Biology and Identification of Aquatic Weeds

Results of another *Weeds and Turf* field research project

MAN IS in conflict with nature at almost every turn.

This fact is no less true in his use of natural or artificial water bodies. In smaller lakes and ponds, where there is no wave action or water level variation to prevent vegetation from running rampant, there is a natural progression from open water to shallow water, through various stages of vegetation, to a swamp or marsh stage. This, in turn, leads to a bog condition, and finally back to land.

This observable pattern takes many years to complete, but each year, vegetation whittles away at waters man finds useful. Gradually the progression, if not stopped by man's ingenuity, will steal the carefully cultivated usefulness of lakes and ponds.

Lakes are harnessed for food, recreation, transportation, flood control, electrical power, and water supply. Other waters, such as canals and ditches, are used for irrigation, drainage, and transportation. Aquatic weeds in these waterways annually cost millions of dollars, money which is spent to forestall, halt, or set back nature's progression that aims to create land where water is.

At other times, outbreaks of aquatic plants destroy the usefulness of existing waterways. When an alien plant, such as waterhyacinth, is released into new surroundings favorable to its growth, it multiplies rapidly and spreads over many acres of water surface. In these cases, man must attempt to correct nature's imbalance, or suffer the losses caused by weed growths.

Markets for aquatic weed control exist all over the United States. To accommodate these markets with service, chemicals, and information, competent applicators must know more about the aquatic environment and plants they want to control. This three-part series will deal with aquatic plant biology and identification, chemicals used for control, and application equipment and techniques.

Aquatic World is Unique

An aquatic environment is a different world from that which is familiar to man. Weeds must be destroyed selectively; desirable animals and fish inhabitants must live. To deal with an aquatic environment, a new set of factors must be considered in addition to plant species: biological factors (waxy cuticle on leaves), pH (acidity or alkalinity), hardness (mineral content), or organic content, currents, control period (when plants are killed most easily), to name just a few. These factors will be mentioned as they arise in the discussion.

Most logical sequence for a study of aquatic weed control starts with the organisms. Knowledge of the form and function of pest plants makes them easier to control.

For general background, certain terms will have to be defined. Plants are usually divided into two arbitrary groups: higher and lower. *Higher plants* are thought of as more advanced on an evolutionary scale. It is generally assumed that some plants came from ancient seas when land became habitable. The flowering habit evolved on land. Since higher plants have flowers, and some aquatic plants have flowers, they are thought to have been evolved from plants which formerly lived on land and readapted to water after developing the flowering-seed habit.

Lower plants are those which never left water in the course of their development. Algae are the most widespread representatives of this group.

Lower plants, which do not flower, have a vegetative growth pattern. Some lower plants, such as algae, grow by cell division; each two new cells are exactly like the original. There are other groups of lower plants which have more advanced growth patterns and unusual methods of reproduction.

Higher aquatic plants, since they are derived from land plants, have similar life cycles. They sprout from seeds, grow to maturity, develop flowers, and produce seeds. Some of the more troublesome aquatic weeds are perennial plants.

Perennials are long-lived, higher plants which resprout each year from tubers, underground rhi-

Controversy over the use of chemical pesticides has insured 1963 an important niche in the chronicle of modern weed control practices, and nowhere is the need for safety and technical proficiency more obvious than in aquatic weed work. For this reason, *Weeds and Turf* is proud to present the first in a three-part series of articles designed as a working manual for aquatic weed controllers.

Part I deals with growth habits and ecology of aquatic species; Part II, which appears next month, discusses chemicals in detail; Part III, slated for December, explains equipment which is used to apply controls. Included with the final installment will be an extensive bibliography.

This three-part report was prepared by W&T's technical staff and then circulated among leading authorities with university and government agencies, and with suppliers. The reviewers have been most thorough and painstaking in their comments, and we wish, at the outset, to publicly acknowledge their help.

Unless otherwise noted, photographs are from the Plantation Field Laboratory of the U. S. Department of Agriculture in Ft. Lauderdale, Fla., with the cooperation of staffers Lyle W. Weldon and R. D. Blackburn. — *Ed.*

zomes, or stolons (rootlike stems); seeds are not necessary to carry on the species, but contribute to the spread of perennial weeds. Weeds which choke waterways with thick, matted growth are often perennials.

Second Grouping System

A second grouping system used by aquatic plant experts is a separation with respect to how weeds are found in the water, for this often determines the control method to be used.

If plants are found completely under water, they are called *submersed aquatic plants*. This distinguishes those plants naturally found under water from those which are submerged when flooded or inundated.

Plants found protruding significantly from the water, such as cattail, are called *emersed aquatic plants*.

Floating weeds, such as waterhyacinth and duckweed, which are not rooted but may protrude above the water line, are called *surface aquatics*, or *unattached-floating plants*. Species which are rooted and have an "anchored" leaf or "pad" are called *attached-floating aquatic plants*. Some variation may be found if authors wish to designate whether emersed parts have leaves, flowers, or branches.

To describe where aquatic plants are found, we can use a division from ecology (Odum, 1959). Of three zones of a lake, *littoral* (marginal or closest to shore), *limnetic* (served by sunlight but over deep, open water), and *profundal* (beneath the limnetic; not furnished with light), the first, littoral, is the most important. It is in shallow littoral zones where all rooted and most floating vegetation is found. Where the littoral zone may be affected by rising and falling water lines, some "amphibious" plants may live both on land and in water (Hall, 1961).

After the plants are placed and different growth habits defined, one can concentrate on specifics about aquatic plant pests.

There are 25 families covering some 185 species of plants classed as aquatic weeds. This article will include habits, identification, and distribution of the most important of these families. Names of species are in accord with the Report of the Terminology Committee of the Weed Society of America (1962). First to be considered are those emersed species with parts protruding above the surface.

Cattails Are First Invaders

A most familiar emersed species is cattail, *Typha* spp., family Typhaceae (family suffix -ceae; tie fay' sea ee). Cattail is found throughout the United States, and is easily recognized by its tall, slender leaves, and tannish-brown flower spike. Cattail is usually the first rooted vegetation to invade shallow margins of a manmade farm pond; it grows in any wet place where its airborne seeds may land and germinate. Cattail colonies are formed from a fast-spreading underground root system. These stems and roots catch and hold soil firmly and begin to fill in pond margins and drainage canals. A stand of cattail can significantly reduce the perimeter distance of a pond in a short time. Cattail is found in fresh water, but will tolerate brackish waters of coastal marshes. (Muenscher 1944).

Bulrush Not Rush

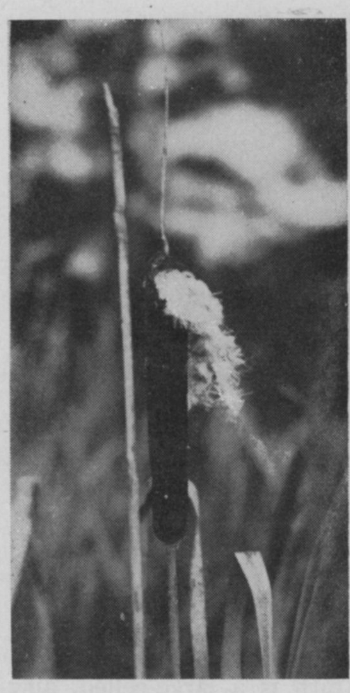
Another slender-leaved emersed species is bulrush, *Scirpus* spp. *Scirpus* is a member of the sedge family, Cyperaceae; it is not a true rush. Bulrushes are generally characterized by rounded or three-angled stems. Insides of stems are solid, contrasted with true rushes which have round and hollow, or nearly hollow, stems. The point where a leaf joins the bulrush stem is covered by a leaf sheath.

Many bulrushes are tall, 3 to 5 feet above water, sprouting from sturdy rootstocks. Reproductive parts are nutlike or conelike seeds borne near the end of an erect shoot. Seed clusters may sit directly on the naked stem or may hang on a branched spikelet, depending upon the species.

Two species of bulrush are especially troublesome across the United States, hardstem bulrush or tule, *Scirpus acutus*, and great or softstem bulrush, *Scirpus validus*. Both have solid circular stems and spikelets (seeds) borne on a branch or panicle, as it is called. Groups of nutlike spikelets of hardstem bulrush are ovate or rounded, while softstem bulrush has spikelets more pointed or lanceolate. A small portion of the main stem extends above seed clusters in both species.

There are many other species of bulrush distributed throughout the United States. They are recognized by a rounded or triangular stem, sheathed leaf

Rush (*Juncus* sp.) Staff photo.



Common cattail (*Typha latifolia*)

Watermilfoil (*Myriophyllum* sp.) Staff photo.

Burreed (*Sparganium* sp.) Staff photo.

Alligatorweed (*Alternanthera* sp.)

bases, and the subterminal nature of reproductive structures.

True Rushes

Commonly confused with sedges are true rushes, *Juncus* spp. (Juncaceae). Rushes can be spotted by a round, hollow, or pith-filled stem (pith is a large-celled, airy or spongy tissue). Species of *Juncus* are adapted to grow in shallow pond margins and along stream edges. Rushes commonly do not grow as high as some sedges. Usually found in grasslike clumps, most rush species do not have extensive underground roots from which to sprout new plants. Reproductive parts are not nutlike as sedges, but bear seeds on subterminal branchlets. Seeds are smaller with subtending stiff hairy parts.

Keep "Reeds" Straight

A so-called reed or reedlike species is burreed, *Sparganium* spp. (Sparganiaceae). Burreeds are widespread throughout the United States.

Leaves of burreed are of two types, erect or floating. Several species have limp leaves which float on top of the water; others stand up, typical of reedlike species. The character of burreed which serves for identification is the bur-type seeds borne on an erect, leafless, crooked stem. Parts of female flowers persist to form stiff hooks on seed clusters; this gives burreed its name, although it is not generally like a reed.

Giant reed, *Phragmites communis,* is the true reed of marshes, lakes, and ditchbanks. It is a perennial with hard, jointed, erect stems. Roots are coarse and scaly. Giant reed may grow to a height of 12 feet and be topped with the large feathery head of seeds. Growth is often so thick and hedgelike that access to the water is hindered (Klingman, 1961).

The time of chemical application which will give maximum control is an important factor when dealing with giant reed. When giant reed, which usually grows on land, becomes inundated with water, it becomes particularly resistant to herbicides which normally control it. The control period, or time span within which the weed can be more easily controlled, is significantly reduced.

Alligatorweed, *Alternanthera philoxeroides,* is a southern resident which was imported from South America. It is prominent in the Gulf States, and southeast coastal areas. Alligatorweed is a hardy weed which grows well as a floating, rooted, or dry land plant. Plants on land or rooted in shallow water arise from relatively stout rootstocks. Plants in floating mats have only fibrous roots arising from stem joints. Stems are erect, with opposite leaves at regular intervals. Leaves are long, tapering to a point (lanceolate); leaf edges are smooth. Many tiny white flowers are on a head which arises either from a terminal shoot or long straight petioles from axils of uppermost leaves. Seeds of alligatorweed are seldom found; this weed propagates mainly by spreading roots or stem shoots, each of which may sprout and grow a new colony (Weldon 1962). It easily forms a mat from the shoreline over all shallow open water. Other plants are crowded out by this persistent growth habit.

"Arrowheads" Can Confuse

Three different aquatic weeds have arrow-shaped leaves which can confound hasty identification. A close look confirms that these three species are different in the way the veins are placed in leaves. Once noticed, this difference is not difficult to see.

Arrowarum, *Peltandra virginica,* is a member of the same family (Araceae) as the terrestrial Jack-in-the-Pulpit and skunk cabbage. As such, arrowarum has a flower spike (spadix) which is enclosed in a wraparound leaf (spathe). Arrowarum has three distinct leaf veins radiating from the petiole attachment. One vein goes to the tip, the other two go to the basal points (arrow barbs). Secondary veins branch off horizontally from the midrib. Margins of arrowarum are sometimes wavy or uneven.

Pickerelweed, *Pontederia cordata,* is another erect emersed species which has arrow-shaped leaves. In the family Pontederiaceae, of which waterhyacinth is also a member, pickerelweed, with exposed purple flowers, is distinguished from arrowarum when flowering. When not in flower, leaves of pickerelweed differ in that there is no main vein or midrib. All veins originate at the petiole attachment and travel singularly to the tip. Veins are curved into the lobe portions of this "arrowhead."

Most familiar genus in the waterplantain family, Alismaceae, is arrowhead or duck potato, *Sagittaria* spp. Arrowhead is common and widespread throughout the country.

Flowers of arrowhead are distinctive. They are borne on a tall stalk, usually in groups of three about a stem. Flower structure is simple; there are three small, white, or sometimes pink, petals. Several groups of three will be found at different levels on the erect stem. Stems of water plantains are fleshy and have a milky juice. Although leaf shape varies from one species of *Sagittaria* to another; (some are broad; others very slender), they retain an arrowhead shape. At times species have two different kinds of leaves on one plant; one kind above water and one below. Submersed leaves are usually slender and ribbonlike.

Venation will help distinguish *Sagittaria* from other "arrowhead" plants. Veins of *Sagittaria* are parallel, similar to those of terrestrial plantains. There is no strong midrib; veins which supply nourishment to basal lobes are branches of those which run to the tip.

Sagittaria is considered a valuable food plant for waterfowl, and is often introduced into a lake for duck food (Fassett 1960). Ducks relish the tuberous roots of some species of arrowhead, hence the common names of duck potato or swamp potato are used in some parts of the country.

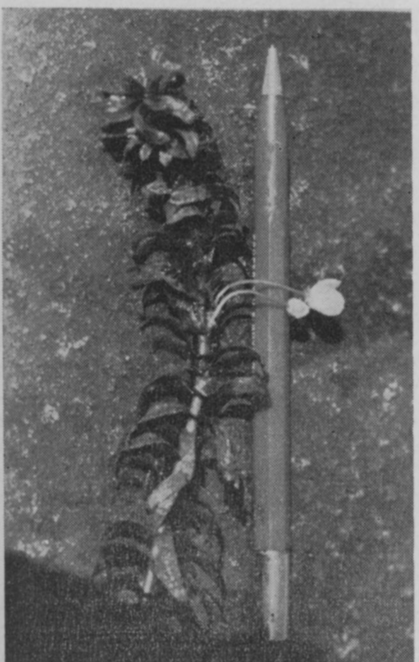
Water smartweed, *Polygonum amphibium*, is a member of the buckwheat family, Polygonaceae. The quickest way to confirm identification of a smartweed, when a pink, white, or greenish flower spike is seen along with alternating lanceolate leaves, is to check the jointed stem. If there is a sheath or stem extension at the base of each leaf petiole covering each joint or node, it is a *Polygonum*.

Smartweed species are generally distributed over the United States.

Waterprimroses, *Jussiaea* spp., are members of the evening-primrose family, Onagraceae. Waterprimrose is a rooted emergent genus. Species of waterprimrose (*J. repens* var. *glabrescens*, *J. californica*, and *J. grandifolia*) form mats of vegetation due to the air-holding capacity of stems. Roots are embedded in marginal shallow areas, and vast mats spread outward from the shoreline. Leaves are willowlike; long and slender. Flowers have 5 yellow petals, and are borne in the axils of leaves. The fused petals form a long tube connecting the flower stalk with the open petals. The ovary is long and slender and produces many seeds. Waterprimrose has an underground stem which sends up new shoots intermittently.

Waterwillow, *Justicia* (*Dianthera*) *americana*, (An alternate genus or species in parentheses indicates that either name may be found in texts depending upon date of publication. The first name is preferred.) has leaves similar to true willows (*Salix* spp.), but waterwillow, being herbaceous in nature, is not related to the woody species. This member of the family Acanthaceae is widespread throughout the eastern half of the United States.

Brazilian elodea (*Elodea densa*)



Waterwillow is a perennial with thick creeping rootstocks. It reaches a height of about 5 feet. Leaves are willowlike, opposite on the stem and entire (not toothed or scalloped around the edges). Flowers are purple. Waterwillow is found nearer the edge of a lake or pond and does not spread lakeward. It can also survive out of water, but thrives when partly submerged.

Submersed Weeds: Anathema To Boaters, Swimmers, Fishermen

Submersed aquatics are the second group of important weeds. These weeds usually grow entirely under water, but leaves may reach the surface when growth is dense. They may or may not be rooted. Submersed aquatics do not have enough supporting tissue in their stems to maintain an erect posture out of water. Many submersed species do develop short flower stalks which may extend above the water surface for fertilization. This is an ephemeral occurrence and reproductive parts usually bend into the water after pollination.

Submersed weeds are the most troublesome group of aquatic plants that occur in irrigation and drainage ditches. Underwater weeds clog waterways, collect silt, and reduce flow to agricultural fields under irrigation.

One of the most common submersed aquatics is *Elodea* (*Anacharis*) spp., sometimees simply called waterweed. Sinc wat erweed is such a nondescriptive term, we shall refer to this weed as elodea.

Elodea is a favorite "seaweed" for use in goldfish bowls. Although it is normally rooted, it is easily fragmented and can survive as a floating plant or plant parts. This factor is important when controlling weeds of this sort. Chaining and plowing do not kill it, but merely spread the infestation.

Elodea is normally found in calcareous or hard water, water which contains dissolved calcium minerals. It grows rapidly, frequently branching from nodes. Each node is represented by a

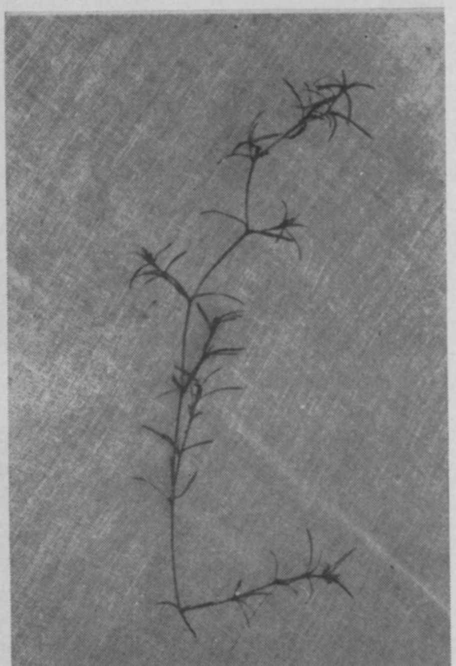
Arrowhead (*Sagittaria* sp.) Staff photo.

Pickerelweed (*Pontederia cordata*)

Arrowarum (*Peltandra* sp.) Staff photo.

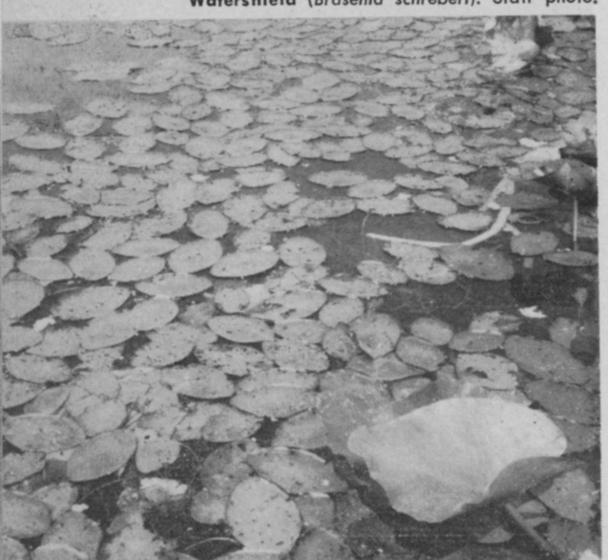
Waterprimrose (*Jussiaea grandiflora*) below.

Coontail (*Ceratophyllum demersum*)



Southern naiad (*Najas guadalupensis*)

Watershield (*Brasenia schreberi*). Staff photo.



whorl (circlet) of leaves described as straplike, relatively long and flat. Often the stem grows to such a length that it breaks, and sends out new roots to become established in another place. Vegetative propagation is the prominent means of reproduction, although elodea does reproduce by seed. Sometimes male and female flowers are found on the same plant. Flowers are small and inconspicuous, found growing near stem tips. While developing, the flowers grow on slender filaments to the surface where pollination may take place.

There are two common species of *Elodea*. Most widespread is *Elodea canadensis*, American elodea. This native North American plant became a pest of waterways in Europe soon after it was introduced there.

Elodea densa, Brazilian elodea, is a large species introduced from South America. It is commonly used in aquaria and outdoor pools. It has adjusted to the wild and is now found throughout North America. As the name suggests, leaves grow in a dense whorl around the stem.

Watermilfoils "Smother" Oysters

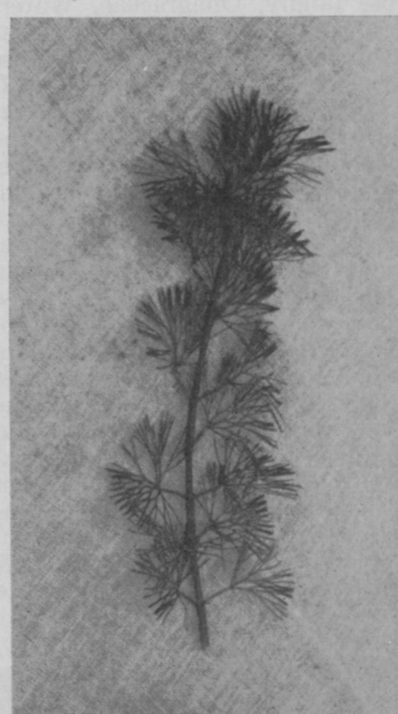
Another troublesome weed of inland lakes and coastal flats is watermilfoil, family Haloragidaceae, genus *Myriophyllum*. There are about 20 species of this important aquatic weed. Stems of watermilfoil are not greatly branched; leaves occur either in whorls or are alternate on stems. Leaves are finely dissected (featherlike) or branched.

One very important pest species, parrotfeather, *Myriophyllum brasiliense* (*proserpinacoides*), was introduced from South America. It is common along streams, brooks, drainage and irrigation ditches. Reproductive structures and foliage of parrotfeather protrude above the water. It is a pest along the east coast, in Florida and California. Beds of watermilfoil have been known to be so thick that herbicide granules could not penetrate the mat of weeds.

Various watermilfoils have adapted to different water types. No single general statement can be made regarding water and its relationship to milfoil. Some are adapted to hard water and are usually found over a limestone bed. Others are found in noncalcareous waters, and one imported species, eurasian watermilfoil (*M. spicatum*), has adapted to living near the sea in water intermediate in salt content between sea water and fresh water. In these areas, heavy stands of eurasian watermilfoil interfere with oyster farming by killing young oysters and hampering harvesting operations. Thick mats impede water movement, reduce microscopic oyster food, and lower water oxygen content (Steenis and Stotts, 1961). This weed is also a pest in some inland waters.

All watermilfoils are basically alike in that they have very fine, feathery leaves. They are all "rooted" to the bottom by a weak horizontal underwater stem from which new plants sprout.

Coontail, *Ceratophyllum demersum*, is a notorious member of the

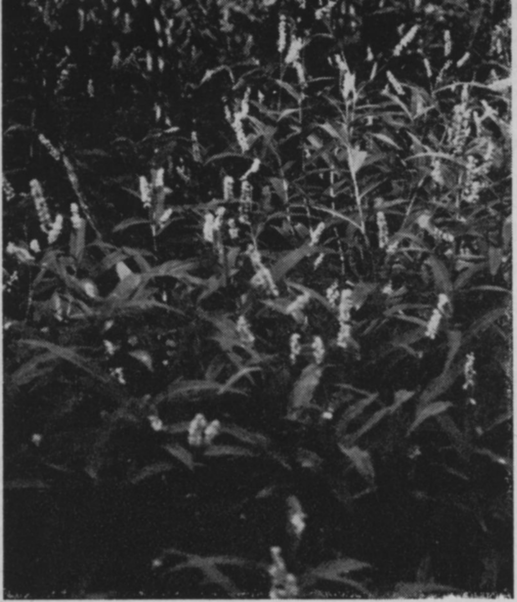


Cabomba (*Cabomba caroliniana*)

family Ceratophyllaceae. Coontail is found in every state in the country. It will be found in lakes and ponds where there are sufficient nutrients and organic matter. Wherever it grows, it is usually a plentiful and dominant species.

Recognized by the stem with whorled leaves which bears a resemblance to the tail of a raccoon, coontail has fine forked, pointed leaves. Each leaf in the whorl radiating from the stem has "teeth" or barbs along one edge. This characteristic identifies coontail readily. Coontail appears olive green when viewed through clear water.

Coontail has no roots but is often found with its basal stalk embedded in soft mud early in



Smartweed (*Polygonum* sp.) Staff photo.

Spirodela (*Spirodela* sp.)

Spatterdock (*Nuphar advena*)

Chara (*Chara* sp.) below.

the growing season. Late in the summer, mats of coontail will float on the surface and drift with wind and water currents. This weed may collect in one portion of a pond or lake and make it entirely unusable for recreational purposes (Hiltibran, 1961).

An aquatic weed which could, at a hasty glance, be taken for coontail is *Cabomba caroliniana* or fanwort. Cabomba is classed by some as a member of the waterlily family, Nymphaceae. It, too, grows entirely submersed. Close observation reveals that leaves are finely divided, but are more fanlike and blunt tipped. They do not have "teeth," as does coontail. Leaves are attached oppositely to the stem rather than in whorls; they are covered with a gelatinous slime, typical of some waterlilies. Cabomba grows entirely under water except from May to September when the plant sends tiny white flowers to the surface along with tiny peltate (shield-shaped) leaves which give a clue as to waterlily kinship.

Sago is Toughest Pondweed

Next on the list of submersed aquatic weeds are the pondweeds, *Potamogeton* spp. Most widely known and toughest to control is sago pondweed (*Potamogeton pectinatus*). Found in nonacid waters (neutral to alkaline, pH 7 or above) in all states, sago pondweed is responsible for blocking flow in thousands of miles of irrigation ditches.

Sago pondweed is a limp, rooted species which bends freely in moving water. Leaves are rounded in cross section, threadlike, taper to a point, and fan out in water. Sago pondweed is a bushy plant and should not be confused with those pondweeds which have long strandlike leaves that float in water.

Widespread over the United States, sago pondweed is one member of the pondweed family which cannot be killed by applications of sodium arsenite (Hiltibran 1961). Therefore, a recognition of this pest is necessary so that adequate control measures can be applied. Other pondweeds with tuberous roots may be difficult to kill with contact herbicides.

The leaves of other Potamogetons vary in form from broad floating leaves to very narrow and submersed leaves and in some species foliage will vary on the same plant. All pondweeds have a flower spike which extends above the water from the mainstem. Their description and identification are very difficult.

Only a few of the more distinctive Potamogetons will be described here. If others are encountered, a textbook key should be used to confirm membership at least to the genus Potamogeton. A county agent or agricultural experiment station can also be helpful when doubtful species need identification.

Curlyleaf is Crispy

Curlyleaf pondweed, *Potamogeton crispus*, as its name indicates, has curled, wavy leaves, a crispy texture, and fine "teeth" along leaf edges. Curlyleaf pondweed is common in temperate United States and extends its range south to Tennessee and Alabama and west to California. It will thrive in hard, muddy, or brackish water.

Another group of submersed pondweeds is the fine-leaved species. These have grasslike leaves which are variable as to the shape of the tip and the type of venation. Leaf edges of fine-leaved pondweeds are entire (smooth) as opposed to the naiad, *Najas* spp., which also has fine leaves, but is finely toothed along both edges.

Naiads: Bushy Pondweeds

Naiads, *Najas* spp., are of the family Najadaceae, although some authors include them in the same family with Potamogetons (Fassett, 1960). Naiads are collectively called bushy pondweeds; they do not exhibit as much variation within the genus as do Potamogetons.

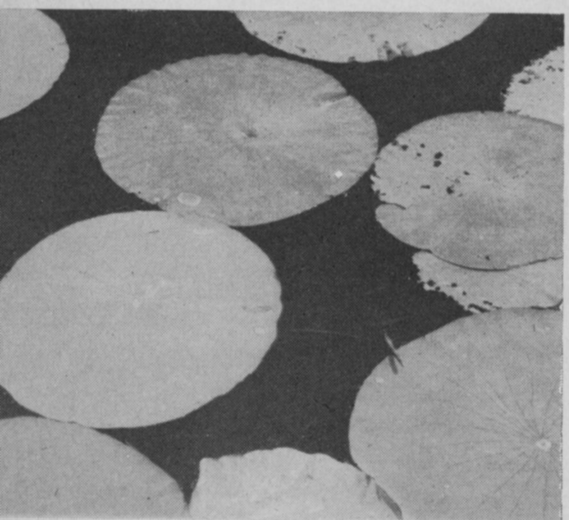
In general, naiads are more uniform plants. Leaves are opposite and somewhat regularly spaced; all leaves are pointed and widen near the base. All species are submersed and there is no leaf variation on individual plants as there is in the Potamogeton pondweeds. Naiads flower from axils of leaves.

Two species which are most widespread and troublesome are southern naiad, *Najas guadalupensis*, and slender naiad, *N. flexilis*.

Southern naiad ranges along the Atlantic and Gulf coasts extending northward through the Mississippi basin onto the Plains and North Central States. It is also common in shallow waters in California. Southern naiad has fine teeth on both edges of leaves. All naiads have a widened base but some taper gradually; some have lobes. Southern naiad tapers gradually to the stem. Its dull seeds are pitted across the middle with

Fragrant waterlily (*Nymphaea odorata*)

Waterhyacinth (*Eichhornia crassipes*)



American lotus (*Nelumbo lutea (pentapelta)*)

Waterlettuce (*Pistia stratioites*) below.

10 to 20 rows of coarse pits. (Hiltibran 1961).

Slender naiad, *Najas flexilis*, also has "toothed" leaves tapering at the base, but seeds are shiny with very fine pits. Slender naiad is a temperate species; it thrives mainly in northern states, ranging westward to the cooler Rocky Mountain and Northwestern States. It is not found in the Plains States.

Any of the several naiad species may be confused with *Elodea* if the naiads appear in closely tufted, shortleaf form. Differentiation is determined by the pointed tips and wider leaf bases of *Najas*, which also has "toothed" leaf edges and flowers in leaf axils.

Final group of submersed weeds to be considered is algae. Algae are free-floating, one-celled, colonial or filamentous, nonflowering plant organisms. A general greenish coloration is imparted to water when algae are present in excess. Sometimes a typical fishy odor will lead one to determine that algae are responsible for the lessened desirability of a lake or pond for recreation.

Increased growth of algae frequently occurs as the result of fertilizer applied to water to increase fish-growing capacity. Generally, the application of fertilizer to ponds already containing higher aquatic weeds is not a good practice. Frequently with the decomposing of higher weeds following herbicide application, algae, because of lessened competition for nutrients, cause water to become sickly green and rather unattractive.

Exact identification of planktonic and filamentous algae is not always necessary because these can generally be controlled with properly applied amounts of copper, such as copper sulfate, also called blue vitriol or bluestone.

One filamentous species which is more difficult to control, and may require more than an inorganic mineral treatment, is *Pithophora* sp. This alga is typical of filamentous types; it grows attached to rocks and other plants. Cells form long, branched, "strings" which resemble hair when wafted by currents. As with some other species already mentioned, *Pithophora* breaks attachments late in the season and masses on the water surface. At this time it is said to look like a mat of wet wool.

Chara spp. is a lower aquatic plant which bears a resemblance to some flowering weeds, but chara does not flower because it is an alga.

Recognized by typical primitive whorled branchlets, and its distinctive musky repulsive odor, chara or stonewort often marks the deepest point of water beyond which no other plants will grow. Beyond the chara line is the water zone which does not receive sufficient light to support rooted plant life (Odum 1959).

Chara is dark green, and very brittle. Since it inhabits calcareous water, it is often encrusted with lime deposits. Heavy stands of chara are said to have a softening effect on the naturally hard water. Presence of chara removes much of the calcium minerals from the water; minerals are apparently "attracted" to chara and held to the plant in an insoluble state. So although water may be suspected to be hard, it should be tested so that controls will be accurate. ("Hard" water is water with large amounts of dissolved calcium and magnesium salts, and high carbonate and bicarbonate alkalinity. Carbonates (CO_3) combine with copper and settle out, reducing the amount of copper for plant control.)

A close look with a hand lens should reveal the stem surface of chara to be ribbed or lined vertically. Chara is highly resistant to most chemicals, and may survive after death of other weeds. Accurate identification can predict this and accusations of job failure will be avoided.

Last group to be considered is surface or floating aquatic weeds. These may or may not be rooted; if rooted, leaves float or extend above the surface; if not rooted, leaves and flowers may stand erect from the floating mat.

One exception will be noted. Some waterlily species will be included in this group although they are rooted and some leaves stand erect, out of the water. Reason for inclusion is so that comparison of different leaf types necessary for identification will be easier.

The duckweed family boasts among its membership the smallest flowering plant and some other very tiny aquatic weeds.

Lemna minor, *Lemna* or common duckweed, is a very small light-green plant which floats on water and reproduces by lateral branching and splitting of the small leaves. Each plant (leaf) has one tiny root which hangs down into the water. Growth and splitting are very fast and *Lemna* is able to cover a small pond in a short time if left unchecked. Small common duckweed plants are about the diameter of a lead pencil and will be seen near the shore protected from open water by larger plants. If common duckweed covers a pond, wind may cause the tiny plants to be blown to the windward side of the pond where they "climb the banks."

Other members of the duckweed family are *Spirodela* sp., giant duckweed, which has several rootlets hanging from the floating leaf. *Spirodela* is only slightly larger than *Lemna* and is usually red or purple on leaf undersides. *Wolffia* sp., watermeal, is nearly microscopic, has no roots, no leaves, and each plant looks like a green grain of sand or collectively as a green scum floating on the surface. It is the smallest flowering plant known.

Waterhyacinth: Expensive Weed

Waterhyacinth is probably the most undesired aquatic weed in Florida, the Gulf States, and California. Since its introduction as an ornamental and subsequent escape in the late 1800's into the inland waterways of Louisiana and Florida, cost of control has reached millions of dollars.

Waterhyacinth, *Eichhornia crassipes*, is a free-floating flowering plant which spreads mainly by vegetative reproduction, budding new offshoots from a parent plant in rapid order. Growth is in a rosette pattern; leaves are somewhat oval and are supported by a long petiole which is inflated and buoys up the plant. Fibrous roots extend into the water and absorb nutrients. New offshoots are bound to the parent plant by strong stolons. Flowers are very showy and attractive, colored white, blue, or violet; there are 6 petals fused into a tube at the base. Many flowers are borne on a single spike.

Waterhyacinth propagates so rapidly that mechanical control is often too slow to keep up with reinfestation. Excessively heavy growths clog canals so that navigation is precluded.

Waterlettuce, *Pistia stratioites*, is similar to waterhyacinth in that it is a floating plant, but it does not clog waterways as much because interplant underwater connections are weak and easily broken. Waterlettuce has a range similar to waterhyacinth except that it does not occur in California, but does occur in Arizona.

Fleshy, prominently veined leaves have a covering of short, fine hair which makes liquid chemical control difficult without a wetting agent (Weldon 1962).

Waterlettuce may sometimes be found stranded on mud flats at which time it will take root weakly in mud. This plant has a flower, but it is a very inconspicuous one and not necessary for identification.

Waterlilies, family Nymphaceae, are easily recognized by the large, floating leaves, or pads, and showy white or yellow flowers. There are 4 genera of importance in this family.

Leaf Structure Spots Waterlilies

Watershield, *Brasenia schreberi*, is the only species in this genus and is identified by the eliptical (peltate) floating leaf with the petiole, or leaf stalk, attached to the middle of the leaf underside. Watershield leaves have no split as do some other waterlilies. To confirm identification, leaf undersides and petiole are typically covered with a jellylike mucilage.

Watershield flowers are less conspicuous than larger waterlilies and not needed for identification purposes. Watershield is amply distributed throughout eastern United States and occurs locally in the Pacific Northwest.

American lotus, *Nelumbo lutea* (*pentapelta*), is also the only native species in this genus and is easily identified by the circular floating leaf which is connected to slender, horizontal roots by a stout petiole which joins the circular leaf in the middle. Leaves are somewhat depressed or saucer shaped, and very waxy to the touch. There is no split in leaves.

In the center of the lotus flower, made up of numerous pale-yellow petals, is the conical, fleshy receptacle in which seeds are formed. No other member of the waterlily family has such a conical receptacle; all others are globular.

Of the remaining two genera, spatterdock, *Nuphar advena*, and white waterlily, *Nymphaea* spp., identification may be determined by venation of the floating or erect leaves.

Both genera have variable leaves; that is, they vary from nearly circular to somewhat arrowhead shaped. Leaves of both genera have a split at the point where the petiole joins the leaf. Despite these similarities, overall venation of the leaves is different. *Nuphar* or spatterdock has a

(*Continued on page W-36*)

WATERHYACINTH

(Eichhornia crassipes)

Waterhyacinth, a flowering, tropical aquatic weed, reproduces by vegetative offshoots from parent plants and by seed. This free-floating weed is found throughout the Gulf Coast region of southern United States where it spreads so rapidly that it clogs inland waterways and prevents navigation for commerce and recreation.

Waterhyacinth was introduced into the United States from South America sometime before 1884. First official account of waterhyacinth was at the New Orleans Cotton Exposition in that year. It bears the nickname of "Million Dollar Weed" in Florida, though cost of its control has long since passed that mark. It is also a pest in areas of California.

A somewhat oval leaf-blade with parallel veins is borne on the end of an inflated bladderlike petiole. It is this bladder which bouys up the plants. Many petioles grow outward in a rosette pattern from a central axis.

Six-petaled flowers are showy and vary in color from white to bluish hues. Many flowers are borne on a single flower stalk which emerges from the central axis. Many tiny seeds are produced, but only about 5% germinate. Enough seedlings may become established in shallow water, decaying vegetation, or on mud along shorelines to reinfest bodies of water from which all waterhyacinth plants have been eliminated.

Waterhyacinth has a densely fibrous root system which dangles in the water but may become attached to mud for a time during periods of low water.

Underwater rhizomes, submerged stemlike structures, are the major means of this weed's spread. After a lateral growth of about six inches away from a parent plant, the rhizome sprouts a new plant. Ten individual plants can cover an acre of water after ten months growth. It is the rhizomes which bind mats of parent plants and offshoots together and restrict movement of watercraft through infested streams.

When a mat of waterhyacinth covers a stream, it so shades out sun that no other plants grow, and in shallow areas the oxygen may be so low under the mat that no fish survive. Mats block water flow and have been known to cause sewage backup in Florida. Matted plants, at times, float downstream and jam against bridges. Many mechanical and chemical controls have been tried; 2,4-D has been the most successful chemical used to date. However Amitrol-T and Diquat have recently been shown to be effective. Chemicals are applied as foliage sprays in a continuing program to eliminate this pest at its source.

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Fertilizer Co., Homestead; William Colburn, Superintendent of The Bay Hill Club, Orlando; and J. Leroy Fortner, Superior Fertilizer Company, Sarasota.

During the annual banquet on August 28, Cary Clark, turf management major at the University of Florida received the second FT-GA $500 scholarship.

Numerous awards were made at the banquet to Floridians who have played a prominent role in turf over the years. Foremost of the awards was the presentation to James E. Ousley, Sr., of Pompano Beach, an FT-GA Director and 1962 Trade Show Chairman, of the first FT-GA Award of Honor, in recognition of his meritorious service to the Florida turf industry.

Aquatic Weed Control

(*from page W-17*)

single midrib vein on each leaf from which small lateral veins are given off. Overall venation may be obscured by the smooth fleshiness of leaves. *Nyphaea* or white waterlily, on the other hand, has veins which radiate evenly from the petiole point of attachment. Identification of leaves can be used when plants are not flowering.

Nuphar's sparsely petaled flower will be yellow; *Nymphaea's* many-petaled flower will be white, rarely yellow, pink, or blue. After petals have dried and fallen, the globular seed receptacles will look alike on both species, so leaf venation identification again should be used.

Although Nymphaea is considered a true floating-leaf aquatic, some species of *Nuphar* are more erect. Stout petioles lift the arrow-shaped leaves out of the water.

The aquatic plants previously discussed do not constitute all pest species encountered. At one time or another, any number of species may become sufficiently plentiful to be bothersome. This listing is intended to offer a brief cross section of the more troublesome species at present.

Chemicals for control of these plants will be dealt with in the second installment of this series, which appears next month; equipment for application will appear in the final segment of this three-part article.