INTERAGENCY EFFORTS TO COMBAT *MICONIA CALVESCENS* ON THE ISLAND OF MAUI, HAWAI'I

EFFORTS INTER-SERVICES POUR COMBATTRE MICONIA CALVESCENS *SUR L'ILE DE MAUI, HAWAI'I*

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Maui is the Hawaiian island where efforts to combat *Miconia calvescens* were first mobilized. An alarm of *M.c.*'s presence on Maui was first raised in 1991, about 20 years after its original introduction to the island. This alarm was taken seriously (based solely on *M.c.*'s track record in Tahiti), and removal of the seven known populations in lowland, windward East Maui was undertaken, but the ability of the species for dispersal was underestimated. By late 1993, when a more comprehensive assessment of the problem was in hand, several thousand fruiting trees were already present in a relatively inaccessible area (on a 500-year-old lava flow, with rugged substrate) upslope of the original introduction. In response to the severity of the threat, a multi-agency effort at *M.c.* eradication/containment was mobilized, based on an innovative, integrated strategy which has involved 1) helicopter spraying of herbicide as a holding action to limit seed production, especially in inaccessible sites beginning in early 1994; 2) development (1996-97) of access routes with a bulldozer to allow on-the-ground control; 3) hiring, beginning in June 1996, a locally-based 5-man crew, full time, charged with mechanical and chemical *M.c.* control; and 4) continuing public information and surveillance for new locations. Given stable funding to support the 5-man control crew for the next five years, we are guardedly optimistic for success in containing *M.c.*'s spread on Maui for the long term, especially if effective biocontrol can be developed. Sustained effort and success in locating and eliminating outliers will be crucial. The battle against *M.c.* has produced positive interagency links which are beginning to lead toward cooperative, coordinated efforts to exclude, eradicate, and/or manage other alien plant and animal species on Maui.

Maui est l'île de l'archipel hawaiien où les efforts pour combattre Miconia calvescens *ont été mobilisés en premier. Une alerte signalant la présence de* M.c. *sur Maui a été déclenchée pour la première fois en 1991, environ 20 après son introduction dans l'île. Cette alerte a été prise au sérieux (basée uniquement sur l'antécédent de la situation de* M.c. *à Tahiti) et une élimination des sept populations connues dans la région basse et sous-le-vent de East Maui a été entreprise, mais la capacité de dispersion de l'espèce avait été sous-estimée. À la fin 1993, quand un bilan plus complet du problème fut dressé, plusieurs milliers d'arbres en fruits étaient déja présents dans une zone relativement inaccessible (sur une coulée de lave âgée de 500 ans, au substrat accidenté) située au dessus de la population originelle. Pour répondre à la gravité de la menace, un effort multi-services afin d'éradiquer/de contenir* M.c. *a été mobilisé, basé sur une stratégie qui a impliquée 1) l'aspersion par hélicoptère d'herbicide comme action de soutien permettant de limiter la production de graines, en particulier dans les sites inaccessibles, dès le début 1994 ; 2) la construction (1996-97) de routes d'accès avec un bulldozer pour permettre une lutte sur le terrain ; 3) l'embauche (début juin 1996) à temps plein d'une équipe de 5 personnes basée sur place, chargée de lutter contre* M.c. *; et 4) la poursuite de l'information du public et la recherche de nouvelles localisations de* M.c. *Grâce à un financement stable permettant de payer l'équipe de lutte de 5 personnes pour les prochaines 5 années, nous sommes prudemment optimistes dans le succès de la limitation de l'extension de* M.c. *à Maui, particulièrement si une méthode efficace de contrôle biologique peut être développée. Le succès dans la localisation et l'élimination des individus isolés sera cruciale. La bataille contre* M.c. *a engendré des relations inter-services positives qui commencent à conduire à des efforts combinés pour exclure, éradiquer et/ou gérer de nombreuses autres espèces animales et végétales à Maui.*

In retrospect, we know that *Miconia calvescens* was introduced to the Hawaiian Islands about 1961 and has reached four islands -- O'ahu (1961), Hawai'i (early 1960s), Maui (early 1970s), and Kaua'i (late 1980s) (Medeiros *et al.*, 1997). We have also been told that after the late Pacific botanist F.R. Fosberg saw the developing infestation of *M.c.* on Tahiti in 1971, he warned Hawaiian botanists that "this is the one plant that could destroy Hawaiian rain forests" (F.R. Fosberg, pers. comm., 1991; Altonn 1991).

Why then was *M.c.* not listed as a Noxious Weed, illegal to sell or possess, under Chapter 68 of Hawai'i Statutes by the State of Hawai`i Department of Agriculture in Hawai'i until August 1992 ? One must assume that awareness of the threat from *M.c.* was not widespread among Hawaiian botanists, conservationists, and agricultural quarantine specialists. As recently as 1990, *M.c.* was not included as one of the 861 naturalized species receiving treatment in the authoritiative "Manual of the Flowering Plants of Hawai'i" (Wagner *et al.*, 1990). Several conservationists had expressed alarm in the 1980s at a spreading *M.c.* population at Onomea, north of Hilo, Hawai'i island (J. Davis, pers. comm.) and volunteer efforts to remove plants were mounted, but unfortunately the alarm did not prove contagious. The concern which has eventually led to statewide action was raised on the island of Maui in early 1991, about 20 years after its apparent introduction at Helani Gardens near Hana, Maui.

INITIATION OF *MICONIA CALVESCENS* CONTROL EFFORTS ON MAUI

National Park Service biologists, based at Haleakala National Park, became aware in 1990 that *M.c.* was present on windward East Maui, about 10 km from the Park boundary. Betsy Gagné, a Park employee who had seen the devastation caused by *M.c.* in Tahiti, noticed a single *M.c.* tree while driving past Ali'i Gardens, 10 km from the town of Hana. Gagné and Park biologist Lloyd Loope contacted the owner of Ali'i Gardens in January 1991, with the hope of eliminating the tree, which by then was surrounded by numerous saplings and seedlings. The highly cooperative owner of Ali'i Gardens destroyed the *M.c.* tree and provided information on the source of his tree -- Helani Gardens on the edge of Hana. Helani Gardens was found to have several dozen mature trees and thousands of saplings, but again, the landowner was cooperative and the problem seemed addressable. A presentation at the 17th Pacific Science Congress in Honolulu in May 1991 (Gagné *et al.,* 1992) and two newspaper accounts (Hurley, 1991; Altonn, 1991) expressed resolve in combating the problem on Maui.

Within the two years following discovery, seven *M.c.* populations were found, all within windward East Maui, but prospects seemed good for eradication because all were easily accessible. Over 20,000 plants were removed in 1991-93 from Helani Gardens and other sites, largely by National Park workers with assistance of volunteers. Scouting missions by foot into secondary forest just beyond the limits of Helani Gardens revealed scattered plants and groups of plants declining in number away from the garden, and the prognosis for winning the battle against *M.c.* seemed highly favorable.

However, the ability of the species for dispersal via birds had been underestimated. A much larger concentration of *M.c.* was discovered nearby during an aerial survey by state forester Robert Hobdy in September 1993. This population (hereafter referred to as the "Hana" population, after the district) already contained several thousand fruiting trees, based on aerial reconnaissance by Hobdy and Medeiros. There were several recognizable dense foci totaling 120 ha within a 1000 ha area upslope (100-350 m elevation) and west of Helani Gardens. The exceptionally rough terrain, underlain by a very young 500-year-old lava flow and thickly vegetated, had discouraged previous ground exploration, and continued to pose major problems for ground access. We realized for the first time that we were faced with

what was probably the largest and most rapidly spreading population of *M.c.* in the Hawaiian Islands.

Thus, a critical stage in the effort against *M.c.* on Maui (and in retrospect, in Hawai'i) was reached in late-1993. For the first time, it was clear that major resources would be required if there were to be any hope of eradicating or containing *M.c.* on Maui. But what to do? Initial reactions of desperation and discouragement by biologists and land managers stimulated a prompt and creative response.

COALESCING OF INTERAGENCY EFFORTS

In response to the severity of the threat, a multiagency effort at *M.c.* eradication was mobilized by the Melastome Action Committee and the East Maui Watershed Partnership.

The Melastome Action Committee (MAC) was formed in August 1991 through the initiative of R.A. Bartlett, conservation manager of the Maui Land and Pineapple Co., and E. Robello, the local representative of the Maui County Resource Conservation and Development Office of the U.S. Department of Agriculture. The Committee was formed to address the severe threats to conservation lands posed by plant species belonging to the Melastomataceae -- most notably *Tibouchina herbacea, Clidemia hirta*, and *M.c.*. *Tibouchina herbacea*, another highly invasive and ecosystem-dominating species, was first noted on West Maui in 1980 and had by 1991 come to dominate huge areas in the West Maui mountains managed by the Maui Land and Pineapple Company. *Clidemia hirta*, first noted in Hawai'i in 1940 and on Maui in 1976, has been recognized since the 1950s as one of Hawai'i's most damaging invasive species. The following state, private and federal entities have since met regularly since 1991: Hawai'i Department of Land and Natural Resources (DLNR), Hawai'i Department of Agriculture (HDOA), The Nature Conservancy (TNC), the University of Hawai'i, the National Park Service (NPS), the U.S. Forest Service, and (split off from NPS since November 1993) the Biological Resources Division of the U.S. Geological Survey (USGS/BRD). Activities of the Committee include public education, lobbying at the Hawai'i legislature and Maui County for funding for weed control programs, and planning, coordinating, and facilitating cooperative chemical, mechanical and biological control programs.

Whereas the Melastome Action Committee was established specifically to address the threat from invasive melastome weeds, including *M.c.*, the cooperative state-private-federal East Maui Watershed Partnership (EMWP) was formed in late-1991 with the goal of protecting watershed and biodiversity in windward East Maui "from non-native pest animals, weeds and other threats." EMWP members include DLNR, TNC, NPS, the East Maui Irrigation Company, Haleakala and Hana Ranches, and the County of Maui (represented by the Board of Water Supply). By late-1993, EMWP recognized *M.c.* as a major obstacle to accomplishing its mission.

The EMWP and MAC have worked jointly and effectively since late- 1993 to develop a strategy, obtain funds, and implement *M.c.* control on Maui. By the end of 1993, these two interagency groups had jointly adopted a strategy and presented it to a public meeting at Hana, Maui.

STRATEGY AND PROGRESS

The strategy against *M.c.*, first presented at the public meeting in Hana in December 1993, involves the following basic elements:

1) helicopter spraying of herbicide as a holding action to limit seed production, especially in inaccessible sites;
2) development of access routes to allow on-the-ground control;
3) mechanical/chemical removal by workers on the ground;
4) continuing public information and surveillance for new locations;
5) measures to prevent seed dispersal by "*Miconia* workers";
6) support for biological control; and
7) monitoring of progress.

These elements are described in more detail in Conant *et al*. (1997); the accounts below primarily provide updates since that article was prepared in early 1996.

1) Helicopter spraying of herbicide was implemented immediately as a holding action to limit seed production, beginning in early 1994. The release device for spot-spraying, attached below the Hughes 500-D helicopter by a cable, had been developed for use by local law-enforcement authorities in controlling marijuana cultivation in remote mountain areas. The herbicide (Garlon 4, ester formulation of triclopyr) was applied with surfactant and blue dye (Turfmark). The dye assists the pilot in judging application rate and identifying treated plants. As of late-1997, this strategy is still viewed as an important tool, especially in relatively innaccessible sites on cliff faces and steep slopes. Monitoring of effects of helicopter spraying of *M.c.* trees (n = 110 trees) in the Hana population with Garlon 4 in 1994 showed 72% of the trees killed and the remaining 28% of the trees with 69% defoliation and reduced fruiting after one year (A.C. Medeiros and C.G. Chimera, unpublished). Spraying of fruiting trees has proved effective as a holding action, but by opening the canopy, typically leads to abundant germination of soil seed banks of *M.c.*, and requires follow-up. Nevertheless, in spite of needed follow-up and the high cost of helicopter rental (ca. $850/hr), this method continues to be regarded as an important tool. As of late-1997, about 280 ha of the 1000 ha infestation have been treated at least once by spraying; the most densely-infested areas within this 280 ha have been sprayed repeatedly. Helicopter spraying is also envisioned as a tool for attacking individual outlier *M.c.* trees, detected within the forest canopy by monitoring from a helicopter, before they set seed.

2) Access routes were developed through rough lava terrain, overgrown with dense secondary vegetation, to allow on-the-ground control at the Hana *M.c.* population. A contracted bulldozer operator, supervised by Robert Hobdy of DLNR, opened the first road in early 1996. Within 18 months, 10 km of 4-wheel-drive roads were in place, subdividing the 1000 ha site into management units and allowing efficient access.

3) A Hana-based 5-man crew was hired in June 1996 and has been working full time to remove *M.c.* at the Hana population ever since. The motivation and effectiveness of this highly-motivated crew, supervised by Robert Hobdy of DLNR, is superb. They are pulling up saplings, cutting trees to large to pull up, and applying Garlon 4 herbicide to cut stumps. As of late-1997, it is foreseen that they will have systematically covered the entire 1000 ha *M.c.*-infested area once by June 1998.

4) Medeiros *et al*. (1997) mapped 10 Maui locations for *M.c.*, all on East Maui. Pat Bily of The Nature Conservancy has been successfully using public outreach/education within the East Maui communities of Keanae, Nahiku, and Huelo as a monitoring strategy to locate plants within known populations and to locate previously unknown invaded sites. The primary new location discovered within the past year was in Wailuku, a relatively dry area (mean

annual rainfall < 1000mm) between East and West Maui. A single planted tree had been removed around 1991, but several seedlings and saplings were found to persist in artificially-watered locations. All but two populations have been fully surveyed and all plants removed at least once. Some have been surveyed and plants removed a second time. The persistent seed bank, of course, necessitates continuing effort. Additionally, a number of isolated single trees have been located on East Maui, either the result of bird dispersal or of inadvertent (on boots?) human dispersal. Such isolated *M.c.* plants have been found as high as 600 m elevation and as much as 2.0 km from the nearest known population (P. Bily, pers. comm., 1997). These "outliers" (new populations?) provide cause for much concern and uncertainty.

5) No obvious problems have been noted in transfer to other sites of *M.c.* seeds in soil on the boots and equipment of crews engaged in control and assessment efforts. However, at this still early point in our efforts, it is difficult to assess the effectiveness of measures to prevent seed dispersal by "*Miconia* workers". Those working with *M.c.* are encouraged to wear conspicuously-marked footwear and other gear which are "dedicated," i.e. used only for work involving *M.c.*. Whenever bulldozers and other vehicles are used in *M.c.* areas, they are to be pressure washed immediately afterwards. The seed dispersal problem greatly complicates the issue of using volunteers. Whenever *M.c.* control is undertaken, a supervisor must be responsible for seeing that safeguards are taken seriously.

6) Biological control is regarded as a highly welcome adjunct to mechanical/chemical efforts, to reduce recovery potential through reduction in leaf growth and reproduction. In mid-November 1997, the fungus *Colletotrichum gloeosporoides* f. sp. *miconiae* (Killgore, Sugiyama and Barreto, this volume), which may prove to reduce vegetative growth of *M.c.*, was released by Dr. Eloise Killgore within the East Maui Hana population. Efforts are planned for the near future to bring a carposinid moth species, *Carposina bullata*, already tested and approved for release in Hawai'i, but not yet established in favorable habitats in Hawai'i, to the East Maui area (P. Conant, pers. comm.). The moth was originally investigated as a promising biocontrol agent for *Clidemia hirta*, upon whose flowers and fruits larvae feed; however, it was found to also attack many *Miconia* species in Trinidad, where *M.c.* is not present. We are hopeful that it will prove to attack *M.c.* as well. *Clidemia*, which is locally abundant on East Maui, not far from the *M.c.* populations, could serve as a primary host for the biocontrol agent even after *M.c.* populations have been largely eliminated. Establishment of insect biocontrol agents in Hawai'i has become notoriously difficult because of the accumulated establishment of a large diversity of alien generalist parasitoids. However, observations of the life history of the two moths in the field (R. Burkhart, pers. comm.) indicate that this larval moth should be protected from parasitism and predation through its feeding on the interior of reproductive parts of host plants.

7) We are committed to monitoring progress of control efforts as needed. The well-documented dynamics of *M.c.* re-establishment after removal within plots on Raiatea, French Polynesia (Meyer and Malet, 1997), suggests a minimum of 4-5 years from seed germination to fruit production; dynamics of East Maui *M.c.* populations closely resemble those found for Raiatea. Meanwhile, a feasibility study, by O'ahu-based TerraSystems, Inc., and the USDA Natural Resources and Conservation Service, will explore the effectiveness of spectral-sensitive aerial photography in detecting and mapping individual canopy trees of *M.c.*. The work is beginning in late-1997 and should be completed within one year.

Individuals of various agencies have stepped in to fill essential niches in the control effort. Major commitments are being made by DLNR (overseeing aerial herbicide application, development of access roads, and supervision of ground crews within the largest population, all by Robert Hobdy), TNC (eradication within peripheral populations), HDOA (logistical assistance with aerial herbicide application), and USGS/BRD (population mapping and monitoring effects of control).

CONCLUSIONS AND PROSPECTS FOR THE FUTURE

Hawai'i is the biological invasions capital of the United States and is in some ways in the forefront in confronting the problem (if not yet in effectively dealing with it). Lessons learned in Hawai'i are clearly highly relevant to other Pacific islands and perhaps to continental areas as well.

The Honolulu-based interagency Coordinating Group on Alien Pest Species is an alliance of biodiversity, agriculture, health, and business interests which has been working since 1995 to begin to seriously address the alien pest crises in the Hawaiian Islands (Holt 1996). A major public relations campaign was launched in late-1996 to increase public awareness of alien species problems (CGAPS, 1996).

Probably the most critical lacking element is a reasonably effective quarantine system -- better-funded, better-staffed, better-equipped, and better-legislated. Additionally, early detection and treatment of invaders before explosive spread occurs can potentially prevent many future problems.

As of late-1997, agencies and individuals on the island of Maui that have been working together at a grassroots level for six years to deal with the weed tree *M.c.* invasion envision evolution toward an interagency working group with subcommittees dealing with major categories of invaders. The group sees itself as a grassroots, single island based, component of Hawai'i's interagency Coordinating Group on Alien Pest Species. An island-wide plan would establish categories (exclusion, eradication, containment, large-scale management), and set priorities and responsibilities for pest management. The greatest challenge appears to involve obtaining funding and personnel to do the control work in an era of shrinking government. Is success possible? All agree that public education is a crucial ingredient of the anti-alien species strategy, to gain broad political support. Direct public involvement in selected eradication efforts is a useful tool. Publicizing success stories is an important formula for gaining support. Maui's successes and failures are likely to guide efforts statewide.

Approximately $500,000 have been committed to *M.c.* control on Maui since 1991. Efforts have intensified in 1996-97, and prospects appear favorable for a positive outcome although continued funding, commitment, and vigilance will be required. Given stable funding to support the 5-man control crew for the next five years, we foresee a chance of success in containing *M.c.*'s spread on Maui. Follow-up, possibly at a much reduced intensity, will be needed for at least an additional five years to deal with the declining seed bank. Ability to locate and eliminate outliers will be crucial to the effort. The prognosis for phasing out continual on-the-ground control effort depends to a great extent on establishment and effectiveness of the biocontrol agents and success in locating and eliminating outliers from the air, and we know that the latter is going to be very difficult. In other words, if everything goes extremely favorably and interagency effort is persistent, we have a chance to succeed.

What is the most potentially useful advice we can give Tahiti, French Polynesia, and other Pacific Islands? Watch out for *Clidemia hirta, Tibouchina herbacea*, and similar melastomes. *Tibouchina herbacea* reached Maui about 20 years and has exploded in pig-disturbed areas, first in West Maui and more recently in East Maui. Its dominance in extensive areas on Maui already rivals that of *M.c.* in Tahiti. Use the public's awareness of *M.c.* to publicize melastome threats. Ban importation of all members of the Melastomataceae.

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