves unlike in cases of other sucking pests, wherein those leaves beneath the infested leaves suffer the mould. When successive leaves were infested, the whole plant specifically, the crown appeared dark and sickly due to heavy sooty mould development. However, the honeydew secretion and sooty mould development were scarce in mealybug infestation on *S. spontaneum* clones. Ants were not observed but the parasitoid activity was also low. It is not known whether the dry abrasive texture of the *S. spontaneum* leaves or relatively low population was the cause of low level of parasitism (<15%), but even a single female or a young colony in *S. officinarum* could draw the ant attendance.

The young mealybugs have a myrmecophilous (“ant-loving”) association which may be obligate myrmecophily (the mealybugs being constantly attended by a huge number of ants) or facultative myrmecophily (infrequently attended by a few ants) depending on the stage of
the mealybugs or the species of ants. In the present case, while free attendance of ants was observed mostly, occasionally the nuclear colonies of mealybugs were rendered ant protection through nests built to house the former (Figure 10).

Ants also guarded the mealybugs by inferring the activity of predators and parasitoids. The most commonly observed predators were apefly, Spalgis epius Westwood (Lepidoptera: Lycaenidae) and coccinellids, Scymnus nubilus Mulsant and Hyperaspis maindroni Sicard. Three encyrtid endoparasitoids, Aenasius phenococi (Ashmead), Aenasius arizonensis (Girault) and Leptomastix dactylopii Howard (Hymenoptera: Encyrtidae) were found to be highly active (Figure 11), but their activity peaked with a lag after the pest population peaked. The natural enemies were active throughout the year (May 2021- June 2022) with the peak following high mealybug population.

Ali27 observed three coccinellid predators Scymnus coccivora Ramak and Scymnus sp. and S. nubilus Muls. on eggs and nymphs of P. saccharifolii and two encyrtid parasitoids Leptomastix sp. and Xanthoencyrtus sp. on nymphs and adults of the pest. Three encyrtid parasitoids, A. phenacocci, Leptomastix ephyra Noyes and Hayat and Leptomastix algirica Trjapitzin have been declared to be apt for augmentative releases against another species of mealybug, Phenacoccus solani Ferris in Israel33. In India, several species of parasitoids and predators have been found to be highly active on other invasive species of Phenococcus10-12.

Conclusion

This is the first report of the crown mealybug P. saccharifolii occurrence and infestation in devastating proportions on sugarcane, though previous records of occurrence and sporadic outbreaks of this pest had been made elsewhere in India six decades ago. Since then, till recently the pest and its damage have not been reported even in the previously reported
areas. Therefore, is essential to constantly monitor the population of *P. saccharifolii* as the homeostatic mechanisms to maintain the ecological or natural balance is yet to be attained by the pest. Hence, outbreaks are to be expected and management measures are to be followed on war footing as the possibility of immediate spread is imminent to virgin lands. Though there are not any specific recommendations for use against this mealybug, curative or prophylactic application of chemicals that are currently in use for sucking pests provide required population containment. Ratoons need additional surveillance, as they seem to be affected intensely. As the wide spectrum of natural enemies active on this pest is common to the other species of this genus *Phenacoccus*, there seems to be a possibility of shifting of natural enemy population from other crops hosting any other species of *Phenacoccus*, specifically polyphagous ones such as *P. solenopsis*. Multiplication of these natural enemies for augmentation would mitigate the population asynchrony in the field between the natural enemies and the pest. *P. saccharifolii* infestation brought out a new scenario of increased severity of *pokkah boeng* and crop failures. Although the affected varieties suffer from *pokkah boeng* in the field, colonization of the insect in the spindle aggravates the disease severity. Further studies are required on the physiological changes inflicted by combined damages by the insect and the fungal pathogen.

**Conflict of interest:** The authors declare no conflict of interest.

**Acknowledgements**

The mealybug reported in this paper, from ICAR-SBI were identified as *Phenacoccus saccharifolii* (Green) by Dr. Sunil Joshi of ICAR-NBAIR, Bengaluru and confirmed by the taxonomist at TNAU, Coimbatore. The identity of the mealybugs *Kiritshenkella sacchari*
(Green), *Dysmicoccus carens* Williams and the scale, *Icerya pilosa* Green mentioned in this paper were also confirmed by Dr. Sunil Joshi of ICAR-NBAIR, Bengaluru.

**References**


Table 1. Percent incidence of *Phenacoccus saccharifolii* on *Saccharum spontaneum*
collections at the ICAR-SBI, Coimbatore

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Figure legends

Figure 1: Experimental setup of laboratory studies

1a) Incubation of mealybug in a cavity box;
1b) Incubation in eppendorf tube
1c) Incubation in a pot and female with the extended ovisac
1d) A female with ovisac and male cocoon;
1e) Crawlers emerging from ovisac
1f) Necrotic spot of feeding by the female

Figure 2: Mealybug infested field of Co 86032

Figure 3: Phenacoccus saccharifolii on S. spontaneum, a wild relative of sugarcane

Figure 4: Different stages of the mealybug

4a) Eggs teased out of ovisac
4b) Freshly laid eggs of Crown mealybug
4c) Crawlers of P. saccharifolii
4d) Male cocoons
4e) Male adults
4f) Females with overlapping ovisacs

Figure 5: SEM pictures showing the morphological features of the mealybug

5a) Whole body (dorsal side)
5b) Anterior portion of the mealybug
5c) Antenna
5d) Close-up of leg
5e) Mouth parts
5f) Abdomen (ventral)
5g) Posterior abdomen

5h) Caudal zone

5i) Whole body (ventral side)

**Figure 6:** Slide-mounted adult female mealybug

**Figure 7:** Symptoms of mealybug infestation and *pokkah boeng*

7a) Leaf blade harbouring large number of mealybugs

7b) Mealybug infestation in the leaf whorl

7c) Necrosis, sooty mould and dead heart

7d) Symptom of mealybug infestation and *pokkah boeng* in young sugarcane plants

**Figure 8:** Coexistence of *Phenacoccus saccharifolii* with yellow aphid of sugarcane

**Figure 9:** Crown mealybug- *Camponotus compressus* association in *Saccharum officinarum*

**Figure 10:** Ant nest for the protection of nucleus colony of *Phenacoccus saccharifolii*

**Figure 11:** Parasitoids of *Phenacoccus saccharifolii*

11a) Cocoons of parasitoids of *Phenacoccus saccharifolii*

11b) *Leptomastix dactylopii*

11c) *Aenasius phenacocci*

11d) *Aenasius arizonensis*
Figure 1
Figure 2
Importance of the work

This is the first report of the crown mealybug, *Phenacoccus saccharifolii* on sugarcane in Tamil Nadu. Furthermore, this is the first report of the occurrence of this mealybug on *Sacchararum spontaneum* L., in the world. This pest alone or in association with the disease, *pokkah boeng* has the potential to devastate the entire crop. The incidence of this pest on major varieties of sugarcane grown in different districts of Tamil Nadu is reported in this paper. We have developed a grading system to screen the varieties for their reaction to this new pest. We have also reported the natural enemies recorded on this pest.
STATEMENT ON NO CONFLICT OF INTEREST

We, Geetha, R. Viswanathan, T. Ramasubramanian, K.P. Salin, C. Yogambal, P. Nirmala Devi, S. Karthikeyan and N. Chitra, the authors of the research article entitled "First report of Phenacoccus saccharifolii (Green) (Pseudococcidae: Hemiptera) on sugarcane in Tamil Nadu, India" hereby declare that there is no conflict of interest.

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