Water weeds that clog Florida's waterways are sunk when treated with ORTHO DIQUAT Herbicide-H/A. DIQUAT is a broad spectrum herbicide that kills both floating and submerged weeds—even the tough ones like hydrilla, water lettuce and water hyacinth. And DIQUAT works fast—in just a few days after application you can see dramatic results.

Diquat interrupts photosynthesis in plants. And DIQUAT is economical to use. It can be used to spot-treat small areas, or control larger infestations. When surface spraying, apply with ORTHO X-77® Spreader for best results.

Licensed applicators: see supplemental label for complete details.

ORTHO DIQUAT. It sends water weeds straight to the bottom.
EDITORIAL

Recently, managers in Florida, as well as in other states where hydrilla has just been introduced, have advocated the use of hydrilla in restoring eutrophic waters for improved fisheries or waterfowl habitat. While hydrilla may provide benefits to a eutrophic system when first introduced such as nutrient absorption, decreased turbidity, cover for forage fish and small sport fish and a food source for waterfowl, the potential detrimental effects caused by hydrilla far outweigh any positive short term aspects.

Once introduced in lakes and rivers, hydrilla cannot be effectively managed. Populations have been documented to increase by several thousand acres in one year. Increases of more than 500 acres were recorded during the past two years in 12 Florida waters. The average cost to control hydrilla in Florida was $411 per acre in 1985. A total of $4.5 million tax dollars were thus spent yet hydrilla increased by over 6,000 acres in 1985. Add to this, the loss of more than 10 million fish from oxygen depletion in hydrilla-choked Redman Reservoir and Lake Winder along with the economic loss surrounding these and other waters afflicted by hydrilla, and it should be clear that hydrilla is a poor choice for management in lakes and rivers.

Rather than encourage the spread of hydrilla because of the ease and up-front low expense of establishment, time must be taken to correct watershed problems and to find native vegetation beneficial to fish and waterfowl which can be planted into systems requiring restoration.

by Jeff Schardt

ABOUT THE COVER

Weed control without a permit? This cattail damage is a response to feeding by the cattail caterpillar, Soma hilaris. Caterpillar photo by Dale Habeck.

Cattail photo by Jim Kelley.

The Florida Aquatic Plant Management Society, Inc. has not tested any of the products advertised or referred to in this publication, nor has it verified any of the statements made in any of the advertisements or articles. The Society does not warrant, expressly or implied, the fitness of any product advertised or the suitability of any advice or statements contained herein.

FAPMS 1986 OFFICERS

President
David Taylor
2416 McVey St.
Tallahassee, FL 32303
(904) 562-1870

President Elect
Michael Mahler
P.O. Box 124
Auburndale, FL 33823
(813) 652-1214

Secretary
Jew Joyner
7922 N.W. 71st St.
Gainesville, FL 32606
(904) 376-0732

Immediate Past President
Clarke Hudson
8242 Sugarbush Ct.
Orlando, FL 32819
(305) 351-3295

Editors-At-Large
Ed Corson
5004-4th Ave. North
St. Petersburg, FL 33707

Bob Bradbeck
121 Whooping Loop
Altamonte Springs, FL 32701
(305) 370-7232

James A. Brewer
P.O. Box 6006
Verbo Beach, FL 32960
(305) 562-0555

FAPMS 1986 COMMITTEE CHAIRMAN

Membership/Publicity
Mike Mahler
P.O. Box 124
Auburndale, FL 33823-0124
(813) 965-1214

By-Laws
Bill Moore
200 Valencia Shores
Winter Garden, FL 32977
(305) 656-5838

Awards
Jim Harrison
P.O. Box 3429
Palm, FL 32078
(904) 328-8321

Govermental Affairs
Bray Bradbeck
121 Whooping Loop
Altamonte Springs, FL 32701
(904) 328-2737

Program
Mark McKenzie
10014 N. Dale Mahry
No. 101
Tampa, FL 33618
(813) 961-7885

Local Arrangements
Eddie Knight
P.O. Box 317
Palm, FL 32078-1317
(904) 328-2737

Aquatic Plant Advisory
Council Delegate
Mike Mahler
P.O. Box 124
Auburndale, FL 33823-0124
(813) 965-1214

Audlt
Terry Stephenson
Auburndale, FL 33823-0124
(813) 965-1214

The Florida Aquatic Plant Management Society, Inc. has not tested any of the products advertised or referred to in this publication, nor has it verified any of the statements made in any of the advertisements or articles. The Society does not warrant, expressly or implied, the fitness of any product advertised or the suitability of any advice or statements contained herein.

1986 FAPMS, Inc. All rights reserved. Reproduction in whole or in part without permission is prohibited.

AQUATICS. Published quarterly as the official publication of the Florida Aquatic Plant Management Society. This publication is intended to keep all interests informed on matters as they relate to aquatic plant management particularly in Florida.

EDITORIAL: Address all correspondence regarding editorial matter to Daniel Thayer, Editor, 'Aquatics' Magazine, 7922 N.W. 71st Street, Gainesville, FL 32606.
**WATER SPRITE**

by

Michael J. Bodle

Florida Department of Natural Resources
Bureau of Aquatic Plant Research and Control
8233-22 Gator Lane
West Palm Beach, Florida 33414

Introduction and Taxonomy

All is change,” said Confucius, or some great sage, yet
its true that the familiar may change and present an
unexpected new aspect. Such is
the case within the family Parkeriaceae or
the floating water ferns. Four species are
commonly called water sprite and
comprise the genus *Ceratopteris*. The
species are *C. cornuta*, *pteroides*,
*richardii*, and *thalictroides*. The members
of the genus can change and seem very
unfamiliar as their life cycles progress.

Life Cycle and Growth

Water sprite are true ferns and as such
exhibit alternation of sexual and asexual
reproductive modes. This alternation of
generations is most overtly apparent by
differences in the fronds themselves.
Fertile, spore-bearing fronds differ from
sterile, vegetative ones in shape and
structure. The sterile fronds are most
often found growing entirely underwater.
Identification confusion may occur when
the fertile, aerial fronds present their
filiform, highly dissected and celery stalk-
like shapes in the same shallow and
littoral waters.

Distribution

The Parkeriaceae are reported to be
South American and African natives.
Introduction to North American likely
occurred by avian and anemophilous
transport. Small plantlets can adhere to
migrating birds and the minute spores,
when released from fertile frond
sporangia, can be carried by the wind.
Reports of manatees bearing rucksacks
stuffed with sprite have not been
confirmed. *C. deltoides* and *thalictroides*
were both reported in Florida along the
Gulf Coast as early as 1880, (Small).
*Ceratopteris* species may be found in
flowing waters but are fragile and easily
fragmented. More common habitats are
slowly moving and lacustrine waters. The
plants are cold-intolerant and distribution
is limited to the tropics and sub-tropics.
All plant parts except the roots are
considered edible with Australian reports
holding that the unopened frond
fiddleheads make a nice addition to
wallaby stew, (Author-personal
communication).

Water sprite is widely cultured for sale
as an aquarium plant and has,
undoubtedly, achieved wider distribution
since the advent of this transport
mechanism. Pantropical distribution is
now reported. Typically, the submersed,
sterile adult stage of the plant is sold.
When encountered in the field this plant
stage may be free-floating, rooted on
mud or in “floating island” communities.
The sterile fronds are usually three to
thirty inches long and two to six inches
wide with oblong rounded lobes. They
strongly resemble spinach leaves. These
fronds may be floating, submersed and,
rarely, emersed. Typically pale green, the
basal frond stipes may be spongy and
air-filled.

Reproductive Modes

As in all true ferns an alternation of
generations occurs during the
*Ceratopteris* life cycle. These generations
are most evident as the fertile and sterile
stages of the plant. The vegetative plant is
predominant and not sexually
reproductive. In Florida, re-establishment
of the vegetative plant after cold season
dormancy leads to fertile frond formation
during the summer and fall. Both frond
types may arise from the same plant.
Sexual reproduction occurs as the
fertile, emergent frond releases spores
that develop into prothalli. The
prothallus is a minute plant body which

Vegetative fronds (left) and fertile fronds (right) of water sprite.
releases male and female gametes while submerged or on mud. The gametes unite to form and embryo that develops into the plant of the new generation.

Vegetative reproduction occurs in the axils of both fertile and sterile fronds by offsetting of plantlets. Such offsetting of daughter plants genetically identical to the mother plant occurs in many higher plants as in the water-hyacinth (Eichornia crassipes [Mart.] Solms.). Ceratopteris offsets are first noticed as small buds at frond indentations. These develop into distinct plants following separation from or the death of parent plants.

Habitat and Conclusion
Water sprite can be found in Florida waters floating in mats of water-hyacinth, water lettuce (Pistia stratiotes L.), and other floating tussock-forming plants such as sedges, smartweed, and water primrose. Also, it inhabits the shoreline, often in calm embayments and coves. The submersed, vegetative plant has an unique appearance but the emergent fertile sporophylls may be confused with aquatic members of the carrot family (Umbelliferae) or even European celery since the basal stipe is ribbed. The stalk is non-fibrous, though, and the spongy, air-filled tissue is delicate despite its robust appearance.

The Department of Natural Resources 1982 Aquatic Plant Survey reported water sprite from only one site. The 1983 Survey reported five sites and eight sites totalling 12 acres of coverage are reported from 1984. The predominantly submersed infertile growth may hinder field identification of this phase. The aerial growth can be quite substantial yet seem odd and unexpected. When encountered it may have been overlooked, rather hopefully, like an obnoxious cousin at a family reunion.

Water sprite is a well-established and, to date, non-problematic element of the Florida aquatic flora which is encountered in both pristine and disturbed waters. In my experience, although the plants are succulent, they show no apparent signs of having been grazed upon. While the plant may not serve as a major faunal food item the fronds and filamentous roots undoubtedly provide substrate for periphyton and invertebrate growth and as such contribute to the overall richness and diversity of Florida waters.


---

**PDA: THE NOT-SO NEW APPROACH TO AQUATIC WEED CONTROL**

BY

John Barltrop, Barbara B. Martin, and Dean F. Martin

CHEMS Center

Department of Chemistry

University of South Florida

Tampa, Florida 33620

Introduction

PDA, an abbreviation for "photo-dynamic action," refers to the light-dependent lethal effects that certain colored organic substances have upon organisms. The effect was first observed in 1900 by Raab (1), who treated paramecia with acridine. The term PDA was coined by von Lippeiner 1906 (2). Since then, many studies have been done on this phenomenon, but we believe that the potential for PDA management of noxious aquatic plants has not been well appreciated.

The application of PDA to management of noxious submersed aquatic plants was suggested by several observations (3). First, we saw how effective the approach could be in laboratory studies of the unarmored dinoflagellate *Psychodiscus brevis* (4, 5). Secondly, a review of the literature (6) indicated several instances in England and the United States when hydrilla and similar plants either failed to thrive or spontaneously disappeared in areas where colored organic materials were either present or being produced. Finally, Quimby (7) noted the effectiveness of hydrogen peroxide in limiting the growth of hydrilla in laboratory studies, and we recalled that some investigators have ascribed the effect of PDA to the production of the hydroperoxide radical at critical sites in plant membranes. Also, the effectiveness of Fluorodone is ascribed to inhibition of carotenoid synthesis and subsequent photodestruction of green pigments (8).

PDA is now considered (9) to depend upon the conversion of ordinary oxygen (called "triplet oxygen") into an electronically excited form known as "singlet oxygen." This conversion required transfer of an appropriate amount of energy, usually from visible or ultraviolet radiation. Colored organic substances absorb light energy (photons) from sunlight and upon collision with oxygen molecules transfer the energy. The colored substances are called sensitizers, and the singlet oxygen produced is a violent oxidizing agent that is capable of oxidizing a large range of organic molecules, including, of course, cellular constituents. A cell exposed to light and oxygen will die, unless repair mechanisms can operate faster than the rate singlet oxygen can destroy or inactivate cellular components. Plants do, of course, produce protective agents called quenchers (e.g. carotenoids), whose function is to inactivate singlet oxygen and convert it to ordinary oxygen.

To be effective in a management scheme, the rate of production of singlet oxygen within the plant must exceed the rate of generation within the cell of critical constituents. Obviously, many plants that contain sensitizers, e.g. chlorophyll, manage to play the game and produce quenchers (carotenoids) and survive.

Continued on page 8
Clean up... with a clear conscience.

Pennwalt’s aquatic herbicides: The responsible choice for aquatic weed control.

For 25 years, Pennwalt’s aquatic herbicides have been effectively controlling aquatic weeds without harming the aquatic environment. Based on endothall, these products disappear rapidly from the water and soil through microbial degradation.
They do not bioaccumulate in the food chain, nor do they bind or leave residues in the hydrosoil. And Pennwalt’s aquatic herbicides provide an ample safety margin to fish, shellfish, birds, and other wildlife.

For a complete aquatic weed and algae control program, Pennwalt offers four choices:

- **Aquathol K** Aquatic Herbicide
- **Aquathol** Granular Aquatic Herbicide
- **Hydrothol 191** Aquatic Algicide and Herbicide
- **Hydrothol 191** Granular Aquatic Algicide and Herbicide
From extensive investigations, it appears that
(1) no organism thus far investigated is immune to damage or destruction by PDA;
(2) species-dependent selective toxicity is often observed;
(3) for unicellular organisms, variation in the structure of the colored substance causes binding to occur at different locations within the cell, so that the site of PDA is subject to control;
(4) a considerable degree of design by calculating chemists in synthesizing better colored substances for better selectivity is possible.

Research at the CHEMS Center on the applications of PDA is an on-going collaboration, and we have found that some dyes can be used to reduce the growth of single-celled organisms (4), that some dyes affect hydrilla in laboratory studies (3), that sediment components do show PDA toward hydrilla and that singlet oxygen is involved (10), and that not every dye works; some like Aquashade® function by shading, not by PDA (11).

At the CHEMS Center, we believe that PDA is a not-so-new approach to management of problem plants that has the potential for selective control, cost effectiveness, demonstrated success, and even, colorful research. On-going research indicates the potential of PDA for management of undesired aquatic plants; the realization of additional field applications may take a while.

References

NEED AERATION EQUIPMENT?
DON'T INSTALL A FOUNTAIN,
DON'T BUY AN AIR BUBBLER,
& DON'T INVENT YOUR OWN.

Save a lot of time, trouble and electric power cost with pre-engineered aeration equipment that works.

State-of-the-art aeration equipment is now available (at dealer prices) from the leader in lake aeration/destratification systems.

No other company can guarantee a 5 mg/l minimum bottom dissolved oxygen level (EPA requirement) with so little horsepower.

We will assist you in sizing and selecting the equipment for each application. We offer low maintenance systems complete with cabinet—from $400.00. Call or write for information and literature.

ELIMINATE FISH KILLS • MEET STATE & FEDERAL STANDARDS

AQUATIC ECO SYSTEMS, INC.
PO. BOX 1446 APPOKA, FL 32704
(305) 886-3939
Until recently, hydrilla (*Hydrilla verticillata*) and water hyacinths (*Eichhornia crassipes*) were the main aquatic plant problem that existed in the lakes maintained by the City of Orlando Bureau of Streets and Drainage, Orange County. Orlando’s twenty years of aquatic weed control, which has been mainly a spray dominated operation, has now evolved into a multi-faceted concept, covering several aspects of aquatic plant control.

Through past work with the diploid, hybrid and now triploid grass carp, along with herbicides, we have most of the hydrilla infestations at a management level. Herbicides have been the major tool used to control infestation of water hyacinths, although some damage by the water hyacinth weevils (*Neochetina bruchi* and *Neochetina eichhorniae*) has been noticed. With the two problem exotic species at a maintenance level, we decided to develop a work plan to address the shoreline vegetation.

Phase I of the work plan was to survey all aquatic vegetation on the lakes. There are 77 lakes within the city limits which range in size from 1 to 320 acres. The City of Orlando has jurisdiction over 45 sovereign lakes. The remaining 32 lakes are privately owned by homeowners or associations.

The survey was conducted from an airboat to document the location, amounts of vegetation and different species of aquatic macrophytes that were present. Additionally, a city photographer took aerial photographs of Orlando’s lakes. From these pictures were made overlays of each lake to map the location of vegetation.

Phase II of the work plan was to review the survey information. We noticed the shorelines were dominated by undesirable vegetation, both exotic and native species. We considered cattail (*Typha* species), water primrose (*Ludwigia octovalvis*), alligatorweed (*Alternanthera philoxeroides*) and torpedo grass (*Panicum repens*) undesirable because they were limiting boat access, were aesthetically displeasing and prohibiting the expansion of desirable aquatic plants. Since only six lakes have public boat ramps, shoreline access is very important for those people in Orlando who fish from the lake banks.

Phase III was to target undesirable vegetation for aquatic herbicide treatments. The recent introduction of new formulations of aquatic herbicides helped to achieve satisfactory results on sprayed vegetation. We left undesirable native and exotic macrophytes unsprayed to encourage their expansion while treating targeted species. Examples of non-targeted macrophytes already present in Orlando’s lakes are maidencane (*Panicum hemitomon*), knot-grass (*Paspalidium geminatum*), fuirena (*Fuirena scirpoides*), elephant ears (*Colocasia lutea*), arrowhead (*Sagittaria lancifolia*), Spatterdock (*Nuphar luteum*), pickerelweed (*Pontederia lanceolata*) and cyperus (*Cyperus* species).

Phase IV was to determine and locate desirable macrophytes to introduce. Our survey showed that bulrush (*Scirpus californicus* or *Scirpus validus*) did not exist in any of Orlando’s lakes. This is one plant we intended to use to replace treated cattails.

With the assistance of the Department of Natural Resources (DNR) and their statewide aquatic vegetation survey, we were able to locate collection sites for giant bulrush. We checked three potential sites for revegetative plant material. A site inspection of East Lake Tohopekaliga in St. Cloud and Lake Hart in Orange County showed that bulrush was growing in water too deep for retrieval. We selected the St. Johns River as our most promising location because it was close to an adjacent boat ramp and also the shallow depth of the bulrush collection site made it easier to remove the plant.

We also noticed from the survey, the absence of cypress trees in and around the lakes. Areas of undeveloped city...
property and ditches adjacent the Beeline Expressway, between Orlando and the St. Johns River, were excellent collection sites for obtaining cypress trees. We may have possibly prevented destruction of several trees by relocating them from the Beeline Expressway. These trees would have been destroyed by mechanical maintenance of the ditches; therefore, we feel the trees were optimally utilized by being transplanted.

Phase V covers the revegetation of desirable native and exotic macrophytes. Our season for herbicide spraying usually concludes during the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.

Herbicide treatment work and aquatic vegetation schedules for physical removal are submitted to DNR under our aquatic work plan. Upon approval of the work plan, which goes into effect in the month of December. Four aquatic technicians, two from the airboat and two from the spray truck crew, are then available to transplant vegetation. Also available for plant revegetation are fourteen maintenance workers. Four personnel normally operated weed-eaters and use backpack sprayers for shoreline vegetation control, while the remaining ten use large mowers and weed-eaters to manage ditch bank vegetation.
and transplanted during their dormancy. If a recently transplanted tree falls over after foliage has established, replanting rarely is successful. We have transplanted established cypress trees during March after foliage had flourished and have had little success with survival rates.

We transplanted cypress trees from standing water and also from areas that were dry. The height of the trees ranged from four to fifteen feet with a diameter of two to six inches. We were interested in transplanting as many trees as possible, so we bare rooted all these trees instead of using the root ball technique. Also, the trees were taken to the lakes and planted in the shallow margins in the same afternoon that they had been dug. The survival rate for these trees has been approximately 80%, which we consider an extremely successful program.

The transplanting of giant bulrush has been the most successful aquatic macrophyte. We learned from past mistakes that by planting the bulrush too deep, the plant survived well but did not expand rapidly. We experienced faster expansion when the rhizomes were anchored slightly into hydrosoil, about three to four inches deep.

Early plantings of elephant-ears were in a straight line around the lakes' edge. We had plants at several locations die when using this method. Later when revegetating the same areas with elephant-ears, we grouped the plants together and had better success.

Now we are using the grouping technique when transplanting all other desirable vegetation. Grouping the plants together provides better protection when the young tender growth starts to flourish and the expansion is faster. This was most evident when transplanting cyperus, arrowhead and pickerelweed.

In addition to the list of transplanted macrophytes we are planning to use maidencane, knot-grass, Indian arrowhead, golden canna (Canna flaccida), and Cyperus elegans. Although some of these species are exotic, experience has shown that they can be used effectively in our program and if necessary managed economically with herbicides.

Phase V of our work plan will continue for years to come. Eventually, in Phase VI, we will work with emersed and submerged species of vegetation; such as yellow water-lily (Nymphaea mexicana), fragrant water-lily (Nymphaea odorata), tapegrass (Vallisneria americana), musk-grass (Chara species) and stonewort (Nitella species).

In summary, when the general public sees us planting vegetation and encouraging the expansion of desirable native and non-native plants, we hope that they will realize we are doing more than killing weeds with chemicals, although we still rely on the use of herbicides to keep the vegetation under control. We feel our program has progressed from a herbicide dominated operation to a more integrated management concept, which expands our motto, "The City Beautiful" into lake management. Therefore, we view the work we are doing as "aquascaping."

We would like to express our thanks to: The Army Corps of Engineers Aquatic Plant Control Section, Palatka; the Orlando Maintenance Section of the Department of Transportation; The Greater Orlando Aviation Authority, and Orange County Pollution Control for their cooperation in allowing us to obtain these plants and trees at no cost. The only expense incurred by the City of Orlando in this program were the costs of equipment and labor.

What's Cooking in Aquatics

By Beth Layer

Cattail Pollen Pancakes

1 package powdered yeast
1½ cups warm water
2 tablespoons safflower oil
1 tablespoon sugar
2 eggs
1 cup whole wheat flour
1 cup toasted wheat germ
3 to 4 tablespoons cattail pollen
¼ cup powdered milk

Stir yeast into warm water. Add the oil, sugar, eggs. Mix well. Then add the remaining ingredients. Let stand in a warm place for 30 minutes. Bake on a hot griddle. This batter can be mixed the previous evening then refrigerated for later use.

Continued on page 22
ELANCO INTRODUCES
Spike for ditchbanks and fencerow use.

SPIKE IS A BRUSH HERBICIDE DESIGNED ESPECIALLY FOR CONTROLLING BRUSH & VINES ON DITCHBANK AND FENCEROWS

SPIKE FEATURES:

- a non-restricted use herbicide
- kills the most brush and vines.
  kills more than 110 woody species,
  in Florida SPIKE kills Melaleuca,
  Brazilian peppertree, willow, yaupon,
  Privit, Waxmyrtle, Oaks, Sweet Gum,
  Maples, Trumpetcreeper and many more.
- easy to apply
- economical
- minimal lateral movement - sticks tightly to soil particiles.
- low volatility - no drift
- sure kill, SPIKE works by root uptake
- long-lasting - kills brush for up to 3 years
- two SPIKE formulations, SPIKE 85DF (dry flowable), SPIKE 40P (pellet).
- slow acting - easy on the environment.

SPIKE 40P (pellets)
15/lb. per acre rate
20 lb. bags
Broadcast or spot treat
Easy to Apply. Use Solo Power Blower, Mod. #423 or Cyclone type spreader.
Solo Power Blower FREE 70 bag purchase
Elanco training on application if needed.
Best formulation to use for ditchbank brush control.

SPIKE 85DF (dry flowable)
4 lb. jug (4 ea. per case)
8/lb. per brush acre (banding)
Apply by banding or lacing
Easy to apply. Use Solo Backpack Sprayer, Model -425, with 0003 straight stream nozzle tip, and pressure regulator.
Solo Backpack Sprayer equipment FREE with purchase of 15 cases of SPIKE 85DF.
Elanco training on application if needed.

Spike kills more brush. So you save more money.
A total of 467 water bodies with a combined surface area of 1,221,750 acres of fresh water were inventoried during 1985 for presence and abundance of Florida’s two most troublesome aquatic plant species, water-hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata*). This survey encompassed 326 lakes (1,011,438 acres), 71 rivers (172,543 acres), and 70 canal systems (37,769 acres) representing approximately 50% of Florida’s reported 2.5 million acres of fresh water (Table 1). The majority of the water not surveyed was in the Everglades National Park, its adjacent wetlands and the water conservation areas of South Florida.

Water-hyacinth and hydrilla distributions recorded during 1985 are compared with survey results from 1982-1984. These two species are of primary importance to the Bureau of Aquatic Plant Research and Control because they have historically posed the greatest biological and commercial restrictions within Florida waters.

The Department of Natural Resources has been designated by the Florida Legislature as the lead agency in managing aquatic plants within the state, and as such, has designed this survey as part of a statewide plan to monitor and control the spread of harmful or undesirable aquatic growth in Florida’s fresh water. The goal of the Department is to reduce the abundance of water-hyacinth and hydrilla along with other exotic or native pest species through a continuing maintenance program while promoting the re-establishment of a diverse community of beneficial native vegetation. By keeping fast growing, exotic plant populations at a minimum, herbicide use (which is the primary means of aquatic plant control in Florida) is reduced, fewer tax dollars are spent to achieve control of aquatic plants and waterways remain accessible allowing the continued exchange of water use related to commerce. To that end, aquatic plant control during 1985 scored one success with water-hyacinth, and one setback — with hydrilla.

**Water-hyacinth — Success**

For years water-hyacinth was the most formidable problem facing aquatic plant managers in Florida. During the past 10 years, a more centralized approach to water-hyacinth control has been conducted. This, coupled with adequate funding, the introduction of various biological control agents and the several herbicides available, has dropped water-hyacinth far behind hydrilla as a pest species in Florida. Records indicate that in the middle 1970’s, approximately 40,000 acres of waterhyacinth were present in Florida lakes and rivers (no records available for canals). In 1985, only 5,800 acres were present.

Water-hyacinth presence in Florida waters remained stable during the past three years, occurring in approximately 63% of the waters surveyed (Table 2). Canals were most often affected as more than 70% of the flood control systems inspected since 1982 harbored water-hyacinth. A peak of 80% was recorded during 1985. The percentage of lakes supporting water-hyacinth slightly increased from 54% in 1982, to 60% in 1985. However, waterhyacinth
Meet the D-30/50 aquatic spray unit from Applied Aquatic Management, Inc. This beauty was designed for aquatic applicators by aquatic applicators. Its lightweight, versatility and performance make it a beast for all types of aquatic treatments, surface, foliar or submerged.

Standard features include:
- 50 gallon, skid mounted, fiberglass tank
- 2 paddle mechanical agitation of marine grade brass and stainless steel
- 9.5 gpm 550 psi Hypro diaphragm pump
- 4.6 hp WISCONSIN Robin engine
- Forced siphon tank filler
- Overall weight approx. 125 lbs.

Plus many other features that add up for simple, efficient operation.

Applied Aquatic Management, Inc. offers a complete line of tank spray systems for boat or truck including tanks from 25 to 1,500 gallons, all types of pumps and related equipment.

For additional information or quotation contact:
APPLIED AQUATIC MANAGEMENT, INC.
P.O. Box 1437 • Eagle Lake, Florida 33839 • (813) 294-1115

---

TABLE 2
Water-Hyacinth Presence and Abundance in Lakes, Rivers and Canals

<table>
<thead>
<tr>
<th>Year</th>
<th>Lakes</th>
<th>Rivers</th>
<th>Canals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>150</td>
<td>32</td>
<td>44</td>
</tr>
<tr>
<td>1983</td>
<td>191</td>
<td>8</td>
<td>49</td>
</tr>
<tr>
<td>1984</td>
<td>203</td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td>1985</td>
<td>194</td>
<td>45</td>
<td>56</td>
</tr>
</tbody>
</table>

Water-hyacinth remains scattered throughout the state, primarily in the central and southern regions. However, in 1985, water-hyacinth was under the best maintenance control in years, possibly since problems were first reported along the St. Johns River in the late 1800's. This control has come at a high price. For years, rafts of water-hyacinth uprooted native vegetation, stunted fisheries and contributed to the filling in of Florida’s waters at a rate of more than four tons of dry sediment per acre of plants each year. Millions of dollars have been spent researching biological, chemical and mechanical controls and even more millions were spent actively controlling this exotic pest.

More than 90,000 acres of water-hyacinth were chemically treated in Florida during the past two years of a net reduction of only 15,000 acres in the standing crop. That is, roughly six acres were treated to eliminate every one acre of plants. Therefore, populations must be maintained at the lowest levels possible to reduce environmental costs and the expenditure of tax dollars in controlling water-hyacinth.

While the total number of systems affected remained fairly constant, plant acres fluctuated widely, due first to weather conditions and then to a strong management effort. Following a two year drought, water levels rose during 1982, germinating dormant water-hyacinth seeds, and the 8,300 acre population blossomed to more than 20,000 acres in 1983.

Cold weather during the winter of 1983 helped to reduce coverage somewhat, but Department of Natural Resources records show that nearly 50,000 acres of water-hyacinth were chemically treated during 1983, using either 2,4-D or diquat formulations. This effort was evident in 1984, an additional 41,000 acres were controlled resulting in a standing crop covering 5,800 acres in 1985.
Water-hyacinth acreage in canals and rivers was maintained at fairly low levels during each survey year because of the importance of these systems to flood control and navigation. The maximum water-hyacinth coverage occurred in 1983 when nearly 1,800 and 3,400 acres were reported in canals and rivers, respectively. Water-hyacinth was reduced in canals to approximately 1,300 acres in 1985; slightly less (approximately 1,200 acres) was present in rivers. The largest reduction (2,124 acres) occurred in the St. Johns River in 1984.

Table 3

<table>
<thead>
<tr>
<th>Water Body</th>
<th>County</th>
<th>Water Acres</th>
<th>Plant Acres</th>
<th>Amount of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Okeechobee</td>
<td>Okeechobee</td>
<td>448,000</td>
<td>515</td>
<td>-1,489 D*</td>
</tr>
<tr>
<td>Lake Lochloosa</td>
<td>Alachua</td>
<td>5,705</td>
<td>12</td>
<td>-368 D*</td>
</tr>
<tr>
<td>Lake George</td>
<td>Volusia</td>
<td>46,000</td>
<td>175</td>
<td>-345 D*</td>
</tr>
<tr>
<td>Lake Kissimmee</td>
<td>Osceola</td>
<td>34,958</td>
<td>50</td>
<td>-290 D*</td>
</tr>
<tr>
<td>Lake Rousseau</td>
<td>Citrus</td>
<td>4,000</td>
<td>45</td>
<td>-280 D*</td>
</tr>
<tr>
<td>Melbourne-Tillman DD</td>
<td>Brevard</td>
<td>3,626</td>
<td>50</td>
<td>-245 D*</td>
</tr>
<tr>
<td>Lake Okeechobee</td>
<td>Highlands</td>
<td>27,692</td>
<td>172</td>
<td>-188 D*</td>
</tr>
<tr>
<td>Orange County WMD</td>
<td>Orange</td>
<td>2,172</td>
<td>65</td>
<td>-185 D*</td>
</tr>
<tr>
<td>Lake Hatchineha</td>
<td>Osceola</td>
<td>6,665</td>
<td>90</td>
<td>-10 D*</td>
</tr>
<tr>
<td>Lake Sawgrass</td>
<td>Brevard</td>
<td>407</td>
<td>25</td>
<td>155 D*</td>
</tr>
<tr>
<td>Orange Lake</td>
<td>Alachua</td>
<td>12,706</td>
<td>95</td>
<td>155 D*</td>
</tr>
</tbody>
</table>

D = Decrease, * Significant Change

Most of the statewide water-hyacinth reduction of the past two years occurred in lakes after a 10,000 acre increase was recorded between 1982 and 1983. An 8,000 acre reduction was brought about in 1984, mainly from control in Lake Okeechobee (3,300 acres) and Orange Lake (1,900 acres). An additional 4,000 acres statewide reduction was reported for lakes in 1985, again predominantly from control efforts in Lake Okeechobee (1,500 acres).

Of the water bodies common to the 1984 and 1985 surveys, 124 supported water-hyacinth increases, but only 19 were significant for an increase of 1,039 acres. (Significance, for the purpose of this report, was a change of at least 20 acres or more in the population.) The largest increases occurred in the upper Myakka Lake (115 acres) and in Barron Water Control District Canals (101 acres) where little or no water-hyacinth control occurred in 1985.

One hundred thirty-seven water-hyacinth population reductions were reported in 1985. Twenty-six were significant accounting for a total reduction of almost 5,000 acres. Table 3 presents the largest water-hyacinth population changes in 1985; all are reductions. The South Florida Water Management District, using a combination of 2,4-D and diquat reduced water-hyacinth on Lake Okeechobee, Lake Kissimmee, Lake St. Johns River Water Management District removed nearly all water-hyacinth from Lake Lachloosa and continued the reduction to less than 100 acres on Orange Lake, in each case by applying 2,4-D. In 1983, more than 2,000 acres of water-hyacinth were present on Orange Lake. Additionally, the St. Johns River Water Management District removed water-hyacinth on Lake Sawgrass to only 25 acres in 1985 using diquat. Diquat was also used by the Southwest Florida Water Management District within Lake Rousseau. The COE removed water-hyacinth from Lake George using 2,4-D as did managers from Melbourne-Tillman and Orange County to control water-hyacinth within their flood control canals.

Table 4

<table>
<thead>
<tr>
<th>Water Body</th>
<th>County</th>
<th>Water Acres</th>
<th>Plant Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Johns River</td>
<td>Okeechobee</td>
<td>448,000</td>
<td>515</td>
</tr>
<tr>
<td>Lake Okeechobee</td>
<td>Okeechobee</td>
<td>96,000</td>
<td>529</td>
</tr>
<tr>
<td>Lake Tualas Apopka</td>
<td>Citrus</td>
<td>19,285</td>
<td>230</td>
</tr>
<tr>
<td>Lower Myakka River</td>
<td>Sarasota</td>
<td>2,500</td>
<td>180</td>
</tr>
<tr>
<td>Lake George</td>
<td>Volusia</td>
<td>46,000</td>
<td>175</td>
</tr>
<tr>
<td>Lake Isokpoga</td>
<td>Highlands</td>
<td>27,692</td>
<td>172</td>
</tr>
<tr>
<td>Lake George</td>
<td>Osceola</td>
<td>3,600</td>
<td>160</td>
</tr>
<tr>
<td>Broward County APC</td>
<td>Broward</td>
<td>1,460</td>
<td>150</td>
</tr>
<tr>
<td>Lake Talquin</td>
<td>Gadsden</td>
<td>8,850</td>
<td>150</td>
</tr>
<tr>
<td>Lake Ponte Lake</td>
<td>Seminole</td>
<td>1,380</td>
<td>130</td>
</tr>
</tbody>
</table>

Hydrilla — Setback

Although, water-hyacinth, for the most part, has been reduced to maintenance levels in Florida, hydrilla continues to flourish. Compared to water-hyacinth, the percentage of waters containing hydrilla was low, yet steadily increased during each survey year from 41% in 1982, to just under 50% in 1985 (Table 5). As with water-hyacinth, flood control systems were most often affected. At least 90% of the canals inspected each year contained hydrilla. Hydrilla has
spread to several rivers since 1983, when only 38% were affected. In 1985, 49% of the rivers inspected supported hydrilla.

The number of lakes supporting hydrilla also increased during each survey year as five new populations were found. Contained small populations in 1985. Encountered 4,176 acres covering 110 species. Despite a statewide net increase from 30% in 1982, to 38% in 1985. Eight lakes in which hydrilla had not previously been identified, contained small populations in 1985.

During 1982, hydrilla was the most abundant aquatic plant species encountered (41,706 acres) covering nearly three times as much water surface as cattails the second most prevalent species. Despite a statewide net increase of 3,700 acres in 1983, hydrilla was replaced by cattails as the most abundant plant species in Florida public waters. During 1984, hydrilla was re-established as the most abundant plant surveyed with more than 46,000 acres.

as five new populations were found. The number of lakes supporting hydrilla also increased during each survey year from 30% in 1982, to 38% in 1985. Eight lakes in which hydrilla had not previously been identified, contained small populations in 1985.

During 1982, hydrilla was the most abundant aquatic plant species encountered (41,706 acres) covering nearly three times as much water surface as cattails the second most prevalent species. Despite a statewide net increase of 3,700 acres in 1983, hydrilla was replaced by cattails as the most abundant plant species in Florida public waters. During 1984, hydrilla was re-established as the most abundant plant surveyed with more than 46,000 acres.

Reported. Coverage continued to increase in 1985, by approximately 6,200 acres, surpassing 50,000 acres for the first time during the four survey years. The 1985 total represents an increase of more than 26% over 1982. Although, reduced to its lowest levels in canals and rivers during 1985, hydrilla was more abundant in lakes (46,589 acres) than ever before. The 7,300 acre increase from 1984 is the largest single year increase during the survey. More alarmingly, in just four years, hydrilla acreage in Florida lakes has risen by 37%. The increase has occurred despite more than 50,000 acres and $12 million of control since 1981.

In 1985, 98 hydrilla reductions were recorded in public waters. Nearly half (42) were significant for a decrease of more than 9,300 acres. Major hydrilla reductions in 1985 are listed in Table 6.

The Crystal River underwent a 600 acre hydrilla reduction in 1985, after Hurricane Elena. Wave action and salt water forced deep within the Kings Bay area from high winds, have both been credited for the decline. About 50 acres of hydrilla remained after the storm, concentrated in the headwater springs and remote canals.

Although hydrilla acreage declined in nearly 100 waters during 1985, 113 population increases were recorded. Thirty-five increases were significant accounting for more than 15,000 acres. The increases are attributable to a lack of funding, the temporary loss of the experimental use herbicide, fluridone, and a reluctance to control hydrilla in several major lakes. The EPA Experiment Use Permit for fluridone expired in June 1985 cancelling scheduled retreatments within Lake.
Lochloosa and Orange Lake. Both of these waters, which had been relatively free of hydrilla for two years following 1983 fluridone treatments, experienced rapid hydrilla regrowth in 1985. The 1984 survey reported approximately 400 acres of hydrilla in Lake Lochloosa. By the middle of 1985, 2,300 acres were present; 4,500 acres by the end of the year. Similar results were observed in Orange Lake where hydrilla expanded from 460 acres in 1984 to 1,000 acres by June 1985 and 3,500 acres at year’s end.

As tannic water receded from a high level in 1984 in Lake Rousseau and the Withlacoochee River, hydrilla recolonized shallow portions of these waters increasing in Lake Rousseau from 500 to 1,500 acres and from approximately 500 to 1,300 acres in the Withlacoochee River.

More dramatic increases were reported in Lakes Winder, Harney and Kissimme. The hydrilla population in Lake Winder, part of the headwaters of the St. Johns River, remained below 100 acres from 1982 - 1984 then spread to cover 1,200 acres in 1985. Hydrilla in Lake Harney, also at the head of the St. Johns River, varied between 2 - 25 acres from 1982 - 1984. In 1985, 800 acres were reported. Hydrilla was not recorded in Lake Kissimme in 1982; less than one acre was found in 1983, 135 acres in 1984 and approximately 1,000 acres in 1985.

Thirteen additional lakes supported hydrilla population increases of 100 acres or more during 1985 and are of primary concern to the Department. Several, including Gopher Slough, Lakes Newman and Patrick contained little or no hydrilla before 1985. Other including Lakes Jackson (Leon County) and Seminole (Jackson County) had stable populations for years until major increase occurred in 1985. Also of concern is Lake Okeechobee. While hydrilla within Lake Okeechobee was fairly stable during 1985, the population has increased by more than 14,000 acres since 1982, crowding out more than 3,400 acres of eelgrass and Illinois pondweed. The largest hydrilla populations recorded in 1985 are listed in Table 7.

Some of the systems discussed in this report which are now choked with hydrilla are important to navigation and nearly all at one time, supported important recreational fisheries. Hydrilla is now present in roughly half of Florida’s public waters. Each year several more water bodies either fill with hydrilla or require expensive management programs. The technology to manage hydrilla has not yet been refined but advances in recent years are promising. Funding may soon be adequate, however; without a strong unified approach by all Florida public water managers, the immediate future of Florida’s lakes and rivers related to hydrilla is not bright.

### Table 7

Largest Hydrilla Populations, 1985

<table>
<thead>
<tr>
<th>Water Body</th>
<th>County</th>
<th>Water Acres</th>
<th>Plant Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Okeechobee</td>
<td>Okeechobee</td>
<td>448,000</td>
<td>21,918</td>
</tr>
<tr>
<td>Lake Lochloosa</td>
<td>Alachua</td>
<td>5,705</td>
<td>5,500</td>
</tr>
<tr>
<td>Rodman Reservoir</td>
<td>Putnam</td>
<td>5,280</td>
<td>3,600</td>
</tr>
<tr>
<td>Orange Lake</td>
<td>Alachua</td>
<td>12,706</td>
<td>3,500</td>
</tr>
<tr>
<td>Lake Rousseau</td>
<td>Citrus</td>
<td>4,000</td>
<td>1,980</td>
</tr>
<tr>
<td>Withlacoochee River</td>
<td>Citrus</td>
<td>3,000</td>
<td>1,250</td>
</tr>
<tr>
<td>Lake Winder</td>
<td>Brevard</td>
<td>1,486</td>
<td>1,200</td>
</tr>
<tr>
<td>Lake Kissimme</td>
<td>Osceola</td>
<td>34,948</td>
<td>1,000</td>
</tr>
<tr>
<td>Lake Harney</td>
<td>Volusia</td>
<td>6,058</td>
<td>800</td>
</tr>
<tr>
<td>Lake Istokpoga</td>
<td>Highlands</td>
<td>27,092</td>
<td>600</td>
</tr>
</tbody>
</table>

NATIVE INSECT ENEMIES OF AQUATIC MACROPHYTES-MOTHS

**by**

Dale H. Habeck¹, Kim Haag¹, and Gary Buckingham²

**Introduction**

This is the first of a three-part series of articles discussing insects that attack aquatic macrophytes in Florida. The series was conceived to provide aquatic plant managers and non-entomologist researchers with a glimpse into the little known world of aquatic plant feeding insects. This world can be entered by simply looking through a small hand lens. We hope this will stimulate you to look for some of the insects we discuss and to observe others that are not discussed and that may be as yet undescribed. Knowledge of the insects and their damage will make your field trips more interesting and better prepare you to respond when others mistake insect damage for spray drift damage. Someday our knowledge of native insects may be sufficient to permit them to be manipulated to help control aquatic weeds.

Insects feeding on aquatic plants illustrate the concept of natural biological control. Biological control is the process in which natural enemies regulate populations of other organisms. When plants are in a habitat for a long time, phytophagous insects are able to find and use them as a food source and place to live. Feeding and other damage by insects helps keep plants in balance in aquatic habitats. A plant accidentally introduced into a country usually comes without its natural enemies and the plant grows unchecked and often becomes a nuisance. Studying the relationships between our native insects and aquatic plants can provide useful information to help us deal with our present and future aquatic weed problems.

Moths and butterflies are common names for the Lepidoptera. The adult mouthparts are siphoning or vestigial and therefore adults are not injurious. However, the early stages called caterpillars have chewing mouthparts and may cause a lot of damage. Most caterpillars possess 3 pairs of thoracic legs and five pairs of abdominal prolegs — 4 pair on segments 3-6 and 1 pair on the last segment. Caterpillars most frequently occur as foliage feeders but others may be borers, leaf miners, or gall makers. Sometimes they have one feeding method early in their lives and then change to another later on. Caterpillars must pupate before becoming adults. Pupation is a resting period during which the caterpillar changes its form to a pupa and then to a moth. Pupation may occur on the plant or away from the plant within or without a cocoon.

**Noctuidae**

The noctuids or eewlet moths are the largest family of Lepidoptera. Adults...
vary in size from less than 1 cm to 10 cm wing span. Caterpillars are equally variable. Some of the better known terrestrial members of this family are cutworms, corn earworms, cabbage loopers and fall armyworms. The cattail caterpillar *Simyra henrici*, as the name implies, feeds on cattails. The larvae eat the epidermal layers of the leaves or completely devour the entire leaf. They can be extremely destructive. The larvae are up to 40 mm long and covered with hairs. They are light brown ventrally and orange and brown dorsally with prominent orange tubercles arranged in transverse bands. The dorsal and ventral areas are separated by a lateral light stripe. The head is black with 2 white stripes on top and has a light colored inverted V on the front. The cocoon is formed between two webbed leaves. The adult moth has straw colored forewings and white hindwings.

A closely related species, the smeared dagger moth *Acronicta oblitina* is also commonly found in aquatic situations. It occurs on willow, smartweed, spatterdock, buttonbush, waterhyacinth, pickerelweed, lotus, water pennywort, canna, wax myrtle, and other plants. The caterpillars are easily recognized by the wide bright yellow lateral stripe extending the length of the body. Adults have mottled gray forewings and white hindwings.

The caterpillar of *Belliata gotoypoides* is known as the bonnetworm and is frequently used as bait by fishermen. The adult moth is stout and is yellowish-brown with some darker motting. Eggs are laid in masses on either side of the spatterdock leaves. Egg masses are covered with hairs from the female's abdomen. The young caterpillars hatch and tunnel directly into the leaf or they may leave the mass and wander a short distance before tunneling into the leaf. They continue as leaf miners for the first 2 or 3 stages until they become too large for the thickness of the leaf. Larger caterpillars bore downward through the petiole and only one individual occurs in each petiole. Tunnels extend below the water line and may fill with water if the caterpillar eats a hole in the side of the petiole. Air is obtained by the caterpillar backing up the tunnel towards the leaf until the posterior end of the body is exposed. The last pair of spiracles are very large and open posteriorly, an adaption for this mode of life. While obtaining air, the caterpillar may also deplete leaving a pile of frass on the upper leaf surface. Caterpillars also emerge from the tunnels at night and feed on the leaf surface leaving characteristic gouged patterns. These patterns plus the presence of a hole in the petiole and frass adjacent to the hole indicate that the leaf petiole is occupied by a caterpillar. However, caterpillars may move from petiole to petiole and not every stem is infested. Pupation occurs either within the petiole tunnel or the caterpillars swim to shore where they find shelter under bark or in dead wood. The caterpillars are light green with light brown heads and may be 60

![Figure 1. A. smeared dagger moth caterpillar, B. bonnetworm in petiole, C. bonnetworm damage on leaf surface, D. spatterdock caterpillar.](image)

Caterpillars of the genus *Spodoptera* are general feeders and are frequently encountered on waterhyacinth and other aquatic plants. They are also important economic pests of many crop plants. Caterpillars are up to 50 mm long and generally brown with two rows of black triangular markings dorsally. Five *Spodoptera* species attack aquatic weeds, with the velvet armyworm *S. latifascia*, the fall armyworm, *S. frugiperda* and the southern armyworm, *S. eridania* being most common.

The spatterdock caterpillar *Homophobesia cristata* (better known under its old name *Neverastria cadua*) is frequently observed feeding on the underside of spatterdock leaves. These green caterpillars are up to 30 mm long and have varying amounts of reddish maroon markings on the upper portions of each side.

**Arctiidae**

Adult tiger moths are generally brightly colored and larvae are more or less densely covered with hairs. Most larvae are known as woolly bears. The hairs arise from raised wart-like areas on the body. The arctids range in size from 12 to 75 mm wingspan. Caterpillars range from 16-75 mm.

The yellow woolly bear *Spilosoma virginica* is the most common species found in aquatic habitats. The adult is completely white except for a few small dark spots on the wing and a row of yellow spots on the sides of the abdomen. Moths are frequently seen sitting on the leaves of aquatic plants. Eggs are laid in masses of 50 or more eggs. The young caterpillars are gregarious in the early stages but later disperse and occur singly when full grown. Caterpillars range up to 50 mm long and despite their name may be any color from dirty white, light to dark brown or brownish-yellow. Pupation occurs on the plant in a cocoon consisting of silk and caterpillar hairs. They feed on a wide variety of aquatic plants including waterhyacinth, waterlettuce, smartweed, frogbit, and pickerelweed.

**Pyralidae**

This large family of small to moderate size moths is very diverse in structure and habits. About 1500 species in about 18 subfamilies occur in North America. The European corn borer is a well known species of this family. Most caterpillars feed concealed in tied, rolled, or webbed leaves. Others are scavengers or borers in stems or roots and a few are predators or leafminers. The true aquatic caterpillars are in this family.

The samea caterpillar, *Samea multiplicalis* is a common species in
The caterpillars are most often collected on water lettuce, but also commonly attack water fern and water velvet and occasionally waterhyacinth. Caterpillars construct a gallery or canopy of silk and hairs of the host plant under which they feed. They may tunnel into the leaves or into the crown and cause severe damage. There are 5 or 6 larval stages. From egg laying to adult emergence requires an average of 25 days at 28°C. Populations gradually increase and are at their highest in the fall. The moths are light brown with many lighter spots on the wings. Caterpillars are up to 22 mm long, light green with a light brown head. The body has many dark hardened plates on it. The caterpillar of the spotted waterhyacinth borer, Syncrata obliterata, is very similar but feeds only in waterhyacinth petioles. It was introduced from South America for control of waterhyacinth.

The waterlily leafcutter, Sphingidae, is the most common of the 25 species of aquatic pyralid caterpillars known in Florida. The adults are small dark moths with some white and orange fleckings on the wings. Moths are variable in pattern and size although females are generally larger than males. The caterpillars are highly polyphagous and have been recorded from more than 40 different hosts in Florida. The caterpillars live in a portable case usually made up of two pieces of leaf. The case is filled with air and the caterpillars never go very deep in the water and may climb out of the water to feed or to cut leaf portions for their case.

The lotus borer, Ostrinia penalis, is common and very destructive to lotus. Young caterpillars are gregarious, whereas older ones disperse, and all stages on the leaves are concealed under silk webbing. The young green seed pods are also heavily attacked. Caterpillar damage to lotus is conspicuous and the devastation may be easily mistaken for herbicide injury. Adult insects are yellowish-brown.

Five species of Parapnoya occur in Florida. The caterpillars are easily recognized by the numerous branched gills found over most of the body. First stage caterpillars are leaf miners; later stages construct portable cases which are filled with water. Pupation occurs in the case which is usually attached at one end to a chewed out area on the stem or leaf. Adults are variable and some of the species exhibit sexual demorphism. P. maculalis and P. seminatae caterpillars feed primarily on waterlilies and floating heart, respectively. P. allionalis and P. obscuralis are polyphagous and feed on a wide variety of aquatic plants. P. diminutalis feeds mainly on hydrilla. All are native except P. diminutalis which was accidentally introduced from Asia.

Cosmopterigidae
The cosmopterigids are small moths ranging from about 5 to 28 mm wing span. The biology of the caterpillars is very diverse. They feed internally as leaf miners, gall makers on roots and stems, in seeds, and as scavengers. Cosmopterix nitens is often very abundant in Florida. The small moth has 10 mm or less wing span and the fore wings are brown with transverse yellow and gray bands. The caterpillars are leaf miners in the leaves of giant cutgrass, wild rice, and probably other grasses. The mines are elongate and parallel with the leaf veins. The old mined areas dry and turn brown. The caterpillars that are abundant whole patches of grass may appear burned and dead. Several years ago, a heavy infestation caused severe damage to giant cutgrass in Lake Seminole.

Sphingidae
This is a family of large moths ranging up to 17.5 cm wing span. Adults are called sphinx moths or hawk moths while the caterpillars are called hornworms since most species have a dorsal horn on the eighth abdominal segment.

The banded sphinx Eumorpha fasciata is common on water primrose and other species of the primrose family growing in moist areas. The large caterpillars, up to 80 mm long are transversely banded with black, red, and white when mature and have seven oblique lateral stripes. Younger stages are generally unmarked and are bright yellowish green or pink. A primrose stem completely or partially defoliated indicates that one of these caterpillars is or has been there.

In conclusion
There are many other moth species associated with aquatic and semiaquatic plants. Space limitations have made it necessary to include only a few of the more common and conspicuous species. Available biological information for most species is incomplete and many new species of moths await discovery.

Acknowledgements
We thank V. Jane Windsor for photographs 1 A, B and 3 A, B.

Continued on page 22
RODEO KEEPS AQUATIC WEEDS & BRUSH UNDER CONTROL, LEAVES NATURE IN BALANCE.

Rodeo® is the aquatic herbicide of choice not only because it's effective—but also because it's compatible with the environment.

Rodeo is practically non-toxic to people, animals and fish. Rodeo breaks down into natural products and does not bioaccumulate in the food chain. What's more, Rodeo will not leach into non-target areas because it has no residual activity.

RODEO WILL CONTROL YOUR TOUGHEST GRASS, BROADLEAF WEEDS AND BRUSH, ROOTS AND ALL, INCLUDING:

- ALLIGATORWEED®
- CATTAIL
- GIANT CUTGRAASS®
- GUINEA GRASS
- JOHNSON GRASS
- MAIDENCANE
- PARAGRASS
- PHRAGMITES®
- REED CANARYGRASS
- SPATTERDOCK
- SALLOW TREE
- TORPEDOGRASS®
- WILLOW

You can use Rodeo in flowing or standing water in most aquatic sites, including ditches, canals, lakes, rivers, streams and ponds.

Get to the root of your toughest aquatic weed problems—without disturbing the environment—with Rodeo.

Rodeo cannot be applied within a half mile upstream of domestic water points, in estuaries, or rice fields when floodwater is present.

ALWAYS READ AND FOLLOW THE LABEL FOR RODEO HERBICIDE. Rodeo® is a registered trademark of Monsanto Company. © Monsanto Company 1986 MOD-6-1038

Monsanto

RODEO. EMERGED AQUATIC WEED AND BRUSH CONTROL.
The annual meeting of the FAPMS will again be held in Orlando on October 13-16. Last year’s record crowd brought out record numbers of people wanting to give presentations. Don’t be left “holding the bag,” get your paper titles in early to avoid the last minute rush. If you know what you are going to present, or if you have ideas and/or comments on this year’s program, contact Mark McKensie at (813) 961-7885 ASAP.

The Smalley 6808, a floating excavator/dredger designed in England and proven over the last ten years is now available in the USA. The 6808 offers a new and effective method of mechanical weed harvesting, canal maintenance, sediment removal, channel deepening, etc. • self-propelled • unique stabilizer system provides stable working platform in up to 9 ft. of water • dredges to 11 ft. • 21 ft. reach • 360° continuous swing • no crane needed for launch and retrieval • loads itself on and off flatbed or trailer • ½ yd. bucket • winch • optional equipment: heavy duty weed rake — rotating grab — hydraulic hammer — post hole digger — clamshell bucket.

CALL 1-800-247-6277 FOR BROCHURE
SMALLEY EXCAVATORS, INC., 71 Hartford Turnpike So., Wallingford, CT 06492

The Aquatic Plant Management Society will hold its annual meeting July 13-16, 1986 in Sarasota, Florida. The meeting will include papers on the distribution, ecology, physiology, and management of aquatic plants in lakes, reservoirs, rivers, streams, and irrigation systems. For further information please contact Dr. David Spencer, Davis, CA., at (916) 752-6260.

Barbara's responsibilities will include the monitoring of administrative and financial functions of the funded aquatic plant control programs and the aquatic plant research grants program. Barbara can be reached at (904) 488-5631.

The Department of Natural Resources announces funding of the following research topics:
1. Dr. George Bowes, UF- An Eco-Physiology Study of the Weed Potential of Filamentous Algae in Florida. $79,694.00.
2. Dr. David Sutton, UF- Use of Seeds for Establishment of Desirable Aquatic Plants. $84,222.00.
3. Dr. Dean Martin, USF- Physiological Properties of Problem Plants: Sensitivity of Filamentous Algae to Photodynamic Action. $25,950.00.
5. Dr. Dan Canfield, IF- Relationships Between Aquatic Macrophytes and the Limnology and Fisheries of Florida Lakes. This project was ambitious beyond DNR's available funds, negotiations are currently underway to fund this work at a reduced scope.

Ms. Barbara Parker has assumed the position of Grants Specialist V with the Department of Natural Resource's Grants Administration Section. Barbara's responsibilities will include the monitoring of administrative and financial functions of the funded aquatic plant control programs and the aquatic plant research grants program. Barbara can be reached at (904) 488-5631.

Dan Thayer has accepted a research position with the DNR, located at the Center for Aquatic Weeds, Gainesville. The position will help develop a technology transfer program, training materials, and assist aquatic plant managers in solving aquatic plant control related problems around the State.

The Department of Natural Resources announces funding of the following research topics:
1. Dr. George Bowes, UF- An Eco-Physiology Study of the Weed Potential of Filamentous Algae in Florida. $79,694.00.
2. Dr. David Sutton, UF- Use of Seeds for Establishment of Desirable Aquatic Plants. $84,222.00.
3. Dr. Dean Martin, USF- Physiological Properties of Problem Plants: Sensitivity of Filamentous Algae to Photodynamic Action. $25,950.00.
5. Dr. Dan Canfield, IF- Relationships Between Aquatic Macrophytes and the Limnology and Fisheries of Florida Lakes. This project was ambitious beyond DNR's available funds, negotiations are currently underway to fund this work at a reduced scope.

Ms. Barbara Parker has assumed the position of Grants Specialist V with the Department of Natural Resource's Grants Administration Section. Barbara’s responsibilities will include the monitoring of administrative and financial functions of the funded aquatic plant control programs and the aquatic plant research grants program. Barbara can be reached at (904) 488-5631.

Dan Thayer has accepted a research position with the DNR, located at the Center for Aquatic Weeds, Gainesville. The position will help develop a technology transfer program, training materials, and assist aquatic plant managers in solving aquatic plant control related problems around the State.

The Department of Natural Resources announces funding of the following research topics:
1. Dr. George Bowes, UF- An Eco-Physiology Study of the Weed Potential of Filamentous Algae in Florida. $79,694.00.
2. Dr. David Sutton, UF- Use of Seeds for Establishment of Desirable Aquatic Plants. $84,222.00.
3. Dr. Dean Martin, USF- Physiological Properties of Problem Plants: Sensitivity of Filamentous Algae to Photodynamic Action. $25,950.00.
5. Dr. Dan Canfield, IF- Relationships Between Aquatic Macrophytes and the Limnology and Fisheries of Florida Lakes. This project was ambitious beyond DNR's available funds, negotiations are currently underway to fund this work at a reduced scope.

Ms. Barbara Parker has assumed the position of Grants Specialist V with the Department of Natural Resource's Grants Administration Section. Barbara’s responsibilities will include the monitoring of administrative and financial functions of the funded aquatic plant control programs and the aquatic plant research grants program. Barbara can be reached at (904) 488-5631.

Dan Thayer has accepted a research position with the DNR, located at the Center for Aquatic Weeds, Gainesville. The position will help develop a technology transfer program, training materials, and assist aquatic plant managers in solving aquatic plant control related problems around the State.

The Department of Natural Resources announces funding of the following research topics:
1. Dr. George Bowes, UF- An Eco-Physiology Study of the Weed Potential of Filamentous Algae in Florida. $79,694.00.
2. Dr. David Sutton, UF- Use of Seeds for Establishment of Desirable Aquatic Plants. $84,222.00.
3. Dr. Dean Martin, USF- Physiological Properties of Problem Plants: Sensitivity of Filamentous Algae to Photodynamic Action. $25,950.00.
5. Dr. Dan Canfield, IF- Relationships Between Aquatic Macrophytes and the Limnology and Fisheries of Florida Lakes. This project was ambitious beyond DNR's available funds, negotiations are currently underway to fund this work at a reduced scope.

Ms. Barbara Parker has assumed the position of Grants Specialist V with the Department of Natural Resource's Grants Administration Section. Barbara’s responsibilities will include the monitoring of administrative and financial functions of the funded aquatic plant control programs and the aquatic plant research grants program. Barbara can be reached at (904) 488-5631.

Dan Thayer has accepted a research position with the DNR, located at the Center for Aquatic Weeds, Gainesville. The position will help develop a technology transfer program, training materials, and assist aquatic plant managers in solving aquatic plant control related problems around the State.

The Department of Natural Resources announces funding of the following research topics:
1. Dr. George Bowes, UF- An Eco-Physiology Study of the Weed Potential of Filamentous Algae in Florida. $79,694.00.
2. Dr. David Sutton, UF- Use of Seeds for Establishment of Desirable Aquatic Plants. $84,222.00.
3. Dr. Dean Martin, USF- Physiological Properties of Problem Plants: Sensitivity of Filamentous Algae to Photodynamic Action. $25,950.00.
5. Dr. Dan Canfield, IF- Relationships Between Aquatic Macrophytes and the Limnology and Fisheries of Florida Lakes. This project was ambitious beyond DNR's available funds, negotiations are currently underway to fund this work at a reduced scope.

Ms. Barbara Parker has assumed the position of Grants Specialist V with the Department of Natural Resource's Grants Administration Section. Barbara’s responsibilities will include the monitoring of administrative and financial functions of the funded aquatic plant control programs and the aquatic plant research grants program. Barbara can be reached at (904) 488-5631.
Our Reputation is Growing

Your supplier for a complete line of professional aquatic weed control products, including:

- Agri-Dex®
- Induce®
- Helena Inverting Blend
- Submerge
- Foamer

For more information, call Tom McPherson at 813/626-5121

Native Insects from page 19

Bibliography


Footnotes

1Professor and Research Associate, respectively, Dept. Entomology and Nematology, Univ. of Florida, Gainesville, Florida 32611
2Research Entomologist, ARS, USDA, P. O. Box 1269. Gainesville, Florida 32602.

What's Cooking from page 11

CATTAIL-CARROT CAKE

2 cups flour
2 teaspoons baking powder
1 1/2 teaspoons baking soda
1 teaspoon salt (can be omitted)
2 teaspoons cinnamon
2 cups sugar
1 1/2 cups cooking oil
4 eggs
1 cup grated carrots
1 cup cattail shoots grated in blender
1 8 oz. can crushed pineapple, drained
1/2 cup butter or margarine
1 8 oz. package cream cheese
1 box confectioners sugar
1 teaspoon vanilla

Sift together first five ingredients. Add sugar, oil, eggs, cattails, carrots and pine-apple. Pour into 2 greased-floured cake pans. Bake at 350° for 35 to 45 minutes. Mix cream cheese, butter, sugar and vanilla. Add milk if frosting is too thick. Spread on cool cake.
Controlling vegetation along railroads, highways, utility and industrial rights-of-way is not only necessary for safety. It’s required by law. But there are other laws to follow. Mother Nature’s. That’s why Cyanamid developed ARSENAL® herbicide. Its advanced chemistry is environmentally sound as well as effective.

WHY ARSENAL IS EASY ON THE ENVIRONMENT

Because of its unique mode of action, ARSENAL®, when used as directed, has no harmful effects on mammals, bees, fish, birds or earthworms. Because ARSENAL® is non-volatile and does not move laterally in the soil, off-target vegetation is unaffected. ARSENAL® is non-flammable, so it poses little fire hazard. Unlike tank mixes, ARSENAL® introduces only one biodegradable product into the environment. And it’s applied only once during a season, resulting in a lower chemical burden.

CONTROLS MORE UNDESIRABLE VEGETATION

ARSENAL® has demonstrated control of a broad spectrum of weeds, vines and brush species. Tests in southern states showed that ARSENAL® alone (at rates of two quarts per acre) out-performed several tank mixes for annual and perennial weed control. Even more impressive, ARSENAL® was most effective on difficult species like Johnsongrass, trumpet creeper, kudzu and red maple.

ONE APPLICATION GIVES SEASON-LONG CONTROL

ARSENAL® gives you full-season control for up to eight months in temperate climates. It fits your spray schedule, because it can be applied at any time during the growing season. ARSENAL® controls not only existing vegetation, but also new weeds that germinate after application. So you get residual control for the rest of the season. On hard-to-kill vegetation, ARSENAL® keeps working on the roots until complete control is achieved. In spray solution, ARSENAL® is stable for several days. That means no waste due to decomposition, and no chance of under-dosing target vegetation.

ARSENAL offers broad-spectrum control, including these tough species:
- Johnsongrass
- Blackberry
- Trumpet creeper
- Birdweed
- Poison ivy
- Canada thistle
- Greenbrier
- Foxtails
- Redvine
- Red maple
- Kochia
- Kudzu
- Multiflora rose
- Sumac

DUAL ACTION CONTROLS IN A WHOLE NEW WAY

Unlike most other herbicides, ARSENAL® is absorbed through both roots and foliage to stop new cell growth. Vegetation absorbs ARSENAL® in less than two hours, so rain won’t wash off your investment. Within four hours, plant growth ceases. In perennials, ARSENAL® translocates thoroughly in the roots to prevent regrowth. This unique chemistry makes the visible results of control more gradual. In some vegetation, loss of color and other outward signs may not be apparent for weeks after application. After a year or more, returning vegetation is mainly desirable annual grasses and legumes.

ARSENAL IS RIGHT FOR YOUR RIGHTS-OF-WAY

On railroad, highway or industrial rights-of-way, around power substations, signal boxes, bridge abutments, lumber or freight yards — wherever you need annual total vegetation control, ARSENAL® is the smart new choice for the job.

ARSENAL® is not labeled for aquatic use.

TOUGH ON WEEDS. EASY ON THE ENVIRONMENT.