



AQUATIC PLANTS AND DISEASES

Schistosomiasis, malaria, yellow fever, filariasis, encephalitis, fascioliasis and paramphistomiasis are diseases which continue to afflict man and his livestock. They are endemic in parts of Africa, Asia and South America where they cause immeasurable health and economic losses. These diseases have another thing in common: their vectors are snails and mosquitoes which are closely associated with certain aquatic plants. For many years, health officials have attempted to control these diseases by the use of insecticides and molluscicides against the vectors. Another way to effect disease control might be to control the aquatic plants which are essential to the life-cycles of the vectors. The Aquatic Weed Program database was searched for information about disease vectors associated with aquatic plants. The search revealed the following information.

Schistosomiasis ("bilharzia") is one of the major diseases of the world, afflicting more than 200 million people. Incidence of this water-based parasitic disease is increasing. The flatworm parasite's larvae swim from their snail hosts to the skin of humans and animals in infested waters. They enter the skin and through the bloodstream find their way to several internal organs. There they multiply, debilitating their victims with a variety of ailments, and eventually can cause death.

Malaria, yellow fever, encephalitis and other diseases are carried by certain species of mosquitoes and also affect millions of people and animals.

Control of these diseases has been limited mostly to the use of molluscicides and insecticides to control snails and mosquitoes but their effectiveness has been questioned. Millions of pounds of DDT, for example, have been used inside homes for years to control the malaria mosquito vector *Anopheles darlingi*. But in one study, DDT use in Suriname homes reduced the *A. darlingi* biting rate by only 20% (Hudson, 1984). Others have concluded that DDT cannot eradicate malaria or *A. darlingi* (Gabaldon, 1952). Under certain conditions such as fast flowing water or extensive plant coverage, other pesticides often are ineffective when applied at recommended rates. Neogy *et al.* (1957), for example, found that larvicidal control of mosquitoes was ineffective because of the rapid growth of aquatic flora which gave refuge to mosquito larvae.

Thomas and Tait (1984) suggested possible controls for snail vectors including "bioengineering" such as ditching, draining, dredging, transplanting, introducing non-host competitive species, and controlling aquatic plants with fishes, domestic animals and mechanical barriers. And there is much published aquatic plant control research, including studies on herbicidal, biological and mechanical aquatic plant control.

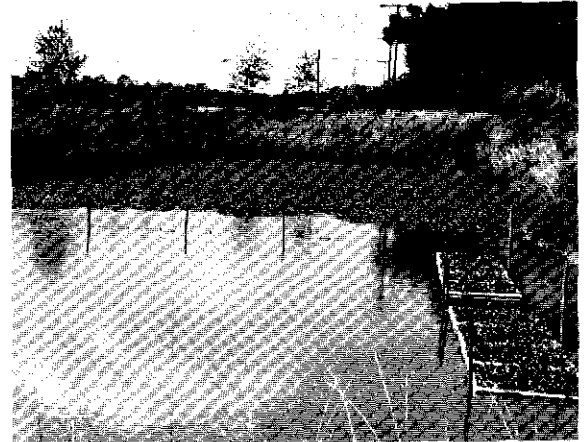
While studies have been made on plant-pest relationships, very little research has been published about the effects of plant control on pest snail and mosquito populations. Researchers agree that certain aquatic plants are essential to the life-cycles of disease-vector snails and mosquitoes, but few can say how controlling these plants would affect the numbers of snails and mosquitoes.

SNAILS

Biomphalaria glabrata and *Bulinus truncatus* are vectors of schistosomiasis. Other snails which carry helminthic diseases are *Lymnaea auricularia*, *L. luteola*, *Indoplanorbis exustus*, and *Austropeplea vinosa*.

Snails and aquatic plants have evolved together for 500 million years. Plants provide food (including plant tissue and epiphytes), oxygen, egg-laying sites, and protection against predators (Thomas, 1983). Aquatic host-plants for snails include *Ceratophyllum demersum*.

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INSECTS AND HERBICIDES WORKING TOGETHER

Integrating methods of control could reduce costs and simplify control of some aquatic weeds. For example, dense infestations of water hyacinths could be quickly reduced by chemical or mechanical means, then biological agents could remain on the job to keep the plants from proliferating again.

Before biological controls and herbicides can be used together, studies must be made to determine their compatibility. To do this, entomologist Dr. Kim Haag, has begun several large-scale pond tests to determine the efficacy of the integrated use of herbicides and insects to control water hyacinths. Various formulations of 2,4-D will be used together with *Neochetina eichhorniae* and *Neochetina bruchi*, two water hyacinth weevils.

In previous tests, Haag gauged direct toxicity of herbicides to weevils and recorded behavioral responses of insects on plants sprayed with herbicides. In the toxicity tests, weevils on plants were sprayed with commonly used formulations of 2,4-D, diquat and glyphosate. Haag found no significant mortality of weevils sprayed

with any of the herbicides. However, she did find that some of the inverting oils were toxic to weevils.

In behavioral trials, weevils were marked and placed in different parts of water hyacinth mats which had been partially-treated with herbicides. Haag recorded the movements of the different groups of weevils and concluded that there were no acute behavioral responses to herbicide application. The insects, which prefer healthy plant material, eventually migrated from the sprayed areas after the plants had yellowed and died.

The large-scale tests underway will help determine if, in natural situations, weevils would maintain their populations by migrating to those plants which were not killed by herbicide application.

Haag's work is funded by a USDA Cooperative Agreement through the University of Florida Center for Aquatic Weeds. Her address is: Dr. Kim H. Haag, Entomology Department, Bldg. 339, University of Florida, Gainesville, Florida 32611. (904) 392-4901.



SONAR STUDIES

The effects of exposure period and light on Sonar (fluridone) uptake and efficacy are being measured in tanks planted with three plant species and hydrilla tubers. Sonar is a new experimental herbicide formulated by Eli Lilly & Co. for hydrilla control. Conducting the tests is Mr. Daniel Thayer, assistant in aquatic weeds at the Center for Aquatic Weeds.

Mortality and dryweight of plants in test and control tanks will be compared to determine how shading and increased exposure times affect plant control at standard herbicide application rates. Plants used in these tests are *Hygrophila polysperma*, *Hydrilla verticillata* and *Potamogeton illinoensis*.

In separate aquatic raceways, hydrilla tubers are being studied for their uptake of Sonar in flowing waters. These tests will help determine if Sonar can be used effectively against hydrilla tubers in canals as a preemergent herbicide early in the growth season. Controlling tubers is a major goal of aquatic plant managers which could seriously affect the ability of hydrilla to infest and spread.



AQUATIC PLANT CONTROL LAWS

Florida has had infestations of water hyacinths (*Eichhornia crassipes*) since they were introduced into the state in the 1890s. Since then, alligatorweed (*Alternanthera philoxeroides*) and hydrilla (*Hydrilla verticillata*) have become nuisance plants as well. Several other exotic and native plants in Florida have the potential to become major "economic weeds". Because of economic and other impacts of these aquatic weeds, the U.S. and Florida governments have passed legislation intended to help control them.

The Florida legislature has stated "the uncontrolled growth of non-indigenous aquatic plants in the waters of Florida poses a variety of environmental, health, safety and economic problems...it is the responsibility of the State to cope with the uncontrolled and seemingly never-ending growth of nonindigenous aquatic plants...and the control of nonindigenous plants must be carried out primarily by means of maintenance programs, rather than eradication or complaint spray programs" (FSS, 372.932.)

"Maintenance control" is defined by Florida law as a method "in which control techniques are utilized in a coordinated manner and on a continuous basis in order to maintain the plant population at the lowest feasible level as determined by the Department of Natural Resources" (FSS, 372.932). Maintenance control is believed to be more economical because lower levels of plants require less control effort and cause less economic loss to users of the water resources. Maintenance control also is believed to be more environmentally safe because adverse impacts caused by exotic species and their management techniques are reduced.

The agencies and programs listed below provide the framework within which Florida manages the technical control operations and the social and political issues associated with aquatic weed management:

- 1) The **Bureau of Aquatic Plant Research and Control** is part of the **Florida Department of Natural Resources**. It coordinates control programs throughout the state, provides matching state funds for federal programs, and promotes and supports research activities.
- 2) The **Aquatic Plant Control Trust Fund** receives \$3.8 million of the funds collected from state gasoline taxes, forty percent of the license fees from commercial vessels, and \$2 from each noncommercial vessel registration fee (approximately \$1.2 million in 1983). The fund provides a stable source of financing for aquatic plant management programs.
- 3) **Aquatic Plant Control Permits** are required in Florida to regulate the types of control methods and the amounts of vegetation controlled. The **D.N.R.** program, which also requires that the public be notified of aquatic weed control work done, is coordinated with the **Department of Environmental Regulation** and the **Florida Game and Freshwater Fish Commission**.
- 4) The importation of plants into Florida is prohibited without first obtaining a permit from the **Department of Natural Resources**.
- 5) The **Center for Aquatic Weeds of the University of Florida** was created by the Florida legislature to coordinate, develop and promulgate research related to noxious aquatic plants. The legislature provides sustained base-level funding for the research facility, its faculty and supporting personnel. The Center conducts research and provides educational

opportunities for students and aquatic plant control personnel.

- 6) The **Aquatic Plant Advisory Council** is made up of agency personnel and water resource user groups, and provides recommendations on policy and procedures for aquatic plant management.

Florida State Statutes

FSS 213.11. Authorizes the **Department of Natural Resources** to receive \$3.8 million from state gasoline sales taxes.

FSS 241.362. Establishes the **Center for Aquatic Weeds**.

FSS 327.28. Authorizes the **Aquatic Plant Control Trust Fund** to receive 40% of the license fees from commercial vessels.

FSS 372.925; 372.932. Vests the **Department of Natural Resources** with the authority to direct aquatic weed research and control statewide, and to disburse funds to other agencies for the maintenance control of aquatic weeds.

FSS 403.141. Establishes penalties which, among other things, applies to negligently applying aquatic herbicides or applying them without a permit. (Not more than \$10,000 per offense, per day.)

FSS 403.271. Requires permits for importing any exotic aquatic plants or seeds into Florida; requires permits for moving or cultivating any aquatic plants within the state.

Chapter 16C-19. Rules of the **Department of Natural Resources** for obtaining permits to import, transport or cultivate aquatic plants, and lists approved and prohibited aquatic plants.

Chapter 16C-20. Rules of the **D.N.R.** for establishing and obtaining aquatic plant control permits.

Some county governments in Florida have their own aquatic plant control departments. They receive funding from their own tax sources, and from the state and federal governments.

The U.S. government also controls aquatic plants. The **River and Harbor Act of 1899** authorizes the **U.S. Army Corps of Engineers** to conduct aquatic plant research and control, and is totally federally funded. **Federal Public Laws 85-500 (1958)** and **89-298 (1965)** provided \$5.0 million per year nationwide for aquatic plant control and call for a federal research program to develop economic and effective control measures and to help local participants with the cost of aquatic plant control. Congress increased the fund to \$10 million per year in 1984 (**Public Law 98-63**).

Two funding programs exist through the **Army Corps Jacksonville District**: 1) **Removal of Aquatic Growth Project (RAGP)**, which provides 100% funding for the protection of navigation in Federal Project waters.

2) **Aquatic Plant Control Program (APCP)**, which is a cooperative program for control in navigable public waters, provides 70% of the cost of control (matched by 30% state or local funds) in lakes and rivers which have unrestricted access to the general boating public.

For more information or for copies of any of these laws, write to the agencies or to: **Aquatic Weed Program, 2183 McCarty Hall, University of Florida, Gainesville, Florida 32611, USA (904)392-1799.**

AQUATIC BIOLOGIST WANTED

An aquatic biologist is wanted by the City of Cape Coral (Florida) to set up a management program for more than 400 miles of fresh and salt water canals. The salary will be between \$20,000 and \$25,000. Applicants should 1) have a master's degree in aquatic biology, aquatics management or a related field and three years experience, or 2) have a bachelor's degree and five years experience. Send resume to **City of Cape Coral, Personnel Department, P.O. Box 980, Cape Coral, Florida 33910.**

MAKING AQUATIC WEEDS USEFUL: SOME PERSPECTIVES FOR DEVELOPING COUNTRIES

1976. *National Academy of Sciences, 175 pages. Fifth printing 1984.*

This popular book has been reprinted and is now available. It reviews methods for controlling aquatic weeds and utilizing them to best advantage. It concentrates on methods which could be used in developing countries.

The book is free and is available from the **Aquatic Weed Program** or directly from the **National Research Council, Office of International Affairs, Reports and Distribution, 2101 Constitution Avenue, Washington, D.C. 20418 USA. (202) 334-2633.**

WEED SOCIETY OF QUEENSLAND

The **Weed Society of Queensland (Australia)** was organized to promote interest in and the investigation of all aspects of weeds and their control and to foster the development of an Australian-wide weeds organization. The Society sponsors meetings and workshops and its members receive the **WSQ Newsletter**. The newsletter includes informative and practical articles about weed control, and introduces to its members new weed control products such as herbicides and application equipment. There are four classes of membership. For a brochure about the Society, write The Secretary, **Weed Society of Queensland, C/-P.O. Box 36, Sherwood, Queensland 4075, AUSTRALIA.**



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EDITOR: Victor Ramey

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Little Wekiva River

FLORIDA CITY FUNDS RIVER STUDY

A new three-year riverine ecosystem study is under way in Florida at the request of the City of Altamonte Springs and the Friends of the Wekiva River. Researchers of the University of Florida Center for Aquatic Weeds have been funded to develop a model to predict the effects of wastewater discharges on aquatic plant growth, algal export rates and other biota in the Little Wekiva River.

The small spring-fed river runs through residential areas receiving nutrients from municipal wastewater treatment plants, street runoff and three major springs. Parts of the river are becoming overgrown with aquatic plants including *Paspalum*, *Vallisneria*, *Hydrilla* and others. The predictive model will help determine how nutrient loading from future riverside development and additional wastewater discharge can affect the river's productivity.

The hydrology, water quality, invertebrate drift rates and fisheries potential of the river also will be studied. In addition, researchers hope to determine if the physical characteristics of the river affect its biological productivity.

Investigators for the project are Dr. Daniel Canfield, Dr. Jerome Shireman and Mr. Mark Hoyer of the Center for Aquatic Weeds. They would be interested in hearing from other researchers who have studied river eutrophication and its effects on biota. Their address is: Center for Aquatic Weeds, IFAS, University of Florida, 7922 N.W. 71st Street, Gainesville, Florida 32606 USA (904) 376-0732.

7TH INTERNATIONAL SYMPOSIUM ON AQUATIC WEEDS

The 7th International Symposium on Aquatic Weeds, sponsored by the European Weed Research Society (EWRS) and the Association of Applied Biologists (AAB), will be held September 15-19, 1986 at Loughborough University of Technology in Loughborough, England.

The theme of the Symposium is "The Biology and Control of Aquatic Weeds". There will be sessions on regional problems and management approaches, future trends in aquatic weed control, impacts of water use on control strategies, and impacts of aquatic weed control on aquatic ecosystems and socio-economic aspects of aquatic plant management. A Proceedings will be published. Information about the Symposium and details for authors and exhibitors can be obtained from Dr. Max Wade, Department of Human Sciences (Ecology Group), Loughborough University of Technology, Loughborough, Leicestershire LE11 3TU, ENGLAND.

HERBICIDE ADVANCED SHORT COURSE

Aquatic herbicide registration, regulation, toxicology, and safe use were the topics of the recent Aquatic Plant Control Advanced Short Course. More than 120 aquatics managers, chemical industry representatives, and state and federal government personnel participated in the seminar, which was co-sponsored by the University of Florida Center for Aquatic Weeds (Dr. Joseph Joyce, Director) and the Florida Aquatic Plant Management Society.

Dr. William Becker, IFAS safety specialist, began the program by saying that the two primary concerns of pesticide programs are the protection of people and the protection of the environment. He recommended policies and procedures for storing, handling, mixing, loading and disposing of pesticides, saying that only through adequate supervision can pesticide programs continue to have good safety records. He said that of 4,000 to 5,000 poisoning deaths a year in the U.S., only 20 to 40 of them are pesticide related.

The U.S. Environmental Protection Agency's Mr. Roy Clark canvassed participants on studies they would require before registering a product (or re-registering an old one). The participants wanted product chemistry studies, residue and persistence studies, toxicity studies including acute effects, effects from sub-toxic and chronic amounts, effects on reproduction, mutagenicity studies, effects on non-target organisms, efficacy of the product, tolerances for water and for wildlife, and more. Clark then listed and described the studies EPA does require before registration is granted. The two lists were nearly identical. EPA requires 27 product chemistry studies, 23 residue studies and 7 toxicology series studies.

Clark also discussed product labeling, saying that labels are loaded with information about the product, and in the U.S., have the force of law. Labels are inconsistent in their formats, however, and managers and applicators often find it difficult to identify quickly needed information on different labels. He said that an EPA task force now is studying ways to improve label uniformity and usability.

Senior product toxicologist Dr. Tim Long of Monsanto Chemical Company described in detail the toxicology studies his and other companies conduct on their products, as required by law. In acute tests, high level doses (meant to "force" toxic effects) are administered to groups of animals (rats, mice and dogs) and short-term gross effects are studied. In subacute tests, animals are repeatedly administered various doses for 30-90 days. In chronic exposure tests, animals are repeatedly exposed for their lifetimes. The potential of a product to affect reproduction in several generations is studied, as is the ability of a product to alter genetic material in cells.

According to Long, these tests take two to four years and cost \$2-3 million. He said the product patent life is 17 years, and often 10 of those years are taken in studies and other pre-registration requirements, leaving 7 years to recover development costs and become profitable. With some products, especially aquatic herbicides which account for only a small portion of chemical company sales, testing and registration costs have little chance of being recovered during their patent lives. This often makes new aquatic herbicides uneconomical to produce.

Short course participants also heard Dr. Daniel Canfield of the U.F. Center for Aquatic

Weeds review the short history of the science of limnology, and explain trophic classifications of water-bodies. Using facts and figures from his extensive studies of Florida lakes, Canfield demonstrated the effects of aquatic plant removal on nutrients, chlorophyll, transparency and other ecosystem parameters, in relation to hydrology, climate, geology and water body morphology. For example, he pointed out that long-term rainfall cycles can affect aquatic plant data interpretation, but sometimes researchers do not take rainfall into account. This can result in faulty conclusions. Canfield also stressed that the "management objectives" of a water body must be established before the system can be successfully manipulated. He concluded that maintenance control of aquatic weeds makes it easier to keep the ecosystem in balance than when aquatic weeds are allowed to proliferate.

The Center's Dr. William Haller described the toxicity and fate of the most commonly used herbicides in Florida (copper, diquat, endothal, 2,4-d, glyphosate and fluridone). He discussed potable water and aquatic animal tolerances and compared these tolerances to the appropriate herbicide rates used for controlling aquatic plants. In all cases, he said, effective plant control rates are well below the tolerance rates set for water and aquatic animals.

A panel discussion among chemical company personnel was moderated by Mr. Carlton Layne of the E.P.A. Panel members suggested changes to herbicide labels and discussed their interpretations of rules and regulations.

Additional advanced short courses are being planned concerning other aspects of aquatic plant management.



Sign in Biscayne Bay, Florida

AQUATIC PLANT JOURNALS

There are two journals which should be of particular interest to aquatic plant researchers and to managers of aquatic plants and ecosystems.

The **JOURNAL OF AQUATIC PLANT MANAGEMENT** is the official journal of the Aquatic Plant Management Society. This journal deals with "all aspects of aquatic vegetation management, field operations, research, regulations, and reviews." It is published in January and July of each year. Approximately \$25.00 per year. For information, contact: Aquatic Plant Management Society, Inc., P.O. Box 16, Vicksburg, Mississippi 39180 USA.

AQUATIC BOTANY is an "international scientific journal dealing with applied and fundamental research on submerged, floating and emergent plants in marine and freshwater ecosystems." It is published in 12 issues per year. Approximately \$230 per year. Contact: Elsevier Science Publishers B.V., Journals Department, P.O. Box 211, 1000 AE Amsterdam, THE NETHERLANDS.

ALGAE

by Dr. Ted Batterson, Department of Fisheries and Wildlife, Michigan State University, Rm. 13, Natural Resources Building, East Lansing, Michigan 48824.

The algae are a diverse grouping of plants that occur in a wide range of habitats. They occur on the land and on permanent ice sheets and snowfields, but predominately are found in the waters that cover over 70% of the earth's surface. They are photosynthetic plants that contain chlorophyll, have simple reproductive structures, and whose tissues are not differentiated into true roots, stems, or leaves.

Algae display a variety of growth forms. There are unicellular species, motile (flagellate), non-motile, or amoeboid. There are multicellular species which grow in colonial and filamentous organizations. Colonies are mass aggregations of individuals and filaments are strands of cells that can be either branched* or unbranched. Some algae have such complex growth forms that they can be mistaken for vascular plants. Members of the Charophyte group are an example of this.

Sizes of individual algal plants range from microscopic, unicellular species, approximately 0.000039 inches (0.0010mm) in diameter, to large filamentous marine algae that attain lengths of over 100 ft. (30 m).

HABITS (OR MODES OF EXISTENCE)

- Planktonic—free-floating
- Benthic—attached and bottom dwelling
- Periphytic—attached to rooted aquatic plants
- Epiphytic—attached to plants
- Epipelic—attached to mud or sand
- Epizoic—attached to animals
- Epilithic—living on stones

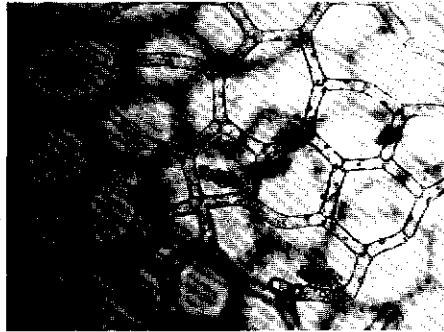
CLASSIFICATION OF ALGAE

The algae are placed into major groups, or divisions, based on the pigments they contain, their storage products, and their morphology (or growth form). Most algal divisions are present in both marine and fresh waters, although some occur more abundantly in one or the other. The *Phaeophyta* (brown algae) and *Rhodophyta* (red algae) are almost exclusively marine, while the *Euglenophyta* (Euglenoids) are almost all freshwater in their distribution.

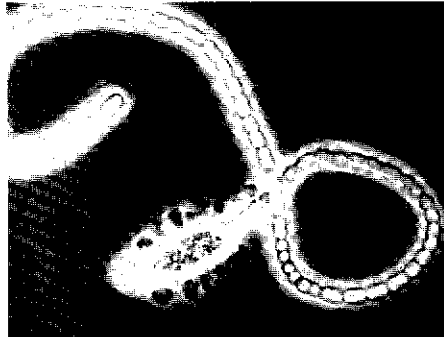
1. *Phaeophyta* (brown algae)—includes the large kelps, almost exclusively marine.
2. *Rhodophyta* (red algae)—usually quite large, visible to the naked eye, almost exclusively marine.
3. *Batrachospermium* -freshwater.
4. *Euglenophyta* (Euglenoids)—although usually green, can sometimes be colored red because of accessory pigments and can form a bright red film in ponds or sloughs under "bloom" conditions. This red coloration is in response to intense light conditions. *Phacus*, *Trachelomonas*, *Euglena*.
5. *Cryptophyta* (Cryptomonads)—closely related to dinoflagellates. *Cryptomonas*.
6. *Pyrrhophyta* (Dinoflagellates)—many in fresh water but the ones which receive the most attention are those that produce "red tides". *Gymnodinium*, *Ceratium*.
7. *Chrysophyta* (yellow-brown or yellow-green algae). *Chrysosphaerella*, *Mallomonas*, *Synura*.

The next four groups are the most commonly occurring ones found in freshwater systems:

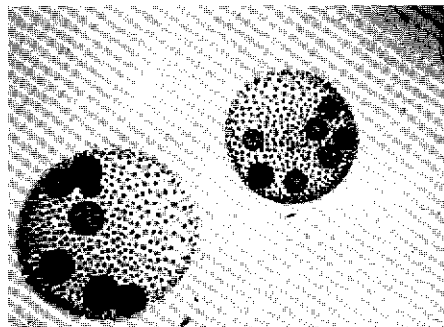
8. *Bacillariophyta* (diatoms).
- Centrales (radial symmetry): *Cyclotella*, *Stephanodiscus*.



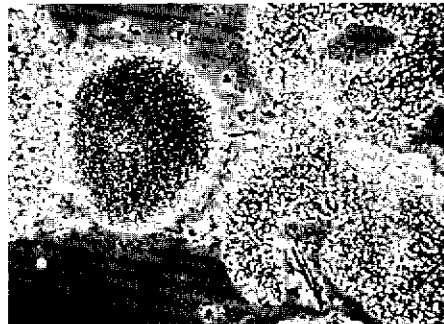
Hydrodictyon



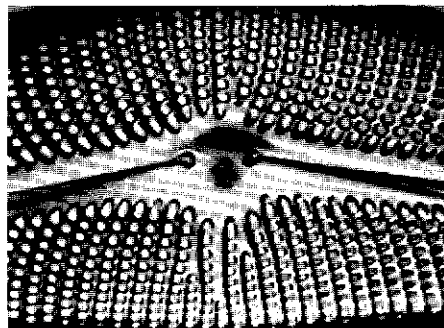
Chrysosphaerella



Volvox



Microcystis



Cymbella

Pennales (bilateral symmetry): *Navicula*, *Mastogloia*, *Cymbella*.

9. *Charophyta* (Charophytes), *Chara*.
10. *Chlorophyta* (Green algae). *Volvox* (colonial); *Coelastrum*; *Scenedesmus*; *Spirogyra* (filament—conjugating); *Eygnema*; *Hydrodictyon*; *Desmids*; *Micrasterius*; *Oedogonium*; *Bulbochaeta*; *Cladophora* (note similarity to *Phithophora*); *Stigeoclonium*.
11. *Cyanophyta* (blue-green algae). *Microcystis*; *Oscillatoria*; *Lyngbya*; *Cylindrospermium*; *Glaucoctysis*; *Agnetellum*.

COLLECTION AND PRESERVATION

Phytoplankton can be collected from the open water in one of the following ways:

- * With a cone-shaped, silk, bolting cloth net (No. 20 mesh) [available from biological supply houses] and then dispensed into a container.
- * With a water sampler (e.g. VanDoran, Kemmerer, etc.) and then dispensed into a container.
- * Submersing a bottle, mouth down, some distance below the water surface and then inverting, letting the bottle fill.

For all filled containers leave an air space and to look at live specimens keep chilled. If not, preserve with 3% formalin, 95% alcohol, or I-KI.

For collection of filamentous mats or charophytes procure a sample and place inside of wet newspaper and wrap with dry newspaper; if possible keep chilled.

IMPORTANCE AND BENEFITS OF ALGAE

From a biological perspective algae are of great importance to fresh water and marine environments: 1) they are important in oxygenating the waters, 2) they convert inorganic materials to organic matter, and 3) they serve as the base of the food chain upon which most of the other organisms in the aquatic habitat either directly or indirectly rely.

All of this is accomplished through photosynthesis, the process in which energy from the sun is converted to chemical energy in the plant. On a global basis, conservative estimates attribute 50% of all photosynthesis to the algae. In many water bodies they may be the only organisms fixing sunlight, while in others it also may be by vascular plants.

Because algae are at the base of the food chain they are being utilized in fish production systems. Fish culturists fertilize certain water bodies to increase algal biomass, which in turn supports greater animal biomass at other levels of the food chain, and ultimately results in greater fish biomass. Unfortunately, there is no simple formula for how much or what kind of fertilization should be used; results from many undertakings have been variable and quite unpredictable. For example, in some cases fertilization led to blooms of undesirable species such as filamentous blue-green algae which are unpalatable to most organisms that feed on algae.

Algae also may be considered beneficial when they grow in high enough density to exclude submersed macrophytes. This is the result of reduced penetration of light by increased turbidity. Aesthetically, this may or may not be preferred to excessive growths of submersed macrophytes.

PROBLEMS CAUSED BY ALGAE

Like all living organisms, the algae require certain conditions for growth. Light, temperature, and the availability of inorganic nutrients are