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THE PRODUCTION OF LONG ANAL FILAMENTS BY THE BAMBOO NODE MEALYBUG, *ANTONINA* SP. (HEMIPTERA: COCCOIDEA: PSEUDOCOCCIDAE), AS A RESPONSE TO LACK OF ATTENDING ANTS.

ABSTRACT

The production of long anal filaments by the bamboo node mealybug, *Antonina* sp. (Hemiptera: Coccoidea: Pseudococcidae), as a response to lack of attending ants.

Bamboo node mealybugs, *Antonina* sp., in the absence of attending ants, were observed to produce long waxy filaments both in the field and in the greenhouse. In contrast, ant-attended mealybugs had only very short filaments or none at all. Ant exclusion experiments confirmed the field observations. The available data suggest that the long filaments are an adaptation for the dispersal of honeydew in the absence of solicitous ants, so as to avoid drowning in the accumulating honeydew or suffocation due to development of sooty moulds.

Key words: Poaceae, Gramineae, *Bambusa*, damage, filament structure, Sternorrhyncha, *Anoplolepis longipes*, *Dolichoderus*, *Oecophylla smaragdina*, *Polyrhachis*, *Solenopsis geminata*, *Monomorium.*

INTRODUCTION

Mealybugs of the genus *Antonina* Signoret are legless and normally sclerotised in the adult stage. They are usually globose and enclosed in a felt-like waxy sac, with only the mouthparts, spiracles and the anal-vulva area exposed. This group has been known to occur almost exclusively on species of Poaceae (= Gramineae) (Ben-Dov, 1994; Hendricks & Kosztarab, 1999).

We have observed one species to seriously affect new propagules and young bamboo plants of several species, particularly *Bambusa tuldoides* Munro, *B. vulgaris* var. *vulgaris* Schrader ex Wendland, *B. v.* cv. *vittata* A. Riviere (= *B. v.* var. *striata* (Lodd ex Lindley) Gamble), *B. philippinensis* (Gamble) McClure (= *Sphaerobambos philippinensis* (Gamble) S. Dransfield) and *B. multiplex* (Lour.) Raeuschel ex J.A. & J.H. Schultes. This *Antonina* species fixes itself on the nodes, forming colonies of as many as 15 adult females on a single node and hence we have called it the bamboo node mealybug.

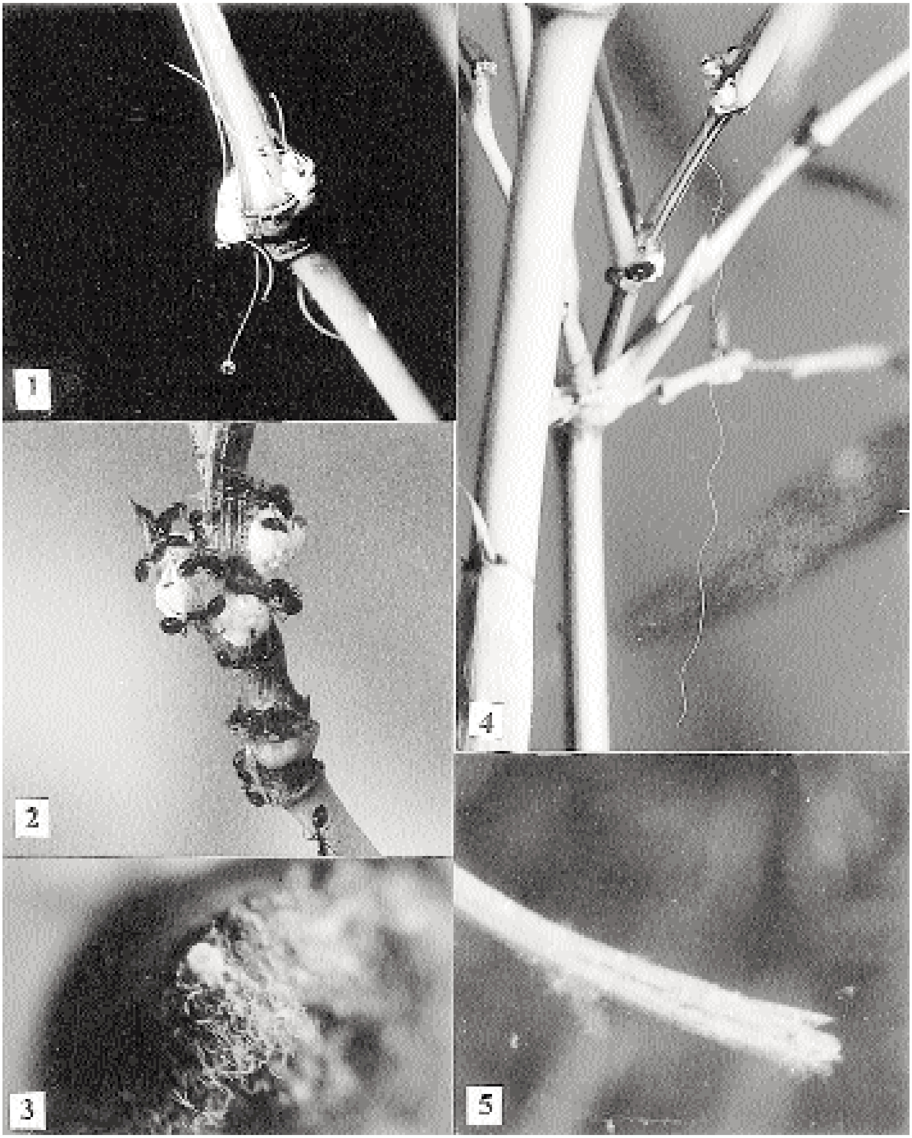
Both in the field and in the greenhouse, the bamboo node mealybug causes yellowing of leaves, stunted growth and, if kept unchecked, eventually the death of young bamboo plants. In the field, these insects apparently benefit from the attendance of various ant species which protect them from most natural enemies and also disperse them, especially the first-instar crawlers, from their maternal or hatching site to other favourable areas or plants. In this mutualistic relationship, the ants are provided with honeydew. This type of classic mutualistic relationship between ants and honeydew-producing Sternorrhyncha has been reviewed many times (e.g., Nixon, 1951; Way, 1963; McKenzie, 1967; Gullan, 1997).

However, in the absence of ants, the accumulation of honeydew can drown the honeydew-producer or they can become suffocated by sooty moulds that can develop on the uncollected honeydew. In addition, the development of the sooty moulds on the leaves can also affect the photosynthetic activity and, therefore, the health of the host plant. Therefore, honeydew needs to be removed by the ants or expelled as far as possible away from the mealybugs and the host plant (Malumphy, 1997). Adaptations of facultatively myrmecophilous mealybugs and other scale insects for the expulsion of honeydew in the absence of solicitous ants have also been documented in previous papers and reviews (e.g., Williams & Williams, 1980). All examples of these adaptations essentially involve active propulsion of honeydew away from the body with the aid of the anal ring setae and/or the anal tube.

In our on-going study of arthropods associated with bamboo, we have observed that the bamboo node mealybugs, in the absence of attending ants, produce long, waxy filaments both in the field and in the greenhouse (Fig. 1). In contrast, those that were ant attended had only very short filaments or none at all (Fig. 2). This phenomenon has not been documented nor studied before in mealybugs but is well-known in some margarodids (e.g., Bhatti, 1990; Morales, 1991) and a few eriococcids, such as *Ourococcus* Fuller (Fuller, 1899). At the same time, the possibility that this could involve adaptations to dispose of honeydew in the absence of attending ants led us to conduct ant exclusion experiments to test our hypothesis, i.e. that bamboo node mealybugs produce long anal filaments in response to lack of attending ants.

MATERIALS AND METHODS

Young bamboo plants propagated from culm cuttings were examined for the presence of ants and mealybugs. Bamboo node mealybugs with and



Figures 1-5: The bamboo node mealybug, *Antonina* sp., and its anal filaments.
1. Unattended mealybugs with long filaments, showing honeydew droplet. **2**. Mealybugs without filaments attended by *Solenopsis* ants. **3**. Anal region of a mealybug (sac removed) with filament starting to form less than 24h after ant exclusion. **4**. Longest filament, 80mm. **5**. Mounted filament showing strands of wax fibres.

without filaments and those found to be with or without attending ants were collected separately, preserved and identified to determine whether they belonged to the same species. In addition, live specimens were observed to establish whether the long, waxy filaments were really of anal origin.

Two ant exclusion trials were conducted. The first trial used a single potted plant (Buddha's belly bamboo, *B. tuldoides*) with many branches, nearly all of which were infested with the bamboo node mealybug attended by the ant *Anoplolepis longipes* Jerdon. Ten branches were selected, each with 2 colonies of 3-6 mealybugs. Ants were removed from half of these branches, after which the basal nodes were coated with petroleum jelly to keep the branches ant free. Daily observations were made for 5 days, starting 24h after isolation from the ants. After this time, the petroleum jelly coatings were removed, allowing the ants to return, and observations were then continued for another 5 days.

In the second trial, 10 similarly propagated, plastic-potted, young plants of the yellow striated variety (yellow common bamboo, *B. v.* cv. *vittata*) were taken from the field where their resident mealybug fauna were also attended by *A. longipes.* The ants were removed and the plants then kept ant-free by applying a repellent chalk around the platform where the plants were placed. Ten colonies, each with about 5 adult female mealybugs, were randomly selected and marked. The lengths of anal filaments were then measured daily using a flexible metre rule. Observations were made for 10 days, starting 24h after isolation from the ants.

While these trials were being conducted, field observations were continued, with an emphasis on the other ant species that attend this mealybug and on any peculiar behaviour on the part of either the ant or the mealybug. All important observations were photographed and voucher specimens collected where applicable. Voucher specimens have been deposited in the Entomology Section of the UPLB Museum of Natural History.

RESULTS AND DISCUSSION

All specimens of the bamboo node mealybug belonged to the same species of *Antonina*. Observations on live mealybugs under the stereo-zoom microscope confirmed that the long, waxy filaments were of anal origin (Fig. 3). In the field, the other ant species attending the mealybug were *Dolichoderus* sp., *Oecophylla smaragdina smaragdina* (Fabricius), *Polyrhachis* sp., *Solenopsis geminata geminata* (Fabricius) and *S. g. rufa* (Jerdon). In both the greenhouse and in the laboratory, the mealybug colonies were also attended by *Monomorium* sp. but this ant not only fed on the honeydew and the waxy filaments but also on the mealybugs themselves.

In both ant-exclusion trials, the mealybugs started producing anal filaments within 24h of the removal of the ants. The daily increase in length of the anal filaments ranged from zero in a few individuals to 8mm, with an average of 2.9mm and a modal value of 3.0mm. In the first trial, the returning ants did not cut off the filaments but were still able to collect globules of honeydew from the tips of the relatively short filaments. There was no further increase in filament length once the ants had returned.

Each mealybug produced only one anal filament at a time, which became either spiral or kinky as it grew. After 10 days, the average length of an anal filament reached 34.9mm. However, the longest recorded was from a specimen reared in the greenhouse before this study, which had a filament 80mm long (Fig. 4). Using the modal value of 3mm increase in length per day, we estimate that this particular mealybug had been isolated from ants for at least 26 days. Mealybugs with very long filaments were not attended by ants. What happens to these mealybugs needs further study.

It is clear that the role of the long anal filament is to dispose of the honeydew. We have observed honeydew droplets accumulating on the distal end of each filament (Fig. 1), regardless of the angle or orientation of the mealybug to the stem or node. Each filament is actually made up of closely packed, minute, wax fibres, which form a microtube or capillary (Fig. 5), through which honeydew droplets are actively eliminated. With regard to the spiral or kinky filaments, there is probably some physical explanation why a spiral microtube or capillary would be more favoured than a straight one (e.g., perhaps related to the fluid mechanics of honeydew). Nevertheless, it will definitely have something to do with the chemical structure of the wax as well as the arrangement of the wax secreting pores or ducts around the anal ring or anal ring setae.

These ant exclusion experiments confirmed the field observations. There still remains, however, the alternative hypothesis that the production of the long, anal filaments may not be a response to lack of attending ants but that the presence of ants inhibits the development of anal filaments, possibly including the cutting of the filaments by the ants. However, it was observed that isolated mealybugs or those that were almost completely covered by the culm sheaths, still developed filaments, even in the presence of attending ants, although not as long as when the mealybugs were entirely unattended. It appears that, with these occasional cases, the filaments were ignored by the ants (except *Monomorium* sp.).

In summary, the available data suggest that the long anal filaments are an adaptation to dispose of the honeydew in the absence of solicitous ants so as to avoid drowning in the accumulating honeydew or suffocation due to the development of sooty moulds. This ability to dispose of honeydew in the absence of ants may partly explain the relative success of these mealybugs in colonising bamboo plants, both in the field and in the greenhouse.

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