Nymphal Behaviour and Lerp Construction in the Mopane Psyllid Retroacizzia mopani (Hemiptera: Psyllidae)

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Nymphal behaviour and lerp construction in the mopane psyllid *Retroacizzia mopani* (Hemiptera: Psyllidae)

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ABSTRACT

The nymphal stages of the African mopane psyllid *Retroacizzia mopani* occur on *Colophospermum mopane* leaves, feeding on the phloem sap. The emergence of *R. mopani* coincides with the dry winter period in South Africa, when other trees are leafless. The nymphal stages secrete a scutcheon-like protective covering called lerp. The position of lerps on the leaflets depended on the stage of development of the nymphs. First and second instar nymph lerps were placed along the smaller secondary veins, whereas third, fourth and fifth instars placed their lerps along the main veins on either surface of the leaflet. Nymphs were more common on the adaxial surface than on the abaxial surface of the leaves, suggesting that the lerp offers some form of protection against predators and desiccation. Nymphs do not co-habit the same lerp. Visible damage caused by nymphs and lerps on the host plant includes discolouration of leaflets around feeding sites and occasional curled leaflets.

KEY WORDS: Hemiptera, Psyllidae, *Retroacizzia mopani*, *Colophospermum mopane*, Afrotropical, nymph, lerp, behaviour.

INTRODUCTION

Colophospermum mopane (J. Kirk ex Benth.) J. Léonard, commonly known as mopane, is one of the best known and valuable tree species indigenous to southern Africa, often being the dominant tree species in species-poor woodlands. It is especially adapted to the drier regions of southern Africa, and is thus an important tree during periods of drought (Palmer & Pitman 1972). It serves as a host plant for a few endemic insect species, among them the African mopane psyllid *Retroacizzia mopani* (Pettey, 1925) (Ernst & Sekhwela 1987).

Nymphs of *R. mopani* emerge from the eggs when the leaves are turning senescent, normally from June or July depending on climatic factors. They feed exclusively on the phloem sap of *C. mopane* leaves (Ernst & Sekhwela 1987). Nymphs of some free-living psyllids secrete protective waxy or sugary coverings called lerp on the leaf surface (Urquhart & Stone 1995). Sooty mould may also develop on these secretions, blackening the leaves and reducing the rate of photosynthesis (Urquhart & Stone 1995).

Some plants have the ability to defend themselves from browsing pressure by producing condensed tannins, which may cause the leaves to become unpalatable (e.g., Mangan 1988; Bryant 1991). However, the sugary lerps of *R. mopani* might play a vital role in improving the taste of the leaves. Animals such as baboons, monkeys and a wide variety of birds are known to consume the lerps (Herremans-Tonnoeyr & Herremans 1995). In the northern parts of South Africa some local people, especially cattle tenders, also use the lerps to supplement their food (Pettey 1925). Lerps are known to contain a high concentration of potassium and nitrogen but a low concentration of manganese and zinc (Ernst & Sekhwela 1987).

Lerp building occurs in several psyllid taxa: the predominately Australian Spondyliaspidinae, the Eastern Palaeartic *Celtisaspis* (Pachypsyllinae), the Neotropical *Euphalerus*

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(Euphalerinae), and the Afrotropical *Retroacizzia* (Euphalerinae). Extensive studies have been made on the biology of various eucalypt psyllids (Spondyliaspidini) (e.g., Basden 1970; White 1972; Hodkinson 1974). However, in southern Africa little work has been done on *R. mopani*. Our knowledge is limited to taxonomic studies by Pettey (1925), descriptions of the life cycle and of the chemical composition of the lerp by Ernst and Sekhwela (1987) and recent studies on egg distribution (Oppong *et al*. 2009). Detailed descriptions of the nymphs, lerp distribution and lerp construction are still limited. The objectives of this study were to investigate the distribution of *R. mopani* nymphs and lerps, to assess the behaviour of the nymphs and to describe the construction of the lerps.

MATERIAL AND METHODS

The study was conducted near Tzaneen in Limpopo Province (23°49'S:30°10'E, 508 m above sea level). The site was abandoned farmland dominated by *C. mopane* trees. Field visits to the study site were undertaken three times a week in July–September 2004. On each sampling day 30 leaves infested with *R. mopane* were randomly collected from the upper, middle and lower canopies of 10 randomly selected *C. mopane* trees. Evaluations were made of the occurrence and behaviour of *R. mopani* in the field. The collected infested leaves were sent to the laboratory for further analysis.

Development of nymphs occurs under the lerp, so *R. mopani* nymphs were studied by opening the lerps to observe individuals at different developmental stages. Each lerp was opened with a pair of forceps and the nymphs under the opened lerps were counted and measured. The nymphs were grouped into five instars based on body length, length of antennae, and size and shape of wing pads. A total of 30 nymphs of the various instars was measured. The behaviour of nymphs and the construction of the lerps by wandering nymphs were closely observed.

The mean number of lerps per leaf was counted for 30 leaves. The structure of the lerp was determined by placing a fresh lerp in trichloroethylene for five minutes to dissolve the soluble parts of the structure. The insoluble part was sputter coated with gold-palladium and viewed with a Jeol 6100 Scanning Electron Microscope at 7 kV.

Statistical analyses performed included ANOVA (Analysis of Variance) and the Mann-Whitney Rank Sum Test. Graphs were constructed using Sigma plot ver. 9.01, 2004 (Systat software Inc.).

RESULTS

Behaviour of nymphs and lerp construction

Five nymph instars were identified. The duration of various instars could not be determined as development after the first instar occurred under the lerps. There was a significant increase in body size from first instar to fifth instar (Fig. 1). Wing-pad development was first noted in the second instar and became marked in the rest of the instars. Nymphs were more common on the adaxial surface (55 %) than on the abaxial surface (45 %, n=580) of the leaves, with a mean of 3.97 ± 4.14 and 3.70 ± 3.48 respectively. However, the difference was not significant (df=1, F=1.38, P>0.26).

Just after eclosion, the first instar nymphs wandered for a few minutes (approximately 5 min), then moved quickly searching for a feeding site where they pierced the phloem tissue of the host plant with their stylet. Nymphs then started to construct lerps over

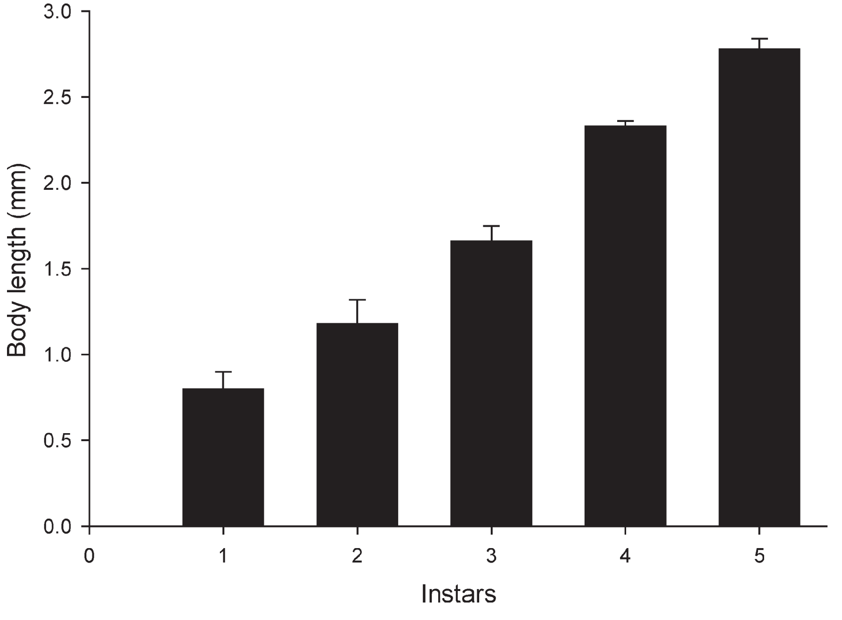

Fig. 1. Mean body length of the various instars of *Retroacizzia mopani* (bars indicate standard deviation).

their bodies. The first instar nymphs preferred the areas between secondary veins. The second instar nymphs mainly selected areas between secondary veins after their lerps were open, whereas the older instars (third, fourth and fifth) settled on and along the main veins.

When the lerp cover was removed, first and second instar nymphs quickly (within 5 min) started to construct a new lerp, but third to fifth instars took more than one hour before constructing a new lerp. Just prior to moulting, fifth instars abandoned their lerps, but remained close to their lerp before moulting to adult. Some nymphs abandoned their lerps only to construct a new one at a different site on the same leaflet. A nymph uses the tip of its abdomen to construct the lerp. During lerp construction, the stylets remained in a feeding position. The nymph pivots its body in a semi-circle around the point of insertion of the stylets and excretes a light brown gelatinous liquid from the tip of the abdomen, which is deposited on the leaf. The abdomen slowly moves clockwise, each movement corresponding to exudation of the gelatinous liquid adding to the base of the lerp.

Lerp distribution and appearance

As for the nymphs, there were more lerps on the adaxial leaf surface than on the abaxial surface, with a mean of 10.63 ± 8.20 and 8.8 ± 6.71 respectively, though the difference was not significant (df=1, F=0.52, P>0. 05). Thus, the number of nymphs was lower than the number of lerps on both adaxial and abaxial leaflet surfaces. The position of the lerps depended on the stage of development of the nymphs. The mean number of lerps were as follows: on veins (13 ± 10.87), between veins (2.7 ± 3.78), along leaf margins (0.87 ± 1.18), pulvinus (0.47 ± 0.78), and petioles (0.33 ± 0.96) (Fig. 2). Almost all the 300 leaves examined carried lerps (94 %) and in many of the leaves lerps were

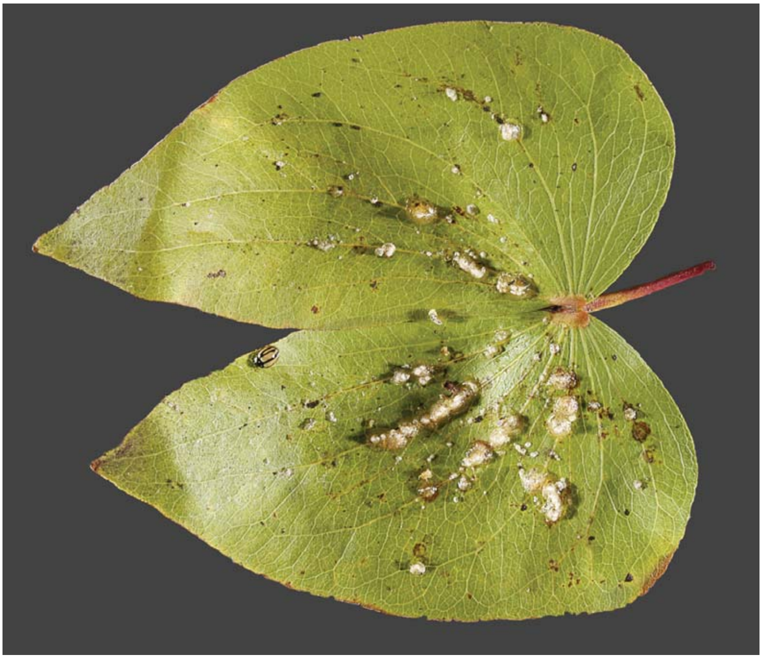

Fig. 2. Distribution of lerps of different *R. mopani* nymphal instars on main veins of the *Colophospermum mopane* leaf.

joined together. The mean number of lerps per leafet was 19 (n=300) and the mean mass of a single lerp was 0.005 g (n=300). Most lerps (80 %, n=300) were light brown, 15 % were white and 5 % were grey to black. Lerps were glued at one end to the leaflet surface and loose at the opposite end. The loose end served as an opening for the fifth instar prior to moulting to adulthood.

Damage caused by nymphs and lerps

Damage caused by nymphs and lerps was visible as black or reddish brown patches around feeding sites (Fig. 3). Black sooty mould was observed on leaves in the vicinity of lerps. Sometimes the black sooty mould covered the entire lerp. A few curled leaflets enclosing lerps and nymphs were also observed.

DISCUSSION

Nymphs were mostly found on the adaxial surface rather than on the abaxial surface. This suggests that lerps offer the nymphs some form of protection against desiccation and predation. The nymphs were observed piercing the phloem tissue with their stylets to withdraw sap from the host plant. The reason the younger nymphs (first and second instars) preferred settling between and along secondary veins is probably that their stylets could not puncture hard tissues such as the bundle sheath cells, which are made of hard fibres, whereas they could probably feed directly from the major phloem vessels of the secondary veins. This is supported by the fact that *C. mopane* leaves have a fibre sheath around the vascular bundle, which must be penetrated to reach the phloem (Potgieter & Wessels 1998).

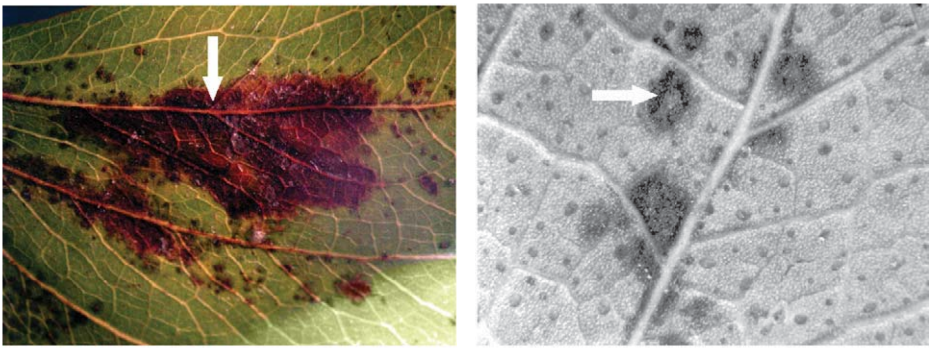

Fig. 3. Feeding damage on leaflets caused by nymphs (arrows) of *R. mopani*.

Compared to the older instars, the younger nymphs (first and second instars) were very quick to construct lerps after emergence from the egg and when disturbed from the existing lerp. This behaviour is assumed to be advantageous to the first and second instars in helping them avoid desiccation and predation. Third and fourth instars did not quickly construct lerps over their bodies when exposed, which suggests possible acclimatization to environmental conditions, but this leaves them vulnerable to predation. The fact that more nymphs were distributed on the adaxial leaflet surface than on the abaxial surface could mean that lerps offer some form of protection against predators and the direct rays of the sun. On the contrary, more eggs are distributed on the abaxial surface of the leaflets than on the adaxial surface (Oppong *et al*. 2009). It also suggests a feeding preference of nymphs for the adaxial surface. No two nymphs were found co-habiting the same lerp. This is perhaps to minimize competition for food and consequent aggressive behaviour.

Lerps were mostly positioned along veins, where nymphs mostly remain feeding (Urquhart & Stone 1995). The lerps are known to provide protection for nymphs against desiccation and predation (White 1972; Gilby *et al.* 1976; Ernst & Sekhwela 1987). Sometimes the infestation is so excessive that the lerps of neighbouring nymphs overlap. According to Van Wyk (1972), large-scale infestations can result in lerps covering large areas of the leaflet surface thereby reducing the penetration of light in the leaves.

The leaf tissues at the edges of lerps appeared stained, which could probably be attributed to the pressure exerted on the tissues by the lerps, or to the glue that attaches the lerps to the leaflet surface, or even to the death of mesophyll cells. According to Urquhart and Stone (1995), when feeding, the nymphs of *Cardiaspina* species secrete substances that cause necrosis. Initially the affected area appears reddish purple but later turns brown. They further stated that in the Sydney blue gum *Eucalyptus saligna* large populations of *Glycaspis baileyi* can sometimes cause a general purplish discolouration of the foliage, and sooty moulds may develop on the sugary secretions, blackening the leaves and reducing the rate of photosynthesis. This study showed similar observations on *C. mopane* leaves, suggesting that *R. mopani* nymphs, like *Cardiaspina* species, might also secrete substances that cause necrosis. The presence of black sooty mould on the leaves in the vicinity of the nymphs and lerps of *R. mopani* is supported by the statement by Dreistadt *et al*. (2004) that all psyllids produce honeydew on which blackish sooty mould grows. Lerps attract humans, baboons, birds and other organisms, which utilize them to supplement their food. These organisms, in the process of removing lerps, might cause secondary damage to the leaves.

In conclusion, the first and second instars preferred settling between and along secondary veins, whereas the third to fifth instars preferred the primary veins. The nymphs of *R. mopani* produce lerps, which partially protect them against predators and desiccation. Lerps are, however, used by different animal species as a source of additional nutrients. *R. mopani* may play a vital role in improving the browse quality to game animals in the region, especially in the dry winter months. Further studies should include the duration of the various stages of *R. mopani* nymphs.

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