# The Potential of Classical Biological Control Against Leucaena Psyllid, *Heteropsylla cubana* Crawford in Eastern Tanzania

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## Abstract

*The Leucaena psyllid **Heteropsylla cubana** Crawford (Homoptera: Psyllidae) has caused damaging effects to **Leucaena leucocephala** (Lam.) de Wit in Tanzania since its outbreak in 1992. Cultural, genetic and chemical controls have been tried in some localised areas. In 1995, a hymenopterous parasitoids, **Tamarixia leucaenae** Boucek (Eupelmidae) was imported from Trinidad and Tobago for biological control of this pest in Tanga and Morogoro areas. Mummies of the parasitoid were recorded from the sixth week after release. The population declined to the lowest level between November 1995 and January 1996 before building-up again to about 10 and 11 mummies per shoot in July for Tanga and Morogogro respectively. Spread of the parasitoid was fairly fast, and at about 16 months after release it had covered over 300 km from the release sites. The spread and population build up indicates that this species has been established in Eastern Tanzania. In spite of declining shoot damage at about ten months after parasitoid release, it is probably too early to associate it with the parasitoid. Shoot damage was found to be more closely correlated to laboratory nymph count ($r^2$ = 0.52) than to field nymph shoot numbers ($r^2$ = 0.35). Several potential indigenous natural enemies were recorded in association with the psyllid; however, their role as biological control agents needs further quantification.*

**Keywords**: *Leucaena leucocephala*, Tamarixia Leucaenae, Biological Control

## Introduction

Leucaena, *Leucaena leucocephala*, a multipurpose tree, which is native to Central and South America is widely planted in the tropics. In its natural habitat there is no record of serious insect problems. In 1983 a sup-sucking insect leucaena psyllid (*Heteropsylla cubana*), which also originates from the leucaena natural range, attacked and caused severe damage to leucaena in Florida (Wheeler and Brewbaker, 1990). Two years later the pest spread across the Pacific and Asia causing severe damage to leucaena (Napompeth, 1994). In 1992 it was recorded in East Africa, the first record of the pest from mainland Africa (Raynolds and Bimbuzi, 1992; FAO, 1994).

In Tanzania, like many other leucaena growing regions, heavy damages have been observed in nearly all infested areas, causing farmers to abandon the species (Johanssen, 1994; Madoffe and Massawe, 1994; TAFORI, 1995). However,

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due to its many desirable qualities, the tree may continue to be widely used if the pest is brought under control.

Of the various control strategies, it is generally recognised that only the development of resistant varieties and/or biological control offer potential solutions which are both economically feasible and environmentally desirable (FAO, 1994). Both methods have been used individually with some success in Asia, but little quantitative information has been reported on the biological control, and there is no work in the integration of host plant resistance and biological control (Day *et al.*, 1995).

In attempting to control this pest in Kenya and Tanzania, the Asia-Pacific experience was considered the best option (Ciesla and Nshubemuki, 1995; Napompeth, 1994). In response to request from the Governments of Tanzania and Kenya, FAO sponsored a Technical Co-operation Project (TCP) to assist in managing this pest. In this programme, two hymenopterous parasitoids *Tamarixia leucaenae* Boucek and *Psyllaephagus yaseeni* Noyes were introduced from Trinidad and Tobago to the region in 1995 and 1996. This paper highlights on the current status of *Tamarixia leucaena* in Tanzania, its introduction, establishment, spread and impact on the leucaena psylllid.

## Materials and Methods

Two localities, Tanga (455'S, 3840E, 100 m.a.s.l.) and Morogoro, (700'S, 3748'E, 350 m.a.s.l.) were used for the release of the parasitoid. Releases were done in July and August 1995 at the Morogoro and Tanga sites respectively. In each location, three Leucaena growing sites (Tanga: Mlingano, Tanga dairy farm and Ziwani; Morogoro: Sokoine University of Agriculture farm, Melela A & B) were selected for the release of *Tamarixia leucaenae*. The sites were selected on the basis of uniformity in climatic conditions, varieties of leucaena, agronomic practices and being more than 20 km apart.

Tanga is a savannah grassland area with mean annual rainfall of 1200 mm and mean monthly temperatures between 19$^0$C and 33$^0$C. Morogoro is pre-dominantly a miombo woodland area with mean annual rainfall of 1100 mm, and mean monthly temperatures varying between 18$^0$C and 32$^0$C.

The parasitoid was imported from Trinidad and Tobago. Mummies of the parasitoid were first shipped to CAB International, UK where they were surface sterilised in sodium hypochlorite and repacked before dispatch to Tanzania. The parasitoid was transported directly to the field sites and released over psyllid colonies in cages to allow free foraging by the parasitoid. A few trees were cut one month before parasitoid release in order to produce new and enough shoots during release. The psyllid population at release was at an average of 6-30 nymphs per shoot, which was considered adequate to host the parasitoid. Releases were made by introducing adults into muslin cages fixed around psyllid infested branches of leucaena. Adult parasitoid were carefully introduced into cages by holding the open vials containing the insects under the netting and allowing them to fly out. This method of release was used to provide some protection of the parasitoids, and assist them with host location, and so increase the chances of establishment. Three days after release, the cages were removed. Release were made on leucaena trees with suitable host stages (flushing) and populations. Sampling was undertaken to determine the psyllid population, the state of leucaena growth and psyllid damage to the trees at the time of release.

A total of 545 *T. leucaenae* were released, 179 in Tanga dairy farm and 366 at SUA farm. Percentage survival of the parasitoid during shipment was 41% and this higher mortality rate could probably have been due to its shorter pupal period, resulting in most of the adults having emerged before the shipment reached Morogoro. At each site, 25 trees, at least 5 m apart were randomly selected. For each selected tree, one large branch with many growing points was marked for detailed studies. Regular census was made on the marked branch once every four weeks, commencing four months before the releases and continued 16 months there after. The growth stage of the trees was monitored by recording the number of actively growing shoots on one tree in each of the 25 plots. Psyllid damage was scored for the same trees using the scale of 1 (no damage) to 9 (total leaf loss and sooty stem), widely adopted in Asia (Wheeler, 1988). Field shoot nymph numbers were scored for the same tree using the scale of 0 (none present) to 5 (>100 nymphs) (Bray and Woodroffe, 1988). Fifteen individual shoots on each tree were also recorded as healthy (score 1), slightly damaged (score 2), heavily damaged (score 3), or dead (score 4). Species and relative abundance of indigenous natural enemies were also monitored on the same trees.

The populations of psyllid and parasitoid mummies were monitored by destructive sampling. The sample unit was taken as one shoot (growing point plus first unfurled leaf) and the three leaves immediately below the shoot. One sample shoot was randomly selected from each plot (tree), giving a total of 75 units i.e. 3 sites × 25 plots per site. Sampling was done in the early mornings. One shoot was carefully cut, placed into a polythene bag (destructive sampling) and put in a refrigerator for overnight to immobilise the nymphs. Laboratory nymph count was taken under dissecting microscope, and nymph numbers were scored as small (yellow in colour, 1st and 2nd instars), medium (blackish in colour, 3rd and 4th instars), or large (greenish in colour, 5th instars). Descriptive statistics was used to establish means for shoot health, tree damage, psyllid and natural enemies populations. The distance of parasitoid spread from the release sites was estimated along the main roads.

## Results and Discussion

At release there was an average of 28 and 35 shoots per tree at Morogoro and Tanga respectively (Fig 1). Flushing declined gradually in September and it reached the lowest level in January and February 1996 due to drought and reached the highest peak during the long rain period (March-May). There was a gradual increase of shoots 15 months after parasitoid release. This increase could be due to more favourite weather and/or the impact of the parasitoid.

As expected, psyllid population was seasonal and intermittent throughout the study period at both sites (Fig. 2). The period between June and September 1996 experienced much lower population than the same period in the previous year. The small nymph population was consistently higher than the other two instars. Larger nymphs had the lowest populations. *Heteropsylla cubana* is highly seasonal in its occurrence (Waage, 1990; Bray *et al.*, 1990) and if food is available, cool temperatures could increase the psyllid populations (Bray, 1992; Madoffe and Massawe, 1994; Napompeth, 1994). Furthermore, dry season leads to tree stress, consequently making them susceptible to even moderate psyllid population (Larsson, 1989). Figure 2

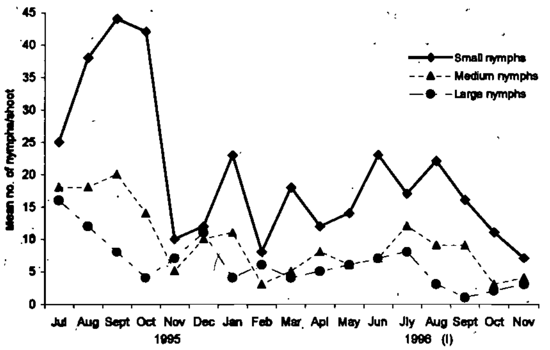



Figure1: Means number of shoots per Leucaena tree growing in Morogoro and Tanga.

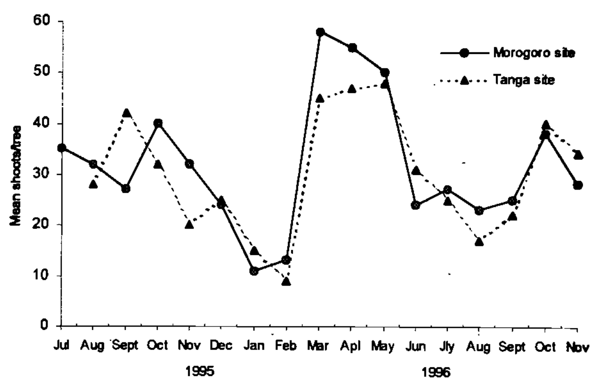



Figure 2: Mean number of leucaena psyllid nymps per shoot of leucaena trees in (i)Morogoro and (ii) Tanga

In Tanzania, the period between June and September is usually cool and dry and leucaena flushes its leaves during this period. At about 16 months after parasitoid release, the psyllid population declined (Table 1 and Fig 2). For example, at release time, 81% and 51% of young shoots were attacked by psyllid at Melela B and SUA farm respectively. However, sixteen months after parasitoid release about 30% of the shoots were free from psyllid at both Melela B and SUA farm. The declining psyllid population recorded was probably due to parasitoid attack as *Tamarixia leucaenae* has been reported to have reduced populations of leucaena psyllid in the Asia-Pacific Region to their present low levels (Napompeth, 1994).Shoot damage was also seasonal and it corresponded fairly well with nymph population (Fig. 3). Shoot damage was highest between July and September 1995 contrary to the following year.

Generally shoot damage decreased at all the study sites from about 10 months after parasitoid release (Fig. 4). At Mlingano, 34% and 50% of the shoots were healthy at release and 10 months after release respectively, while at SUA farm it was 18% and 45%. The declining shoot health at Ziwani after parasitoid release could be due to fire, which occurred six months after release

It is too early to judge whether the shoot improvement was entirely due to the decline in psyllid attack or due to shoot recovery associated with good weather as it has been reported that Leucaena trees could recover after psyllid attack (Mangoendihardjo *et al.*, 1990). In is however, possible that the declining psyllid population and damage recorded between August and September1996 was probably due to the effect of parasitoid or declining number of shoots consequently sparse psyllid population. Shoot damage was found to be closely correlated to laboratory nymph count ($r^2$ = 0.52) than field nymph shoot numbers ($r^2$ = 0.35). Laboratory nymph count appears to be a more effective measure for projecting shoot damage.

**Table 1. Mean distribution of psyllid per shoot of leucaena trees at Morogoro and Tanga**

| Locality | *Shoot nymph number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | At release | | | | After release | | | |
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| SUA farm | 49 | 43 | 7 | 1 | 70 | 23 | 3 | 2 |
| Melela A | 32 | 52 | 14 | 2 | 50 | 39 | 5 | 4 |
| Melela B | 19 | 56 | 24 | 1 | 69 | 25 | 2 | 2 |
| Tanga dairy | 36 | 45 | 18 | 1 | 56 | 37 | 3 | 2 |
| Mlingano | 34 | 61 | 5 | 0 | 60 | 25 | 5 | 5 |
| Ziwani | 40 | 50 | 9 | 1 | 66 | 33 | 1 | 0 |

* 1 = none present, 2 = 1-5, 3 = 6-30, 4 =31-100

Mummies of *Tamarixia leucaenae* were recorded at and around the release sites between six and eight weeks after release. The population was very low until November 1995 when it started building up and it reached 103 and 112 mummies per branch between June and August 1996 for Tanga and Morogoro respectively (Fig. 5). Establishment of the parasitoid was fairly fast probably due to presence of favourable weather and adequate populations of the psyllid which, coincided with the flushing of shoots. Similarly, spread of the parasitoid was fairly fast in both sites, and at about 15 months after release it was observed over 300 km away from the release sites. Leucaena is widely planted in Tanga and Morogoro and this could form a continuous food supply for the host (*H. cubana*). The parasitoid continued to persist even when the psyllid was at very low populations. They survived under adverse conditions probably by concentrating on the few remaining psyllids or lowering their

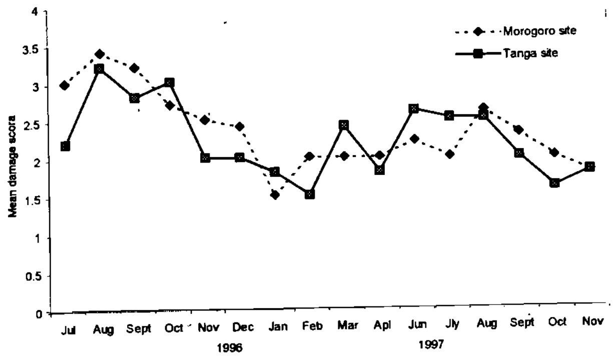



**Figure 3.Mean shoot damage score leucaena trees grown at Morogoro and Tanga**

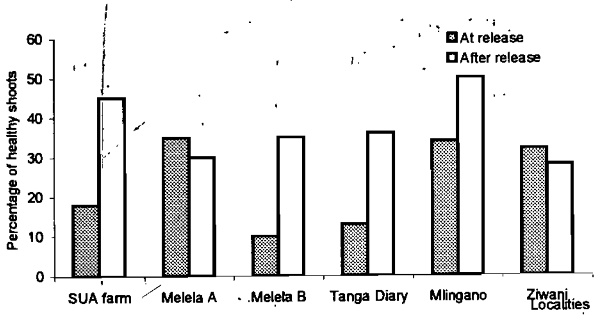



**Figure 4: Shoot health changes (%) at and after parasitoid release at Morogoro and Tanga**

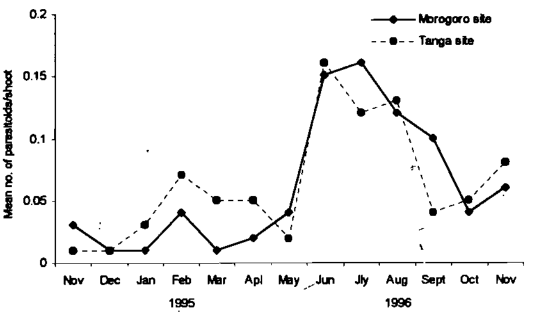
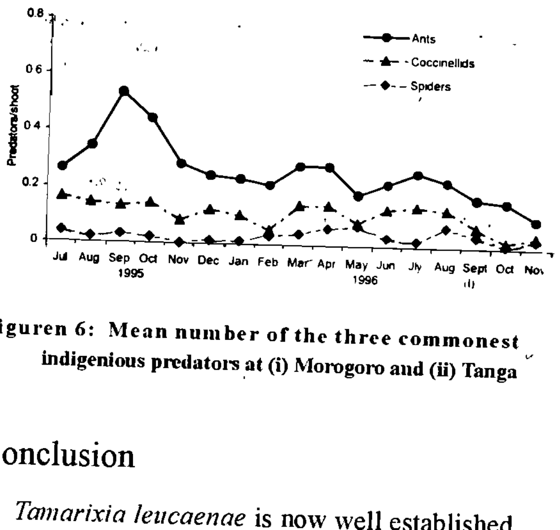



**Figure 5: Mean number of *Tamarixia leucanae* per shoot of leucaena trees at Morogoro and Tanga**

activity. The parasitoid is now well established in many leucaena-growing areas in eastern Tanzània about six years following its release. Their biological control effects may however, be gradual due to slow numerical response. Establishment of *T.leucaenae* has also been recorded in the neighbouring countries of Kenya and Malawi (Ndyadzi *et al.*, 1999).

Several arthropod natural enemies were recorded in association with the psyllid, the most dominant being spiders, ladybird beetles and ants (Fig. 6). Others were dragonflies and lacewings. There was no clear evidence that these indigenous natural enemies were feeding on the psyllid consequently contributing to the declining psyllid population. With the exception of ants, the rest are considered as important predators in South East Asia Pacific Region and Central America (Nakahara, *et al.* 1987; McClay, 1990;

Napompeth, 1994) although there is no quantitative evidence for this (FAO, 1994).




**Figuren 6: Mean number of the three commonest indigenious predators at (i) Morogoro and (ii) Tanga**

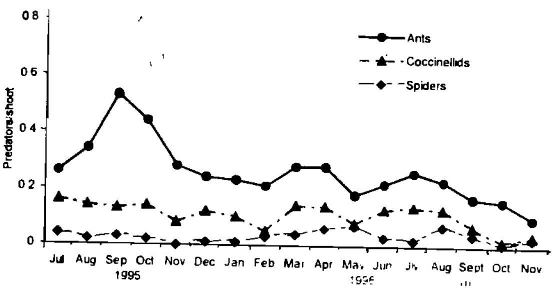



**Figure 6a: mean number of the three commonest indigenious predators at (i) Morogoro and (ii) Tanga**

## Conclusion

*Tamarixia leucaenae* is now well established in the Eastern zone of Tanzania and is spreading to other leucaena growing parts of the country. The reduction of psyllid population and shoot damage recorded could be attributed to the parasitoid. There is little or no evidence that local natural enemies respond to psyllid populations.

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