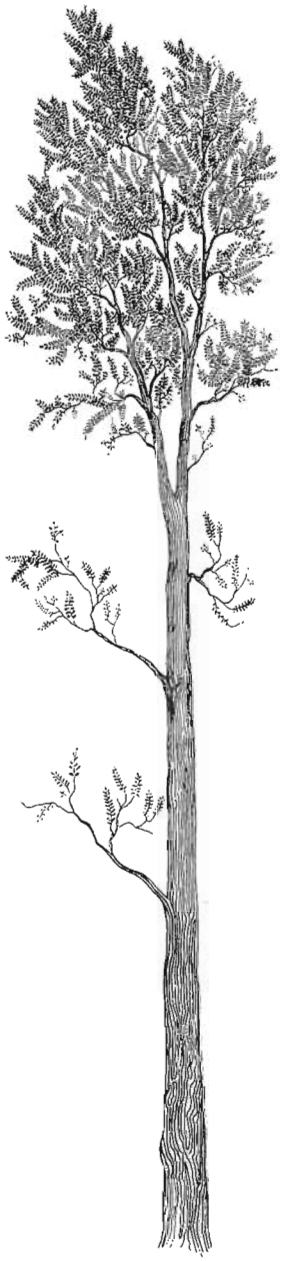

Aquatics
September 1990
Special Melaleuca Issue
Bulk Rate
U.S. Postage
PAID
Stuart, FL 34997
Permit No. 83



Melaleuca quinquenervia

This May Be The Single Biggest Threat To Florida's Environment.

As Melaleuca infestations continue to multiply, the natural balance of Florida's native plants and animals, as well as a large portion of its freshwater supply, are facing serious consequences.

Fortunately, there's ARSENAL® herbicide. Used as directed, it effectively controls aggressive vegetation like Melaleuca and the Brazilian peppertree. And ARSENAL gives you several options for application, including injection, frill/girdle, and foliage applications.

If you want to defend an area from the invasion of the aggressive Melaleuca, choose your weapon carefully. Choose ARSENAL. Because what's at stake is more important than ever.

CYANAMID

American Cyanamid Company
Agricultural Division
VPC Ventures
Wayne, NJ 07470

Always read and follow label directions carefully.

NOT APPROVED FOR USE IN AQUATICS. CONSULT SLN LABEL FOR SPECIFICS AND DIRECTIONS.

Melaleuca Will Be Tough To Dislodge...

Since its introduction to South Florida in the early 1900s, *Melaleuca quinquenervia* has been enormously invasive. The Everglades are highly vulnerable to this exotic tree and hundreds of thousands of acres are now infested.

Melaleuca in Florida does not face the rigorous growing conditions of its native Australia or the melaleuca-feeding insects, viruses and bacteria found there. Its invading strengths here also stem from adaptations to its native habitat. The tree forms coppices, or dense groves of many new offshoots, from solitary "mother" trees. It retains millions of seeds until a traumatic event occurs and induces seed release. It also withstands fire, when layers of peeling outer bark feed quickly moving blazes that spare the tree's core.

Recognizing the risks posed by all exotic plants, the Exotic Pest Plant Council has served throughout the 1980s to sound the alarm and coordinate the exchange of information regarding exotic plant management. Payoffs are becoming apparent, especially for the attack on melaleuca.

Included in the defensive attack is the mandate by the 1990 Florida Legislature prohibiting further melaleuca culture. Also, the U.S. Fish and Wildlife Service and other agencies are performing control operations within South Florida public lands. Spearheaded by the South Florida Water Management District, the 1990 Melaleuca Task Force formulated a regional melaleuca management plan from which melaleuca control contracts with government agencies and the private sector are being developed. Field trials will determine what control methods are likely to provide best control in various soils and hydrogeological regimes. In Australia, the U.S. Department of Agriculture is evaluating melaleuca-feeding insects with wide-ranging support.

The many-pronged attack is drawing upon multi-agency funding and expertise to establish a beachhead against further loss of natural Florida lands. Only a continued and cohesive *blitzkrieg* will achieve solid melaleuca control. As the members of the Florida Aquatic Plant Management Society are only too aware, exotic weeds, such as melaleuca and water hyacinth, are never totally eradicated. Will melaleuca in Florida be brought under "maintenance control," as has the water hyacinth? Those most familiar with the problem tree say that it *can* be done. Time, and continuing effort and dedication, will tell if it *will* be done.

Mike Bodle

About The Cover

Melaleuca quinquenervia looms large over the Everglades, threatening to displace what remains of this unique ecosystem.

Photo by: Gene Li, South Florida Water Management District, West Palm Beach, FL.

Aquatics

September 1990/Vol. 12, No. 3

CONTENTS

AQUATICS: Published quarterly as the official publication of the Florida Aquatic Plant Management Society. This publication is intended to keep all interested parties informed on matters as they relate to aquatic plant management particularly in Florida. To become a member of the FAPMS and receive the Society newsletter and Aquatics magazine, send $10.00 plus your mailing address to the Treasurer.

EDITORIAL: Address all correspondence regarding editorial matter to Mike Bodle, Editor, Aquatics" Magazine, P.O. Box 24680, West Palm Beach, FL 33416.

Melaleuca quinquenervia (Cav.) S.T. Blake: The Paperbark Tree in Florida or An Aussie Out of Control[1]

Description

A genus native to Australasia but represented in tropical Florida by one introduced and widely naturalized species. This tree is widely referred to as *M. leucadendron* (L.) L. but it has been shown that this was based on a misidentification of Florida trees. The tree has a wide ecological tolerance with preference for wet sites and this allows it to compete successfully against the natural vegetation. It is recognized by its white, spongy flaking bark, lanceolate longitudinally parallel-veined leaves and the clusters of woody fruits.

Growth

Leaves are spirally arranged and monopodial growth is pronounced. Saplings of this tree are strongly excurrent with a dominant leader which is readily substituted if the terminal bud is damaged but older trees become several-stemmed. Erect branches are borne at irregular intervals and there is some tendency for them to be tiered. Distal shoots have distinct alternation of vegetative and reproductive increments along the same axis separated by very conspicuous "scale-zones" made up of the closely overlapping scars of numerous bud-scales (Fig. 1f). Scale-zones may be over 2 cm long and represent the position of resting terminal buds. Lengths of shoot with foliage leaves separated by long internodes are produced during more vigorous cycles of growth.

The reproductive phase involves an increment of the axis which bears flowers. Former sites of inflorescences are indicated by the zones of persistent capsules on old wood and are usually separated from leafy increments by a longer or shorter scale-zone. Since all these changes in patterns of growth are reflected in distinct twig features, the previous history of a shoot can be assessed (Fig. 1a). However, different trees and even different shoots on the same tree are non-synchronous in their flowering.

Buds are borne singly in the axils of the foliage leaves but are largely absent from the scale-zones (except for

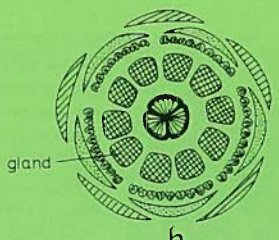


Figure 1. Melaleuca quinquenervia. *a. Habit (x ½); b. flower (x 4); c. flower in longitudinal section (x 4); d. stamen group (x 6); e. ovary in transverse section (x 8); f. unripe fruits (x 2); g. dehisced fruit (x 4); h. floral diagram.*

[1]Description, Flowering and Fruiting sections, reprinted with permission, *verbatim* from Tomlinson, P.B., The Biology of Trees Native to Tropical Florida, 1980, pp.271-285. Harvard Univ. Printing Office, Allson, MA. Illustration by Priscilla Fawcett.

occasional ones in association with the lower scales). Branching is somewhat irregular, but is most common at or just below the scale-zone i.e., from the upper nodes of the previous increment. The morphology of branch bases shows that a branch may grow out early or late i.e., after a brief or lengthy period of "rest." If brief there is but a single pair of prophyllar scales, if lengthy there may be a well-developed scale-zone. In this sense, although there is no sharp distinction, a relative difference between proleptic and sylleptic shoots is maintained.

Flowering and Fruiting

Reproduction involves the direct conversion of an axis into a flowering spike. This seems always to be preceded and succeeded by a "resting" phase represented by a scale-zone. Two main periods of flowering are evident, one in the fall and the other in early summer, but individual trees vary very much and isolated shoots may flower in almost any month. The fruiting "period" is even less easy to define because it is difficult to establish a precise time when capsules are ripe. It is possible that seeds are available throughout much of the year.

Melaleuca flowering in Florida occurs in summer and fall mainly, but also occurs sporadically throughout the year.

The apparent spikes (Fig. 1a) in fact include clusters of flowers in 3s, each triad subtended by a bract which falls early. The triads my be interpreted as dichasial units with the stalks to individual flowers suppressed. Each flower has a trilocular ovary enclosed by the calyx tube (Fig. 1e) and covered by ten prominent, hairy glands in five pairs which seem to be outgrowths of the calyx tube (cross-hatched in Fig. 1h).

The nectar produced by these glands accumulates internally in the cavities evident in Figure 1c. There are five glandular sepals and five white petals, each petal with prominent elongated glands (Fig. 1b). Opposite each petal is a stamen group with 6-10 stamens in each group (Fig. 1d). The style is a little longer than the stamens (Fig. 1c).

The fruits ripen as persistent woody capsules, clustered on the

Seed capsules ripen after flowers are fertilized and each may contain two to three hundred fertile seeds. Thousands of capsules are held on each tree for years, ready to release hundreds of thousands of fertile seeds at any time.

axis (Fig. 1f). They dehisce when dry (Fig. 1g) and the hundreds of minute seeds within each capsule are released.

Introduction of Melaleuca in Florida[2]

Of four possible early introductions of *M. quinquenervia* to Florida, there are two which most likely led to establishment, (Meskimen, 1962). Two independent inquiries to different Australians solicited recommendations of trees which could potentially survive Floridian environmental conditions. Both parties received seeds of *M. quinquenervia* in response.

Dr. John C. Gifford, University of Miami Forestry professor, received Australian seeds in 1906. Seedlings were planted at his home on Key Biscayne, and at Coconut Grove and the Stirling Nursery in Davie, Broward County. A.H. Andrews of Koreshan Unity Nurseries in Estero, Lee County, received seeds from Australia in 1912. Andrews and Stirling are both known to have actively distributed seedlings and seed. In 1936, H. Stirling distributed seed over the Everglades from an airplane.

Natural and man-made expansion of the initial trees proceeded from both locations. By 1962, in Lee County, Meskimen estimated partial to complete melaleuca coverage within an ellipse roughly five by fourteen miles long. During the 1940s, hundreds of thousands of seedlings were planted to provide erosion protection for the Corps of Engineers' newly-constructed Lake Okeechobee levee project. Florida Game and Freshwater Fish

Melaleuca establishment as far as the eye can see in the Everglades Water Conservation Area 2B.

The enemy's up ahead. Aquatic weeds. But so are your desirable native plants. So how do you target just the weeds? Not with expensive mechanical harvesters. Not with grass carp. But only with Sonar aquatic herbicide and your management skills.

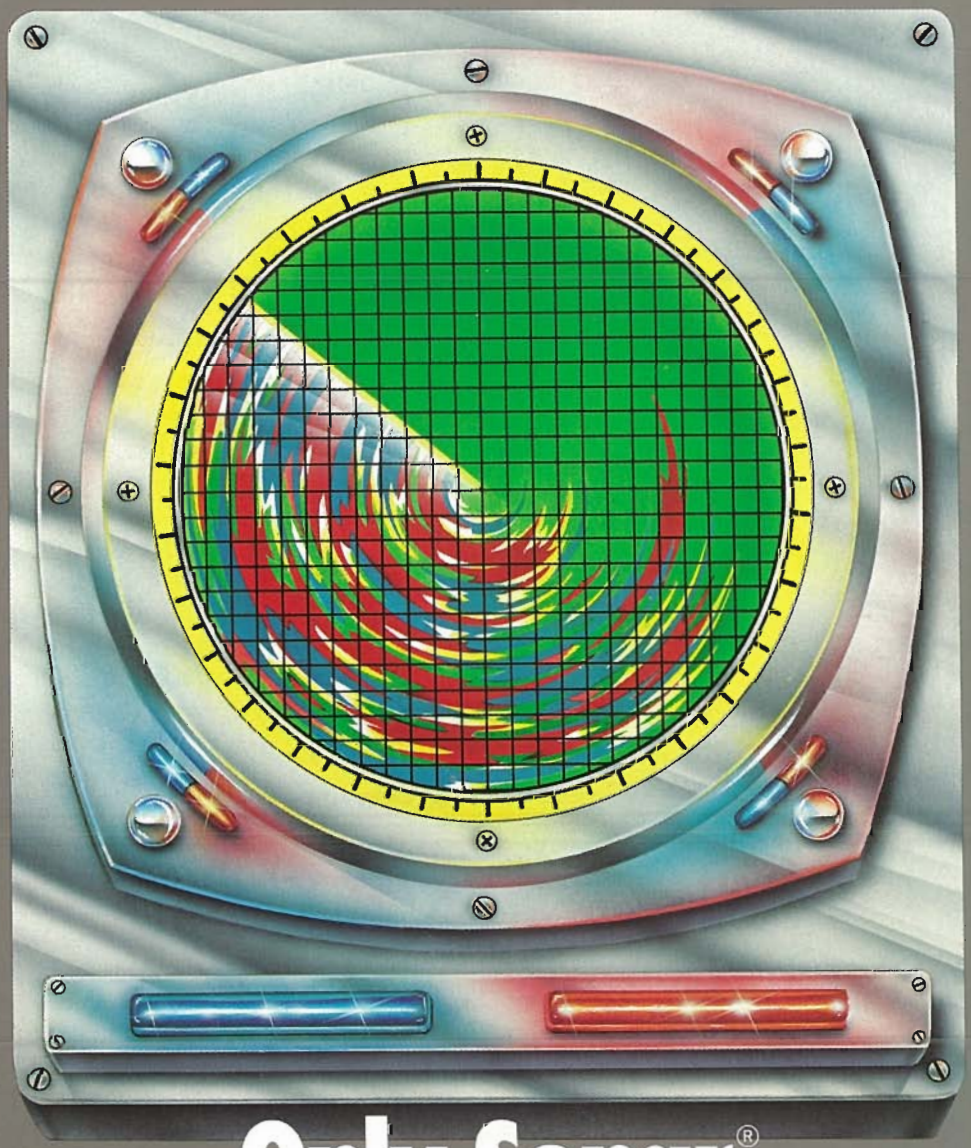
Sonar puts you in command of your aquatic environment. When applied with the right formulation at the proper times, it strikes down enemy weeds. Tough weeds such as hydrilla, milfoil, duckweed, fanwort, coontail and pondweed. And controls them a full year or longer with one application.

But unlike harsh methods, Sonar provides selective control and leaves your desirable vegetation alone. Without harming your aquatic environment, water chemistry or quality. Or depleting dissolved oxygen. Or restricting swimming, fishing or drinking.

Ask your Sonar aquatic specialist for a free water survey to match a Sonar program to your needs. Or for a free brochure, call toll-free: **1-800-352-6776.**

Elanco Products Company
A Division of Eli Lilly and Company
Lilly Corporate Center
Dept. EM-455, Indianapolis, IN 46285 U.S.A.
Sonar®—(fluridone, Elanco)

Weeds or desirable plants?



Only Sonar® knows the difference.

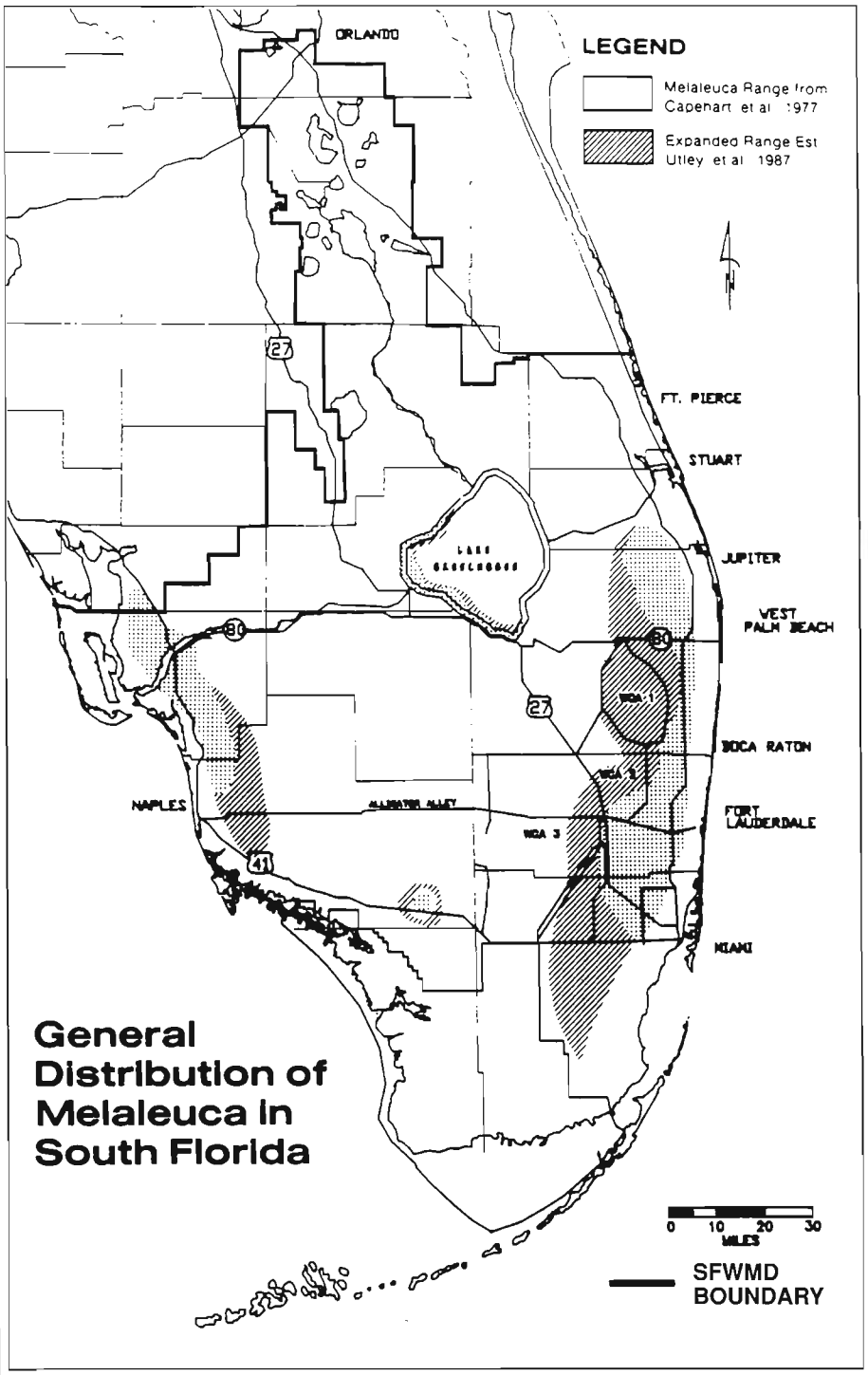


Figure 2. *General distribution of melaleuca in South Florida.*

Commission biologist H.E. Wallace was opposed to the planting, fearing spread of the trees would endanger the lake's northern marshes. By the 1950s, melaleuca was in wide-spread use by the South Florida landscape nursery industry.

Current Melaleuca Population in South Florida

Anecdotal references indicate that significant stands of melaleuca are a recent phenomenon in South Florida. South Florida Water Management District Governing Board minutes from an April 13, 1978 Water Conservation Areas discussion cite first-person memories that "half a dozen" trees were in Conservation Area 2B in the 1950s. Today, tens of thousands of trees are estimated in the same area.

The Forestry Service of the Florida Department of Agriculture and Consumer Services has conducted systematic reconnaissance flight surveys of melaleuca occurrence on 7.7 million acres in 10 counties south of Lake Okeechobee in 1980 and 1987 (Cost, 1981; Flowers, 1988.) The surveys are conducted to inventory forest and gauge the serious fire threat posed by melaleuca stands. Their 1987 data arrive at a grand total of 388,896 acres for the total area containing any melaleuca (Fig. 2). The monocultural stands of melaleuca subtotal of this figure is 46,793 acres.

Rates of Expansion

The rate of melaleuca expansion varies by locality. Ten to twenty percent fertility of seeds is reported (Meskimen, 1962), yet seed in seed capsules can remain viable up to several years. Several million seeds can readily be held on each tree, of which hundreds of thousands could be fertile and viable at any time. Seedling survival is more limiting. Following a seed release, a carpet of germinants is common but establishment is rare. Yet, with lots of seeds around, a low probability event becomes possible. In repeated trials, Meskimen found a maximum of 21 seedlings one year after planting 100,000 seeds.

Generally, seedfall occurs within one to one-and-one-half tree heights (Meskimen, 1962). Woodall (1981), hypothesized a population cell where expansion from a primary epicenter occurred by seed dispersal under ideal conditions such as "...a crown fire, followed by gale force winds, followed by sustained optimal soil moisture conditions." Such theoretical expansion could allow establishment up to 200 m from the epicenter every once-in-several-years of ideal fire, wind and soil condition events. Maximal 2 km dispersal distance is postulated for once-in-twenty-years combined events. Densities decrease exponentially with distance from the central population.

Populations would stabilize as maximum potential coverage was

attained. The potential range of melaleuca in Florida includes the "majority of the peninsula south of Lake Okeechobee, excluding the saline zone," (Woodall, 1978). Survival occurs northward, yet, for this discussion, will be limited to this area. The 7.7 million acres in this area include at least 388,896 acres (Flowers, 1988) of melaleuca. Assuming worst case potential for complete infestation of half of the entire area, this would place the current population at ten percent of its potential.

Melaleuca quinquenervia is now poised to expand throughout the Everglades. The time for integrated management of the tree has come. Combined efforts and methods will, hopefully, reverse this weed's expansion.

References

Cost, N.D. and G.C. Carver. 1981. Distribution of Melaleuca in South Florida measured from the air. In: R.K. Geiger, 1981.

Doren, R. and L. Whiteaker, Editors. In press, Proc. of the Symp. on Exotic Pest Plants, 2-4 November 1988, Miami, FL. Everglades National Park, Homestead, FL.

Flowers, J.O. 1988. Subtropical fire suppression in *Melaleuca quiquenervia*. In: R. Doren, in press.

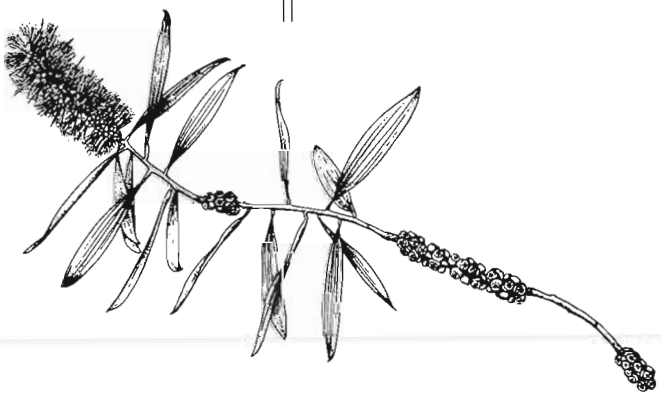
Geiger, R.K., Editor. 1981. Proceedings of Melaleuca Symposium, 23-24 September 1980. Florida Dept. of Agric. and Consumer Services, Division of Forestry.

Meskimen, G.F. 1962. A silvical study of the melaleuca tree in Florida. M.S. thesis. University of Florida, Gainesville, FL.

Woodall, S. 1978. Melaleuca in Florida: A progress report on research by the U.S. Forestry Service, Forest Resources Laboratory, Lehigh Acres, Florida.

Woodall, S. 1981. Establishment of *Melaleuca quinquenervia* seedlings in the pine-cypress ecotone of Southwest Florida. Fla. Sci. 46:65-72.

[2]Reprinted from, Thayer, D.D. and M. Bodle. Editors, Melaleuca Management Plan for South Florida, 1990, pp. 14-18. South Florida Water Management



Controlling Melaleuca, Trees From Hell

Aerial treatment provides cost-effective control of large stands of dense melaleuca.
Photo by D. Thayer, SFWMD

By
Ken Langeland, Associate Professor
Center for Aquatic Plants
University of Florida
Gainesville, Florida

Melaleuca quinquenervia, (Cav.) S.T. Blake, a hardwood species that can reach a height of 15 m (50 ft) was introduced into South Florida from Australia, in the early 1900s for landscaping purposes and to help dry up what were then considered to be useless swamps. Melaleuca grows more densely in Florida than in Australia, perhaps because of release from natural competition, insect feeding and disease. It can spread very rapidly into a variety of habitats and has the potential to alter vast areas of tree islands, sawgrass marshes, mesic prairies and aquatic sloughs, by displacing native plant communities. The dense monocultures that commonly result have reduced wildlife value and stability of the ecosystem can be lost.

Efforts to manage melaleuca have been conducted on localized levels by several agencies. The results of these efforts have resulted in varying levels of success. The need for communication between agencies and organization of efforts was soon recognized and the Exotic Pest Plant Council (EPPC) was established in

Algae control we can all live with...thanks to HYDROTHOL 191.

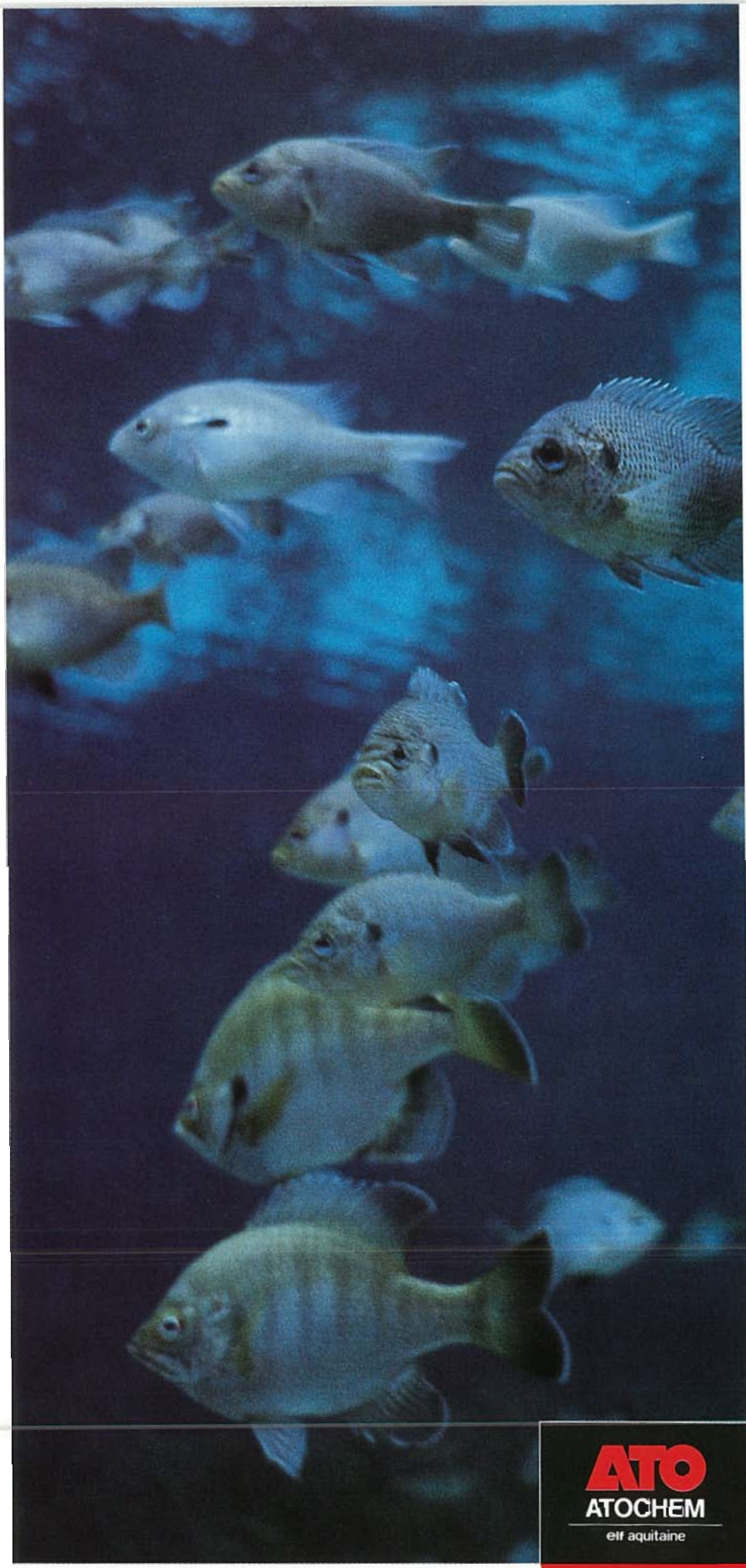
When you need to control algae in your lake, pond or canal, you want an algicide that's effective without being hazardous to fish or other aquatic life forms. That's why you should rely on HYDROTHOL® 191 Aquatic Algicide and Herbicide.

HYDROTHOL 191 works quickly on contact against Cladophora, Pithophora, Spirogyra and Chara. In both still and moving water. And, when applied at the recommended 0.2 ppm, HYDROTHOL 191 won't kill fish.

HYDROTHOL 191 is broken down by microorganisms into naturally occurring by-products based on the elements carbon, hydrogen and oxygen. It won't leave residues, accumulate in the hydrosoil or the food chain, or discolor your water.

As with any chemical product, you should read and follow label instructions carefully. Application by a certified applicator is recommended. We've taken great care to provide the information needed to help you enjoy algae free water in an environmentally compatible way. Talk to your distributor or ATOCHEM Representative today about HYDROTHOL 191.

ATOCHEM North America, Inc. Three Parkway, Philadelphia, PA 19102. 215-587-7219.



ATO
ATOCHEM
elf aquitaine

The Heritage: *Pennwalt* and *M&T*. The Future: *Atochem North America*.

1985 for this purpose (and for similar efforts related to other exotic pest plants).

More recently, a Melaleuca Task Force, sponsored by the South Florida Water Management District developed a "Melaleuca Management Plan for South Florida." This plan utilizes control technologies that have been compiled by the EPPC and recommends research that is necessary to develop needed control technology.

An effective melaleuca management program is difficult and a major reason for this is the lack of cost effective control methods. A successful management program will combine the use of herbicides with biological, mechanical and physical control methods and all of these are used or being studied. Whatever methods are used, persistence and surveillance are essential because of the tree's ability to release enormous amounts of seed following control measures.

Selection of herbicides for melaleuca control is difficult because the trees are often in aquatic habitats, saturated soils, or sensitive natural areas where damage to non-target vegetation is a concern. One of the major drawbacks to successful large scale melaleuca management is the lack of a selective, foliar active herbicide that is labeled for use over water and results in consistent control.

Control efforts in aquatic sites are limited to frill/girdle applications of Arsenal (imazapyr, 24C label, standing water only) or Rodeo, which can also be applied foliarly. Foliar application of Rodeo (glyphosate) is only effective on small trees and inconsistent. Frill/girdle applications of Velpar L (hexazinone) are effective but can only be used where water will not occur for 90 days after application. These application techniques are very expensive and time consuming and therefore, limit the amount of control that can be accomplished. Additional herbicides for use in aquatic sites are essential if melaleuca is to be managed. Frill/girdle and foliar applications of Garlon 3A (triclopyr, Experimental Aquatic Use Permit label in effect), foliar applications of Arsenal, and foliar application of Rodeo with different adjuvants in aquatic sites are under study.

On upland sites, monocultures of mature trees or seedlings can be killed by soil applications of Spike 80W, Spike 40P, Spike 20P (tebuthiuron), or Velpar L but the necessary precautions to prevent damage of non-target vegetation must be used. Frill/girdle and cut stump applications of Round-up (glyphosate), Velpar L, Garlon 3A or Arsenal can also be used. Foliar application of Banvel 720 (dicamba + 2,4-D) is effective on seedlings. Foliar application of Arsenal and Garlon 3A have been inconsistent and are under study with respect to variables such as timing of application and use of adjuvant.

Biological control organisms are essential to long term, cost effective

THE BRAND THE PROS USE

for Control of Suspended and Floating Algae

CUTRINE®-PLUS LIQUID

ALGAECIDE/HERBICIDE

E.P.A. Reg.No. 8959-10AA

Whenever waters are used for recreational, functional or aesthetic purposes, CUTRINE-PLUS offers the best solution to your algae control needs.

- *Broad range algae and hydrilla control*
- *Tank mix compatibility*
- *No water use restrictions*
- *9% active copper—contains no sulfates*
- *Will not corrode equipment*
- *So unique—it's patented*

for Control of Bottom Growing Algae

CUTRINE®-PLUS GRANULAR

ALGAECIDE

E.P.A. Reg.No. 8959-12AA

Specially formulated for ease of application and effectiveness in controlling bottom-growing forms of algae.

- *Eliminates weed-like forms of algae such as **Chara** (muskgrass) and **Nitella***
- *Controls filamentous algae at its source before surface mats form*
- *Economical—60 lbs treats an entire acre—no special equipment needed*
- *Ideal for spot treatment around piers, rafts and beaches—no water use restrictions*

For Additional Information:
Call 800-558-5106
In Florida 813-584-5230

applied biochemists inc
quality chemicals for the environment
6120 W. Douglas Avenue
Milwaukee, Wisconsin 53218

melaleuca management and a great deal of research toward identifying insects and disease organisms for this purpose is currently being conducted. These efforts are discussed on pages 15-19 in this issue of *Aquatics*.

Hand removal of small melaleuca seedlings is used in some situations but regrowth will often occur from small fragments that remain in the ground.

Bulldozers and logging equipment have been used to remove melaleuca trees from rights-of-way and a Menzi Muck has been used by the city of West Palm Beach. However, mechanical removal of melaleuca trees is not widely used because disturbance of the habitat by machinery creates conditions for regrowth from seedlings and root fragments. Follow-up applications of herbicides to stumps, suckers and seedlings is necessary following mechanical removal.

Physical control, i.e. fire or flooding alone, are not effective for controlling mature trees but can be effective, where applicable, for controlling seedlings, especially in combination with herbicide application. Fire with sufficient fuel will control small (<0.5 M) seedlings and rising water level following seed release has been found to kill newly germinated seedlings. Therefore, timing of herbicide applications with hydroperiod or properly timed controlled burns following herbicide application can augment management programs.

In summary, technology exists for small scale management and containment of melaleuca but current methods are too expensive and time consuming for large scale control operations. Research and development of herbicides and biological controls that will allow for cost effective melaleuca management is essential. The current level of melaleuca infestation in South Florida and the potential for continued alteration of natural habitats by this invasive biological pollutant signal that the need for a statewide melaleuca management program is now!

Australian Insects to Control Melaleuca

By
Joseph K. Balciunas
Research Entomologist
USDA Agricultural Research Service
Aquatic Plant Management Lab
Ft. Lauderdale, Florida

Melaleuca (*Melaleuca quinquenervia*) is an Australian native tree, introduced into Florida as an ornamental at the beginning of this century. In the past 30 or 40 years, an enormous, rapid expansion of this pest's range has taken place in southern Florida. Almost half a million acres are now infested, resulting in extensive environmental and economic damage.

In Australia, there are approximately 250 species in the genus *Melaleuca* (Barlow 1986). Most of these do not resemble *M. quinquenervia* in appearance, being small shrubs with needle-like leaves. Blake (1968) places *M. quinquenervia* and nine other closely related *Melaleuca* species in the *Melaleuca leucadendra* complex. These ten species, in nature, have different habitat requirements and can usually be reliably distinguished by differences in their fruits and flowers. Saplings and sterile material from older trees can be problematic, and sometimes cannot be identified to species level even by botanists very familiar with the group.

M. quinquenervia , while widespread along the eastern coastline of Australia, is usually restricted to swamps and wetlands, with some of the most extensive *M. quinquenervia* forests being found near the Queensland and New South Wales border. These forests bear little resemblance to the dense, monotypic infestations of *M. quinquenervia* in southern Florida. Although apparently mature (some even appear senescent) the trees in these Australian forests are relatively small (5-8 m tall), evenly aged and relatively widely spaced. The sparse canopy permits the growth of grasses and other understory vegetation. In Australia, *M. quinquenervia* is considered a desirable tree and is frequently available from commercial nurseries. Its popularity as an ornamental plant does not, however, approach that of the closely related, but more majestic *M. leucadendra*.

In late 1986, we initiated a preliminary search for natural enemies of melaleuca in conjunction with another USDA-sponsored project in Australia. These preliminary surveys indicated a large number of herbivores, in excess of 150 species, which at least occasionally feed on melaleuca. In 1989, the promising results from these initial surveys, and the efforts of the Exotic Pest Plant Council (EPPC) led to the formation of a coalition of federal, state and local agencies to support the expanded USDA Biological Control of Melaleuca (BIOCOM) Project.

The year 1989 was one of transition for what is now called the BIOCOM Project. The initial USDA project in Australia on the aquatic weed *Hydrilla verticillata* ended and the emphasis shifted to melaleuca.

1989 Field Results

Our field collections consist of two main types. Most are quantitative and are designed: 1) to list herbivore species for our melaleuca survey, and 2) to detect and estimate relative population levels of potential biological control candidates. The plant material for a quantitative collection, each assigned a unique collection number, was obtained by cutting or breaking branches from a sample tree. Tree height, sample height, trunk circumference, bark thickness, climatic conditions, as well as observations on abundance of fruit/flowers and visible herbivore damage were all recorded on the field data sheet. The twigs with leaves, fruit and flowers (if present) were snipped from these larger branches, placed in a large, transparent plastic bag and transported back to the laboratory. There, approximately one kilogram of this plant material was carefully searched and all insect fauna removed and counted. The weights of the leaves, twigs, fruit and flowers inspected was also recorded. The fruit and flowers were kept in individual ziplock bags and examined regularly over the next 1-2 months for any additional herbivores which might emerge. Non-herbivorous insects

were usually immediately preserved. Immature herbivores were placed into individual rearing cups (300 ml clear, plastic "fast-food" containers), provided with food, pupation material, etc. until they emerged as adults or died.

Our other main type of collection was a "field-search" collection. These consisted of insects collected directly from the vegetation while in the field. These on-site collections were more superficial than the quantitative collections, but usually far more plant material was examined. Large numbers of a particular insect species could be collected in this way, especially if that insect was the target of one of these "field-search" collections. This type of collection is the most efficient and reliable for obtaining the specimens needed for our laboratory cultures and tests. It can also be very effective for detecting low field densities of a particular herbivore, especially if the insect causes distinct damage to the plant.

In northern Queensland, during 1989, we made 96 quantitative collections of melaleuca herbivores. Most (n=40) of these were from *M. quinquenervia*, 36 from *M. leucadendra*, while the remaining 20 quantitative collections were from 3 other, closely related *Melaleuca* species. This brings our project totals in northern Queensland to 422 quantitative collections; 174 from *M. quinquenervia*, 98 from *M. leucadendra* and 150 from 8 other *Melaleuca* species. During 1989, we supplemented these with 37 field-search collections. These field-search collections are now the prime source of particular insects for our laboratory tests.

Matthew Purcell, my assistant in Brisbane, 1000 mi south of Townsville, made 48 quantitative collections in southern Queensland and 14 collections in the northern portion of the state of New South Wales during 1989.

1989 Laboratory Studies

We studied the biology and the life history of these insects by; 1) rearing individual larvae in small containers, 2) monitoring develop-

The larvae of the sawfly, Lophyrotoma zonalis, *defoliate melaleuca trees in Australia.*

ment of larvae feeding on our outdoor, potted test plants, and 3) inducing oviposition on caged saplings.

Sawfly-*Lophyrotoma zonalis*

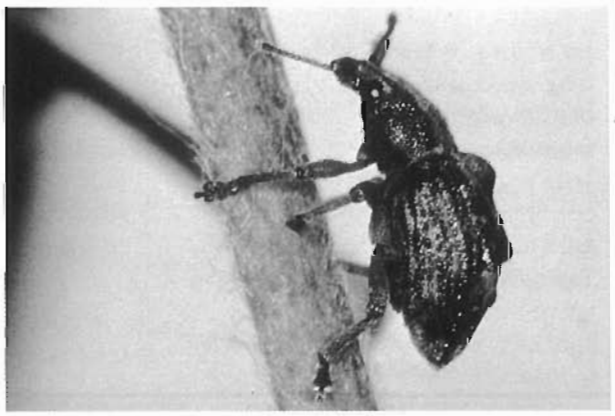
In Townsville, our studies emphasized the sawfly, *Lophyrotoma zonalis*, which periodically defoliates melaleuca trees in northern Australia. Because of the tremendous damage this insect sometimes causes, and since our initial observations lead us to believe that it is safe, *L. zonalis* is one of our top candidates for importation to the USA. These studies will hopefully allow us to maintain a constant laboratory culture of this sawfly for our host-specificity and other tests.

Adult *Lophyrotoma* live only 3-6 days and the female begins to oviposit within 2 days of emergence. Similar to some of the other species in the order *Hymenoptera*, these sawflies are parthenogenetic and do not require males for reproduction. The female usually inserts several dozen eggs in a line along the margin of a melaleuca leaf. This row of eggs turns brown and hardens with age, leaving a dark egg "case" along the edge of a green melaleuca leaf. These eggs may hatch in about 3-4 weeks during the summer, but hatching may take 5-7 weeks during cooler weather.

After hatching, larvae develop fairly rapidly, reaching pupal stage in approximately 5 weeks under ideal conditions. From our measurements of *L. zonalis* head capsules, it appears that the larvae pass through 10 instars. Pupation takes place on the tree's trunk and branches, in chambers excavated within melaleuca's thick, papery bark and underlying wood. This specialized pupation requirement indicates the close association of *Lophyrotoma zonalis* to papery-barked melaleuca species. It also suggests that *L. zonalis* is likely to be highly host specific and therefore safe to use as a biological control agent.

Our field studies of this sawfly during 1989 showed that it was less seasonal than initially believed. Once again, peak abundances, exceeding 100 larvae/kg of leaves, were observed during March and April. However, this year we also collected larvae, at much lower densities, throughout our southern hemisphere winter. In the field, this sawfly only attacks *Melaleuca* species that are very closely related to *M. quinquenervia*. Although preference appears to vary with locality and season, *M. leucadendra* and *M. quinquenervia* seem to be the preferred hosts.

This sawfly's geographic range may be limited to northern Australia. We have collected sawfly larvae very similar to *L. zonalis* near Brisbane. However, no adults have, as yet, emerged from the pupae formed by these larvae.



The adults and larvae of the weevil, Oxyops vitiosa, *feed on seedlings, saplings and new growth of mature trees.*

Weevils – *Oxyops vitiosa*

The other main focus of our research during 1989 was the biology and host-specificity of the weevil, *Oxyops vitiosa*.

Both the larvae and the adults feed externally on the new growth of melalueca, especially on saplings. Unlike the damage from other

foliage-feeding insects, the *Oxyops* feeding scars persist for most of the year. Also, melaleuca saplings do not respond to this feeding by producing new foliage. This results in a stunted and deformed sapling. If similar damage occurred in the Everglades, I believe that *M. quinquenervia*'s fire tolerance would be greatly decreased. It could become a fire-intolerant species as it is in Australia.

We are investigating the life history of this weevil at both our Townsville and Brisbane laboratories. Our studies show that the female weevil oviposits a single egg in a feeding hole on a "soft" leaf near the tip of new growth. This egg is then frequently covered with feces. The larvae cover themselves with a black, slimy secretion to which they sometimes attach feces and debris. This probably deters predation by birds and other vertebrates. Each larva develops through 4 instars in approximately a month, then pupates in the soil and litter underneath the sapling. Pupation may be as short as 11 days, but some adults do not emerge from the soil for as long as 6 weeks. The adults are long-lived and some are still alive in our laboratory after more than 9 months.

In August of 1989, we had the opportunity to perform a similar field host-specificity assessment in Townsville, but on a more quantitative basis. We noted *O. vitiosa* attacking some small *M. quinquenervia* trees in the Geosciences parking lot at James Cook University. We closely examined a portion (usually ¼ tree) of each of the 162 trees, belonging to 36 species, in the parking lot and its immediate vicinity. All *O. vitiosa* weevils, including eggs, larvae and adults were counted, and the number likely to be present on the entire tree extrapolated. Table 1 summarizes our results. Of the 4 *M. quinquenervia* trees in the study area, 3 were attacked by *O. vitiosa*, and one tree had over 200 larvae. A few *Oxyops* larvae were also found on 2 of the 6 closely related *M. leucadendra* trees in our study area. Of the remaining 152 trees, 33 were the red-flowered bottlebrush tree, *Callistemon viminalis*. One, whose branches were intertwined with the most severely-infested *M. quinquenervia*, had 3 large *Oxyops* larvae. These three larvae were provided with *C. viminalis* foliage in the laboratory, but they soon died. Other larvae fed on *M. quinquenervia* completed their life cycles. Thus, this bottlebrush tree, widely used as an ornamental in Florida and other states, does not appear to be a host for *Oxyops* weevils. This is good news, since we considered the bottlebrush trees might be at high risk, due to their close taxonomic relation to melaleuca. In fact, some taxonomists (Byrnes 1984) now place *C. viminalis* in the genus *Melaleuca*!

Other Weevils and Beetles

One of our collecting sites near Cairns, continued to provide small numbers of a weevil, *Haplonyx sp.*, throughout most of 1989. We have reared this weevil from larvae burrowing within (and destroying) the axis of *M. quinquenervia* inflorescences. Thus far, we have been unable to elicit oviposition from the *Haplonyx* adults we have exposed to *M. quinquenervia* saplings and small trees. Melaleuca flowers may be required for oviposition and none of our shadehouse *M. quinquenervia* has yet flowered.

Lepidoptera (moths)

In June of 1989, we began to replenish our depleted stock of *M. quinquenervia* seedlings and saplings in the shadehouse. This has given us an opportunity to begin preliminary studies of several insects which have become pests on our shadehouse melaleuca cultures. These include a tiny, as yet unidentified, moth whose larvae form blisters on melaleuca leaves. The small female (body length = 3 mm, wingspan = 6.5 mm) oviposits 1 or 2 eggs beneath the cuticle of a melaleuca leaf. The developing larva feeds beneath the cuticle, forming an individual blister that covers most of the leaf surface by the time it pupates. Development from egg to adult takes approximately 4 weeks, of which at least 18 days is spent as a pupae. The emerging adult uses the puparium to form a tube which pierces the blister and allows it to escape and mate. These shadehouse pests are occasionally collected in small numbers in the field. This suggests that the natural enemies of this blister moth are being excluded or reduced in our shadehouse. These same natural enemies are unlikely to be present in the USA. Thus, if this blister moth proves to be safe enough for release in Florida, it should be as damaging as in our shadehouse.

Other Insects

Various sap-sucking *Homoptera* were consistently collected on *M. quinquenervia* throughout 1989. The Eurymelid leaf hopper, *Ipo conferata* appears to be the most common and

Table 1. Individual trees on which *Oxyops vitiosa* was found during Geoscience Study 1, August 1989. Representative life stages of *O. vitiosa* are given as abundance per tree.

Host Tree	*Oxyops vitiosa* 1st instar	*Oxyops vitiosa* 2nd instar	*Oxyops vitiosa* 3rd instar	*Oxyops vitiosa* 4th instar	*Oxyops vitiosa* Adults	*Oxyops vitiosa* Eggs	*Oxyops vitiosa* Total
Melaleuca quinquenervia	36	36	44	84	0	28	228
Melaleuca quinquenervia	8	16	12	8	0	68	112
Melaleuca quinquenervia	8	4	0	8	4	12	36
Melaleuca leucadendra	0	0	0	0	0	4	4
Melaleuca leucadendra	4	0	4	0	0	20	28
Callistemon viminalis	0	0	0	6	0	0	6

A moth larvae feeding on melaleuca flowers parts is one of more than one hundred and fifty melaleuca-feeding insect species encountered in Australia.

widely distributed of these *Homoptera*. A preliminary exclusion experiment conducted in 1987-88 indicated the possibility that the feeding of these insects on small saplings could cause dramatic reduction in growth. We are therefore planning additional evaluations of these insects.

Less frequently, we also collect other sap-feeding insects which belong to the order *Hemiptera* (true bugs). Unfortunately, none of our *Hemiptera* specimens have yet been identified. I hope to visit Canberra early in 1990 and try to hasten the identification of our specimens being examined by the experts at the Australian National Insect Collection.

During 1989, we also continued rearing insects from a half dozen different types of melaleuca galls. Many different tiny wasps have emerged as well as a variety of flies and moths. Most of these, especially the wasps, are probably parasites of the insect which actually causes the gall. Many others are inquilines, uninvited guests, which utilize the gall for food or shelter, but which do not necessarily directly harm the gall-forming insect. The taxonomy of these insects is generally poor and most can only be identified to generic or family levels. Despite these drawbacks, we plan to continue our studies to determine the causative agent for each type of gall. Gall-forming insects are frequently highly host-specific, and therefore might be good candidates as biological control agents.

1990-91 Plans

During 1990 and 1991, we will continue life history and host specificity studies of the sawfly *Lophyrotoma zonalis* and the weevil *Oxyops vitiosa*. We are obtaining taxonomic assistance to verify that each of these insects is represented by only a single species. If space is available in the Florida quarantine facility, we hope to ship one of these insects there by 1991.

We also plan to conduct another experiment to verify the dramatic stunting attributed to sap-sucking *Homopteras*, especially *Ipo conferata*. We will continue investigating gall-forming insects as well as tip-binding moths and the numerous flower-feeders. We will also continue opportunistic studies of shade-house melaleuca pests, such as the blister moth.

In the field, our studies of host specificity will increase, and will probably be patterned after the Geoscience Parking Lot study detailed earlier in this report. Likewise, field collecting will be expanded to provide additional data on the seasonal and geographic distribution of melaleuca herbivores.

References

Barlow, B.A. 1986. Contributions to a revision of *Melaleuca* (Myrtaceae):1-3. Bruonia 9:163-177.

Blake, S.T. 1968. A Revision of *Melaleuca leucadendron* and its Allies (Myrtaceae). Contrib. Queensland Herbarium, No. 1, 114 pp.

Byrnes, N.B. 1984. A revision of *Melaleuca L.* (Myrtaceae) in Northern and Eastern Australia, l. Austrobaileya 1(1):65-76.

AQUAVINE

1990 FAPMS ANNUAL MEETING, FT. LAUDERDALE

The 1990 Florida Aquatic Plant Management Society Annual Meeting will be held October 2-4, 1990 at the Bahia Mar Hotel on Ft. Lauderdale's beach. On October 1, the Florida Aquatic Plant Advisory Council will meet at the Bahia Mar at 4:00 P.M. and the Board of Directors of FAPMS will meet at 7:00 P.M. All are welcome at all meetings.

The banquet will be the evening of October 3, and will have a country/western/cracker theme so all you Canal Cowboys and Cowgirls bring your western duds and saddle up your airplane boats as a good time is bound to be had by all, y'all.

IN MEMORIAM RAYMOND E. GOODMAN

SFWMD
Aquatic Plant Technician II
Kissimmee

It is very sorrowfully reported that Raymond E. Goodman died August 6, 1990 in Kissimmee after a brief illness. Ray was an integral member of the team which maintains the lakes of Osceola County. During thirteen years with the South Florida Water Management District he came to be a valued friend as well as a trusted and expert aquatic plant manager and is deeply mourned by all who knew him. His wife, Kathy, requests that remembrances of Ray be made as donations to the American Heart Association.

USDA BIOCONTROL NOTES

Namangana pectinicornis, the water lettuce moth, has received general release approval by the USDA Technical Advisory Group (TAG) on Biocontrol Insects. Additional approvals of the FDACS Plant Industry Division Arthropod Release Committee and the APHIS Environmental Assessment Group should also be forthcoming. Then, when sufficient numbers are reared and released by the team at the Fort Lauderdale USDA Research Station, Floridians may enjoy the relatively rapid water lettuce control seen elsewhere in the world when this moth has been released. In southeast Asia, water lettuce control by Namangana has been found to be thorough and reproducible, spurring comparisons to herbicide applications. Comparisons to herbicide use extend further since the control agent doesn't persist, but has needed to be applied again in the same area if water lettuce populations recur.

Also, another weevil of the Bagous genus has also received APHIS TAG general release approval. This hydrilla weevil bores and feeds within hydilla stems in its larval stage and is more truly aquatic throughout its life cycle than the hydrilla tuber weevil, *Bagous affinis*, which was released in Florida several years ago. Unlike *B. affinis*, *Bagous n.s.* (for Bagous new species) is not dependent upon water level fluctuations for establishment and has shown significant ability to damage hydrilla.

Recent surveys in Florida by visiting USDA research entomologist Richard Deonier, confirmed the establishment in Florida of the exotic hydrilla fly, *Hydrellia pakistani*. In the meantime, Dr. Deonier believes he identified seven new native species of the Hydrellia genus. That so many new species would be found during one whirlwind survey illustrates how little is known of our native aquatic insects.

The African hydrilla tip-feeding midge, *Polypedilum sp.* has been cultured successfully in the Gainesville quarantine lab and fed upon Florida hydrilla there.

Somewhere, amid the onslaught of hydrilla flies, hydrilla weevils, water lettuce moths and hydrilla midges, Florida's exotic aquatic plant woes may lessen in the not-too-distant future.

ANOTHER NEW FDNR REGIONAL BIOLOGIST

In the continuing (and august) procession of Florida DNR regional biologists, we now welcome Mr. David Demmi into the fold. Mr. Demmi has been with FDER where for eleven years he's analyzed water quality and mine reclamation activities. He is stationed at the Tampa office where he will regulate Polk, Highlands, Glades and Hendry counties along with Mr. Terry Sullivan and Mr. John Rodgers.

FDNR APM BUREAU ADDITIONAL MINUTIAE

The DNR Bureau of Aquatic Plant Management has promoted Mr. Dean Barber, Orlando office, and Mr. James Kelley, Floral City office, to the positions of Biological Administrators to oversee the activities of their proximate regional biologists, namely Messrs. Sullivan, Rodgers, Demmi, R. Lovestrand and Ms. Judy Ludlow. Additionally, Mr. Jess Van Dyke and Mr. Joseph Hinkle have been promoted to Environmental Specialists III, in light of their increased responsibilities as overseers of aquatic plant management contracts in their respective areas of Northwest Florida and Suwannee River Water Management Districts.

FLMS 2nd ANNUAL MEETING

The second annual meeting of the Florida Lake Management Society will be held at the Canterbury Retreat and Conference Center in Oviedo, FL, Sept. 26-27, 1990. Details are available from:

Vince Williams, FGFWFC
207 W. Carroll St.
Kissimmee, FL 34741
(407) 847-7293

PAUL MYERS' SPEEDY RECOVERY CONTINUES

Best wishes of the FAPMS Board and Membership go to Paul and Linda Myers. Unfortunately, Paul underwent surgery in August. But, he's on the mend and recovering quickly. In addition to Paul's generally being acknowledged as a great guy, he's always there when this Society needs help. Also, he's a FAPMS Past President and Charter Member. Keep up the quick recovery, Paul!

APMS 1990 ANNUAL MEETING

The national Aquatic Plant Management Society held its annual meeting July 16-18 in Mobile, Alabama. Along with the program proceedings, reported highlights for the 176 registrants included a beachside seafood banquet with live entertainment provided by country-western recording artist Ronnie McDowell.

Congratulations to the student paper award winners who were:

First Prize: Greg McDonald, "Comparative Effects of Antagonistic Ions on Glyphosate Efficacy on Torpedograss," University of Florida, Gainesville, Florida.

Second Prize: Tom Byl, "The Peroxidase Response of *Hydrilla verticillata*, (Royle) to Sublethal Concentrations of Heavy Metals and Sulfometuron Methyl," Memphis State University, Memphis, Tennessee.

Third Prize: Jan Miller,"The Effects of Slow-Release Fertilizer Application on Wild Rice Production," Lakehead University, Thunder Bay, Ontario, Canada.

Fourth Prize: Mark Mossler, "Microbial Degradation of Fluridone," University of Florida, Gainesville, Florida.

NEW AQUATIC PLANT GUIDE AVAILABLE

A new publication, *Aquatic and Wetland Plants of South Carolina*, is available from the S.C. Water Resources Commission. The manual has been specially designed for easy plant identification by botanists and nonbotanists alike using over 260 color photographs and illustrations. Color coded chapters, an illustrated glossary and an index with common and scientific names further assist the user in properly identifying over 90 aquatic plants and algae that occur in fresh water of South Carolina and neighboring states.

The principal author, Cynthia Aulbach-Smith, is the former curator of the University of South Carolina Herbarium and is a recognized authority of aquatic and wetland plants in South Carolina.

Development and printing of the book were coordinated by the South Carolina Aquatic Plant Management Council with funds provided by the South Carolina Water Resources Commission and corporate contributors. All proceeds from the book will go into a special public education account of the South Carolina Aquatic Plant Management Trust Fund.

Copies of the book are $8.00 plus postage and can be obtained by contacting:

Lyle McElveen
Publications Coordinator
S.C. Water Resources Commission
1201 Main Street, Suite 1100
Columbia, SC 29201
(803) 737-0800

NALMS 10th ANNUAL SYMPOSIUM

The 10th Annual Symposium of the North American Lake Management Society will be held Nov. 6-10, 1990, in Springfield, Massachusetts. Details are available from:

Gerald Smith
I.E.P., Inc.
6 Maple St.
P.O. Box 780
Northborough, MA 01532
(508) 393-8558

MELALEUCA CONTROL IN FEDERAL, STATE AND LOCAL LAWS

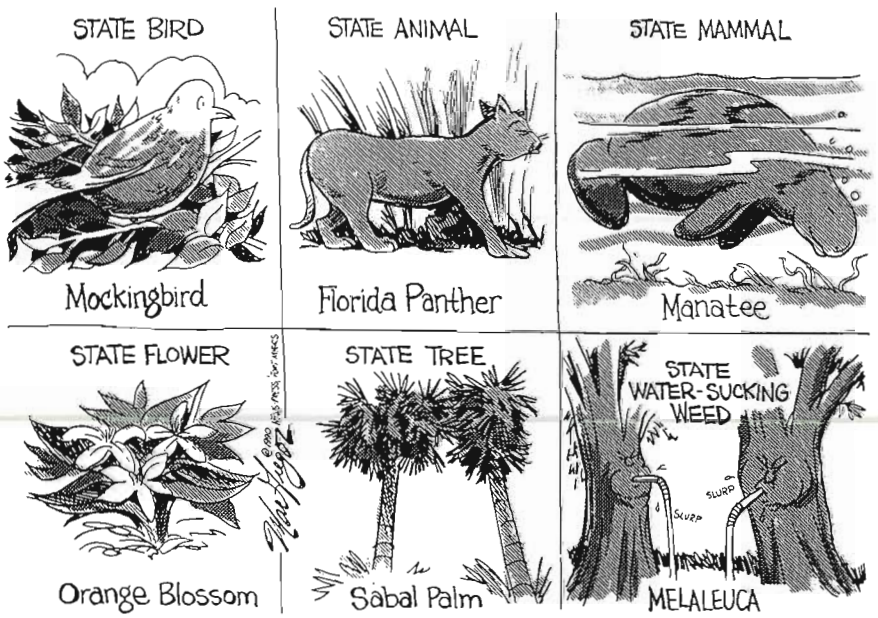
A number of melaleuca control ordinances, bills, rules and acts have been proposed or enacted by local, State and the Federal governments.

Most of the counties of South Florida now have, or are in the process of adopting, codes under which melaleuca culture is prohibited or it is not considered of value in the implementation of tree protection ordinances. Also, it may be required to remove melaleuca upon site development and melaleuca trees are not valid to show compliance with landscaping codes.

The city of Sanibel Island, Lee County, has achieved nearly complete melaleuca eradication by requiring private landowners to remove all melaleuca trees present. If the landowner fails to perform the removal, the city is empowered to do so, later invoicing the homeowner for the cost. On Sanibel, no invoicing was necessary since the landowners complied completely with the removal requirement. The city of Hollywood, Broward County, prohibits the sale, transportation or cultivation of melaleuca. Many other municipalities, for instance, the city of Boca Raton, Palm Beach County, are contemplating similar legislation.

The 1990 Florida Legislature enacted a law which prohibits the sale or transport in Florida, without a DNR permit, of melaleuca, Brazilian pepper, two species of Australian pine and *Mimosa pigra*. Additionally, the South Florida Water Management District is mandated to remove such plants from the Everglades Water Conservation Areas and DNR is directed to adopt rules to implement this act.

In the Federal Congress, Rep. E. Clay Shaw, Jr., R-Fla., is supporting construction of a South Florida USDA melaleuca biocontrol quarantine facility which would accelerate the melaleuca biocontrol initiative. The Fort Lauderdale Congressman's proposal may be considered by the Joint Congressional Committee in October. Also, as described in June 1990 *Aquatics*, the proposed Plant Protection Act of 1990, would include the present Federal Noxious Weed List with pest insects and pathogens and give USDA authority to readily amend the list.



Cartoon reprinted with permission from the *News-Press* of Fort Myers, Florida.

Rodeo® clears the way to better water management.

No other herbicide offers such effective performance.

You can clear away more than 170 emerged grasses, broadleaf weeds and brush species with Rodeo® herbicide. And once they're gone, they won't grow back. That's because Rodeo moves through the entire plant and kills it – roots and all.

Some herbicides provide only a temporary burndown. And mechanical efforts are also ineffective at providing lasting control. With Rodeo, however, maintenance becomes an economical spot treatment that takes minimal time.

There's no longer any reason for wetland sites or ditchbanks to become eyesores, health hazards or unsuitable as wildlife habitat. Rodeo is an effective, economical way to care for these areas. Just apply Rodeo a half mile or farther from a potable water intake. When this is done, treated water has no use restrictions.

Plus, with no residual soil activity, Rodeo won't leach into non-target areas. Use it with confidence to treat vegetation in and around lakes, rivers, streams, ponds, seeps, irrigation and drainage ditches, canals and reservoirs.

It's clear to see why you should use Rodeo. See adjacent list for your agent.

RODEO®
EMERGED AQUATIC WEED AND BRUSH HERBICIDE
BY Monsanto

ALWAYS READ AND FOLLOW LABEL DIRECTIONS FOR RODEO HERBICIDE.

ROP-0-169B

Clear things up completely with DIQUAT Herbicide.

If aquatic weeds are getting you down, we have the perfect prescription. DIQUAT Herbicide.

DIQUAT is a highly active, water soluble contact herbicide that controls a broad spectrum of floating, submerged and marginal aquatic weeds, like hydrilla, salvinia, water hyacinth and cattails.

Not only is DIQUAT fast-acting and biologically inactivated when absorbed through soil, it has no fishing restrictions. So don't let your weed problems develop into something serious. Give them a dose of DIQUAT, for really fast, long-lasting relief.

DIQUAT
Herbicide H/A

Avoid accidents. For safety, read the entire label including precautions. Use all chemicals only as directed.

VALENT™

FAST RELIEF FOR CONGESTION HEADACHES.