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SURVEY OF INVASIVE WEEDS AFFECTING BIODIVERSITY IN THE FORESTS OF THE EAST USAMBARA MOUNTAINS, TANZANIA

1-6 OCTOBER 1995

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East Usambara Catchment Forest Project

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1. Summary

The threat to the remaining indigenous forests of the East Usambara Mountains in NE Tanzania has been highlighted since large scale commercial logging ceased in the 1980's. Invasive alien plants of concern include the tree, *Maesopsis eminii*, and the shrubs, *Lantana camara* and *Clidemia hirta*. Environmental and development programmes in the region have expressed interest in the potential biocontrol of invasive weeds, particularly *M. eminii*.

However, recent ecological studies have questioned the scale of the problem with *M. eminii*, suggesting that its invasion is dependent on human disturbance, and that existing stands of the tree will eventually be replaced by native trees. Nevertheless, these studies conclude that reducing the seed source from large stands of *M. eminii* by selective logging, or by killing the trees in situ (using herbicide or ringbarking), could be useful.

From our visit to the East Usambaras we also conclude that that *M. eminii* is less of a threat to the indigenous forests than previously suggested. We also think that selective logging could damage regenerating native species, and that even localised disturbance of this sort could encourage the re-invasion of *M. eminii*. If the succession to native species is to be accelerated we think that killing existing *M. eminii* by ringbarking is probably better than selective felling or the use of herbicides.

If the current low levels of human disturbance of the forests are not maintained for the foreseeable future then *M. eminii* will invade. If this is perceived as a risk, then investigating biological control might be prudent. The cost of a new biocontrol programmes in this case is impossible to justify, but a survey of natural enemies attacking *M. eminii* in its native range might be worth considering (e.g. as a student project).

Neither *Lantana camara* or *Clidemia hirta* appear to be significant problems to either the conservation of the indigenous forest or to local agriculture. However, *Clidemia hirta* can colonise intact canopy forest as a low growing, understorey shrub, and if it continues to spread it could represent some threat to native understorey plants and cause problems for forest regeneration by rapidly colonising natural light gaps. We recommend that the status of *Clidemia hirta* in the East Usambaras should be monitored at intervals in the future. Both weeds have been the target of at least partially successful biological control programmes in other parts of the world in the past, so tried and tested biocontrol agents are available.

Many plant species have been introduced into the East Usambaras through the Amani Botanic Gardens, and it is perhaps surprising that so few species have naturalised. One species of great concern to us was wild guava (*Psidium cattleianum*, also known as Chinese or strawberry guava). In montane forests in Hawaii and Mauritius this South American plant has become one of the most serious threats to the indigenous forest species. The extent of the invasion of this weed should be surveyed, and control measures to restrict its further spread should be considered. Recent conservation work on Mauritius indicates that complete eradication of small infestations is feasible. There is also interest in the potential biological control of this weed, particularly in the Indian Ocean islands and in Hawaii, and this control method could also be applicable in the East Usambaras in the future.

2. Objectives

To follow up on Garry Hill's visit to the forests of the East Usambaras (Hill 1995), and assess whether invasive exotic weeds represent a sufficient threat to the indigenous biodiversity in this internationally important conservation region, to warrant the development of biological control programmes.

3. Persons met and organisations visited

East Usambara Catchment Forest Project (EUCFP)

Stig Johansson, Chief Technical Adviser, Finnish Forest and Park Service
M.I.L. Katigula, Forest Project Officer, and EUCFP Project Manager, Ministry of Tourism, Natural Resources and Environment, Forest & Beekeeping Division

East Usambara Conservation and Agricultural Development Project (EUCADEP)

Julius K. Ningu, Project Manager, Ministry of Agriculture
Graham Burt, Chief Technical Adviser

East Usambara Tea Co. Ltd

Neil Goonetilleke, Controller of Plantations

TAFORI
Ahmad Mdowla, Botanist

4. Background

Great concern has been expressed about the actual and potential threat that invasive alien weeds represent to the indigenous biodiversity, particularly the tree *Maesopsis eminii* and the shrubs *Clidemia hirta* and *Lantana camara*, in the indigenous forests of the East Usambara Mountains in North East Tanzania (Hamilton & Bensted-Smith 1989; Binggeli 1990; Hill 1995; Sheil 1994). The major purpose of this visit was to assess the importance of these weeds, and discuss the possibilities for biological control programmes with the East Usambara Catchment Forest Project and other local organisations/contacts. For Maesopsis the assessment had to consider the conflicting reports of its threat to indigenous forest presented firstly by Hamilton and Bensted-Smith (1989) and Binggeli (1990), and secondly by Hall (1995) and Geddes (1995).

Maesopsis eminii was originally introduced to the East Usambaras around the turn of the century, from its native range which extends from equatorial West Africa through to the northeast of Tanzania. In its native range, Maesopsis is a pioneer, gap-colonising tree species that only forms a very small proportion of native canopy forest unless the levels of disturbance are unusually high.

Substantial clearance of parts of the forests occurred in the 1950s with the expansion of the tea plantations. The rapidly expanding human population also led to further logging, pole cutting and clearance for small scale agriculture. Considerable commercial logging of indigenous forest trees took place in the 1960s. At Kwamkoro, one of the extensively logged areas, a plantation of Maesopsis was established, primarily to encourage the regeneration of shade requiring indigenous canopy tree species such as *Cephalosphaera usambarensis*. Selective logging by Sikh Saw Mills continued until the mid 1980s, when it ceased because of environmental and conservation concerns. This level of disturbance, together with a large seed source from existing Maesopsis, either deliberately planted or self sown, allowed the tree to spread at an alarming rate. Maesopsis seed is dispersed by hornbills and other animals, allowing the tree to spread rapidly into other sites disturbed by human activity or by natural tree falls. Against this background of a high level of disturbance, and a resulting high rate of spread of Maesopsis, Binggeli (1989) predicted that up to 50% of the forest canopy could consist of Maesopsis if the invasion continued unchecked. Maesopsis invasion was also reported to change the characteristics of the lower vegetation in the forests so that it comprised mostly of pioneer species and weedy shrubs, with few plant species typical of the more mature natural forest (Hamilton & Bensted-Smith, 1989). Furthermore, substantial canopy cover of Maesopsis was implicated in changes in the soils, which lacked humus and contained a different fauna compared with the soils under native forests (Hamilton & Bensted-Smith, 1989).

Concerns over the conservation and sustainable utilisation of the natural resources of the East Usambara Mountains led to the initiation of two projects :

1. The East Usambara Conservation and Development Project (EUCADEP), operated by the Tanzanian Ministry of Agriculture & Livestock Development and assisted by the International Union for the Conservation of Nature and the European Community. This programme is primarily involved with rural development and sustainable use of local resources. Although IUCN was involved in the launch of the environmental programme for the East Usambaras in 1987, activities directly concerned with the conservation of the

forest reserves were transferred to the Catchment Forest Project in 1991 (see below). The current EUCADEP project is due to finish in 1996.

2. The East Usambara Catchment Forest Project (EUCFP), is managed by the Tanzanian Ministry of Natural Resources & Tourism with assistance from FinnIDA. The aim of the project is the conservation of the indigenous forests and forest catchments by the gazetting and protection of reserves, associated with education of the local communities in the importance of forest conservation. In 1995 the project started its second 4 year phase, and plans for a third phase are already in place.

Dr Garry Hill (IIBC, Kenya) visited the East Usambaras in early 1995 to establish links with the two projects and discuss the possibilities for biological control of key invasive weeds affecting the indigenous biodiversity in the remaining upland forests. After discussions with EUCFP and EUCADEP, it was suggested provisionally that the Maesopsis eminii problem might warrant a biological control programme, and that the impacts of *Clidemia hirta* and *Lantana camara* on indigenous biodiversity, particularly the understorey and natural gap colonising flora, should be examined further (Hill 1995). In 1994 an assessment of the threat posed by *Maesopsis eminii* was made by Professor John Hall (University of Wales, Bangor, UK) on an EUCFP consultancy (Hall 1995). This study concluded that *Maesopsis eminii* was much less of a threat to undisturbed canopy forest in the East Usambaras than the scenario proposed by Binggeli (1989). Hall (1995) did suggest that selective logging of large Maesopsis eminii trees might usefully reduce the seed source for further invasion (particularly from the Kwamkoro plantations), but biological control was not mentioned as a possible method to reduce the invasiveness of *Maesopsis eminii*. The likely impact and local applicability of various methods of harvesting *Maesopsis eminii* have been assessed (Seymour 1992) but all methods involve considerable disturbance to the forest and are likely to provide conditions that encourage the regeneration of Maesopsis eminii. Such methods will also damage any native tree species that are regenerating under the Maesopsis canopy. The effectiveness of arboricide treatments and ring barking as methods for the selective control of *Maesopsis eminii*, with minimal disturbance to desirable native vegetation, was investigated by Neville Geddes (University of Wales, Bangor) (Geddes 1993). Ringbarking did not appear to kill the trees, and Geddes (1993) concluded that glyphosate applied to machete cuts around the trunks had the best potential for control of *Maesopsis eminii*.

Geddes (1995) also carried out a more detailed survey of *Maesopsis eminii* and native tree species in transects in a 450 ha area of submontane forest in the Kwamkoro Forest Reserve. The study site included the Maesopsis plantations at Kwamkoro, which provide the largest Maesopsis seed source in the region, and areas of exploited and unexploited native forest. A preliminary analysis of the results from this survey is presented by Geddes (1995). Some of the key findings were:

1. There was no evidence that the species richness of sub-canopy (<20 cm dbh) native tree species declined with increasing percentages of *Maesopsis eminii* in the upper canopy, except for the smallest size class of trees (<1.3m height) when Maesopsis comprised more than 60% of the upper canopy.

2. There was a positive correlation between the % area of plots affected by past timber harvesting or disturbance (>15 years previously) and the % of upper canopy now comprising of *Maesopsis eminii*.

3. Compared with other tree species in the plots, there were fewer Maesopsis in the smaller size classes, supporting the view that recruitment of Maesopsis is decreasing with the recent reduction in levels of disturbance. Nevertheless there were still more Maesopsis in the 5-10 cm (dbh) size classes than in any of the larger size classes, so recruitment has probably not stopped completely.

4. The percentage ground cover of litter was lower, and the percentage of ground cover of mineral soil was higher, with increased levels of Maesopsis in the upper canopy. This concurs with the studies reported in Hamilton & Bensted-Smith (1989), but given the above results in (1) this change does not appear to reduce the recruitment of native tree species.

5. Distance from the plantation at Kwamkoro (the major seed source), was a major determinant of the extent of invasion by the tree, which suggests that the importance of long distance dispersal of the seed by hornbills etc. may have been overstated in the past. In addition, there was a slight negative relationship between the % area of the plots affected by natural tree falls and the extent of invasion by Maesopsis, which suggests that the significance of invasion of natural gaps in the canopy forest may also have been overestimated.

These detailed studies suggest that *Maesopsis eminii* is not as great a threat to undisturbed indigenous canopy forest in the East Usambaras as has previously been suggested (e.g. Hamilton & Bensted-Smith 1989). However, the levels of Maesopsis appear to be closely related to disturbance, particularly from past harvesting, and distance from seed sources. Geddes (1995) therefore suggests controls on the levels of human disturbance and measures such as the harvesting or killing in situ of the dense Maesopsis in the plantations to reduce the largest seed sources. Although specialist seed feeding insects might be available from the native range of Maesopsis, the possible use of biological control was again not mentioned.

The differences in the assessment of the threat posed by *Maesopsis eminii* between the studies reported in Hamilton & Bensted-Smith (1989) and the more recent work by Geddes (1995) can be largely attributed to the huge reductions in the levels of disturbance to the East Usambaras forests over this period. This serves to emphasise how important it is that the current low levels of disturbance are sustained. Any increase in the level of disturbance will lead to renewed invasion by *Maesopsis eminii*. Under these circumstances a biological control programme could probably be justified.

5. Results from the current survey and assessment of the invasive weed problems in the East Usambaras forests

5.1 *Maesopsis eminii*

We examined sites in a range of areas (by necessity only a small number because of the limited time). These areas included the oldest planted sites of Maesopsis at Amani itself, the Kwamkoro plantations dating from the 1960s, and areas of selectively felled forest and intact forest both close to and several kilometres from the existing Maesopsis plantings. We also examined some experimental sites set up to look at possible control methods for the tree (Geddes 1993), and part of a transect from the plantations to relatively intact forest (Geddes 1995).

We saw very little sign of Maesopsis regenerating under any canopy, even in the relatively light shade cast by the tree itself. Where the ground vegetation was left undisturbed, it appeared that indigenous shade tolerant/requiring plant species were colonising well. This was even true for the oldest Maesopsis plantation just below the Amani Rest House. The situation is very much confused by the levels of management applied to the plantations. If regular clearance of the undergrowth is carried out then clearly little regeneration of tree species can occur. Indeed, this probably provides conditions under which Maesopsis seeds can germinate and survive.

In areas that had been badly disturbed in the past, such as forest margins near human habitation and major tracks, *Maesopsis eminii* was clearly capable of creating dense monospecific stands. These will probably continue to self-thin, and eventually as the surviving Maesopsis eminii trees age, replacement by indigenous forest trees should occur. Our impression was that any felling of the *Maesopsis eminii* for timber would create such levels of disturbance that the regeneration of the tree would occur. Even selective felling of trees would cause considerable disturbance, and damage any native understorey species that were regenerating under the Maesopsis canopy. Provided that levels of disturbance can be maintained at low levels, our impression of the successional future of the *Maesopsis eminii* stands concurs with that of Hall (1995) and Geddes (1995), i.e. that if they are left undisturbed, that they will eventually revert to native forest. However, we would go further than these previous reports in suggesting that disturbance is so important that we feel that no harvesting of *Maesopsis eminii* should take place in forest areas where it is hoped that native trees will eventually predominate. It may be possible to accelerate the successional process by killing at least some of the *Maesopsis eminii* in situ, but even this need to be carefully considered. Contrary to Geddes (1993), we think the best way to kill *Maesopsis eminii* in situ is probably by ringbarking. When we examined the experimental plots set up by Geddes in may 1992, it appeared to us (during the admittedly brief visit) that the ringbarked trees had all died eventually and that even some of the trees receiving the highest doses of glyphosate had partially recovered. Ringbarking may take up to 4 years to kill the trees, but is guaranteed to kill them eventually. We suspect that this slow rate of mortality would be beneficial for the encouragement of native tree species. Ringbarking will be very labour intensive, but glyphosate use is also expensive and is environmentally undesirable in a conservation region.

5.2 *Lantana camara*

During our visit we saw dense infestations of Lantana only along the edges of tracks and in other highly disturbed areas. Lantana did not appear to penetrate into intact canopy forest, and we saw little evidence that it could colonise natural forest gaps to any great extent. Lantana was very common in areas where cropping had recently been abandoned. We asked a small sample of local farmers who indicated that lantana was no problem to them, and in some ways could be beneficial: lantana was easy to clear from previously disused land, and the farmers felt that leaving land fallow with lantana cover improved the fertility of the soil.

Biological control has had some success against lantana in the many areas of the world where it has been attempted, but failure to control lantana adequately has been the most common outcome of such programmes. Work continues, particularly with the potential use of pathogens for the biocontrol of this weed, and detailed plant taxonomic studies are beginning to unravel this complex 'species'. The lantana we now find as a pan-tropical weed is the result of much hybridisation, polyploidy and selective breeding, which has resulted in a complex of forms - some of which have been more amenable to biological control than others. Although there does not appear to be a current need to consider biological control of lantana in the East Usambaras, it is an option that could be considered in the future when the probability of a successful outcome is likely to be improved. It would probably be prudent to send some lantana material (e.g. close up photographs of the flowers at various stages) to the relevant authorities (e.g. The Royal Botanic Gardens, Kew, UK) to discover which forms are present in the East Usambaras. The introduction of any forms of lantana that are not currently present should certainly be discouraged.

5.3 *Clidemia hirta*

Dense stands of *Clidemia hirta* were common in the same situations as lantana along tracks and in other highly disturbed areas. However it did not appear to invade recently abandoned agricultural land in the same way as lantana, and the local farmers appeared indifferent to it. In our visits to the forest reserves, including some of the remaining Saintpaulia sites, it was clear that *Clidemia hirta* can colonise the understorey of relatively intact canopy forest. It did not appear to grow vigorously as an understorey plant, but was widespread and could have some impact on native understorey species. Given the specialist habitats of the two Saintpaulia species that we saw, i.e. damp rocky outcrops and rocks in stream gullies, *Clidemia hirta* did not appear to be a threat to these rare plants. For Saintpaulia spp. growing on the forest floor per se, the weed could be a threat (but given the very limited sites involved, hand weeding is probably a reasonably sustainable management strategy). One possible concern was the way that Clidemia hirta colonised natural forest gaps if it was present as a local understorey plant. Should *Clidemia hirta* spread to be a virtually ubiquitous part of the understorey in the canopy forests, then its' effect of forest regeneration in natural gaps could be significant. The status, rate of spread and impact of *Clidemia hirta* on understorey plants and forest succession in gaps ought to be assessed.

Biological control of *Clidemia hirta* has been tried on Fiji (successful using *Liothrips urichi*) and on Hawaii (a number of agents including the thrips - all having apparently negligible impact) (Julien 1992). Interest in the potential biological control of this weed continues, and may accelerate given its importance on several oceanic islands as well as Hawaii.

5.4 Other weeds

Although *Maesopsis eminii*, *Lantana camara* and *Clidemia hirta* have received attention as the most serious threats to the indigenous biodiversity in the region, there are 48 species that have been reported as naturalised in the area (Sheil 1994). Considering the very extensive planting of alien species in the Amani Botanical Gardens this number is perhaps surprisingly low. One particular species of concern is wild guava (*Psidium cattleianum*), also known as Chinese or strawberry guava. There are small stands in the forests above the Amani Resthouse. During this visit, plantings of *Psidium cattleianum* dated 1968 were seen in the lowest altitude parts of the Amani Botanic Garden. The extent of the infestations of this weed should be surveyed at Amani and in other regions of the forest. The results from this survey should give some idea of the invasiveness of this species in these submontane forests, and this should be confirmed with a regular monitoring programme. Any substantial infestations, such as the one near Amani, could be held in check by manual control methods if they are found to spreading. Smaller infestations could be eliminated by intensive manual/chemical control. There is substantial expertise on Mauritius with methods for local elimination or control of *Psidium cattleianum*, and assistance/advice could usefully be sought from this source should such methods be considered necessary in the East Usambaras. This guava species has the potential to devastate high altitude forests given its ability to colonise intact canopy forest as a dense understorey shrub, and then form a sub-canopy so dense that regeneration of all tree species is prevented. Together with a wild privet species (*Ligustrum robustum*), which does not appear to be present in the East Usambaras, wild guava has caused massive degradation of the indigenous forests of Mauritius and is considered the worst forest weed in Hawaii (Cronk & Fuller 1995). The original reason for the introduction of wild guava into all these reasons is its prolific production of edible fruits. The plant also coppices very well, producing high quality poles. Given these attributes, it is possible that its further spread into the forests of the East Usambaras could be encouraged if local people become familiar with the plant. Any further spread of the plant has the potential to have a very serious long term impact on the forests. Some control measures against the plant are probably justifiable on this basis even if it is not currently a significant threat to the indigenous biodiversity. There is considerable interest in the potential biological control of wild guava both in Hawaii and in the Indian Ocean islands. A small programme run by the Hawaiians has identified several gall forming insects on wild guava in Brazil of potential interest as biocontrol agents (Wikler et al. in press), and CAB International has identified several plant pathogens attacking the plant, again in Brazil, that are of considerable interest (H.Evans pers. comm.). IIBC is currently seeking funding for a full biological control programme of both wild guava and wild privet for the Indian Ocean islands, and should this proceed, there will be the potential to use the agents identified by the programme for biological control of these weeds elsewhere in the world with relatively little extra research effort.

6. Recommended action and follow up

6.1 *Maesopsis eminii*

The low level of disturbance in the forests that prevents the re-invasion of *Maesopsis eminii* should be maintained as far as possible. Where high levels of disturbance are unavoidable it might be possible to encourage local people to promote the regeneration of native trees, which they value for timber, by manual control on Maesopsis eminii. Ideally, the status of *Maesopsis eminii* in the East Usambaras forests should continue to be monitored at intervals of several years. Currently, our view is that biological control of *Maesopsis eminii* is unnecessary, and that because of the need to limit disturbance, other control measures against the tree in areas where native trees are regenerating are also probably not needed. Should some selective elimination of the tree be considered advantageous, ring barking appears to be the best option. If low levels of disturbance are not maintained for the foreseeable future, *Maesopsis eminii* will be a significant threat to the indigenous forest species and would then warrant a biological control programme. If feasible, a low cost (e.g. student) project to examine the natural enemies of *Maesopsis eminii* in its native range would be currently justifiable.

6.2 Lantana

It would be useful to find out which form of this 'species' is present by sending material (e.g. close up photographs of the flowers at various stages) to the Royal Botanic Gardens, Kew, UK.

6.3 *Clidemia hirta*

Some monitoring of the impact of this weed on native understorey plants and on regeneration of native forest species in natural light gaps would be valuable.

6.4 *Psidium cattleianum*

An assessment of the scale of the current infestations and the threat posed by this alien plant, which has a track record of causing disastrous problems in montane forests in Mauritius and Hawaii, should be carried out with some urgency. Mechanical control using existing expertise from Mauritius should be considered and, if the infestations are on a small scale, the aim should be to eradicate the plant from the region. The International Institute of Biological Control will keep relevant bodies informed about progress towards the potential biological control of *P. cattleianum* should local eradication not prove feasible.

7. Acknowledgements

Stig Johansson and other staff of the East Usambaras Catchment Forest Project arranged the visit and provided valuable insights during discussions on a range of issues both during and after the field visits. Without the expert local botanical knowledge of Ahmed Mndowla, who accompanied us on all our field visits, our attempts to assess the impact of invasive plants on the indigenous flora of the region would have been vastly more difficult. Prior to our visit, SVF had valuable discussions with Alan Hamilton (Worldwide Fund for Nature) concerning the conservation problems in the East Usambaras. The mission was supported by the CABI Partnership Facility (international travel and IIBC staff costs) and by EUCFP (local travel, accommodation and other assistance).

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