Underwater Pond Plants

By E. LAURENCE PALMER

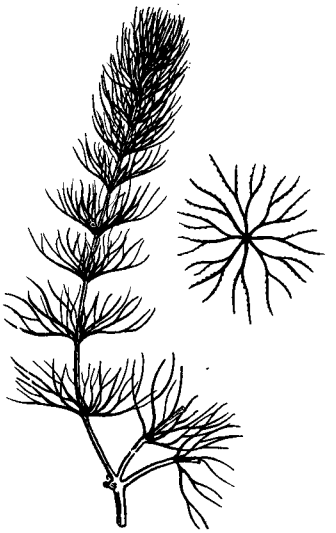
Illustrated by Elizabeth Burkmyer

This is the eighty-second in NATURE MAGAZINE'S *series of educational inserts.*

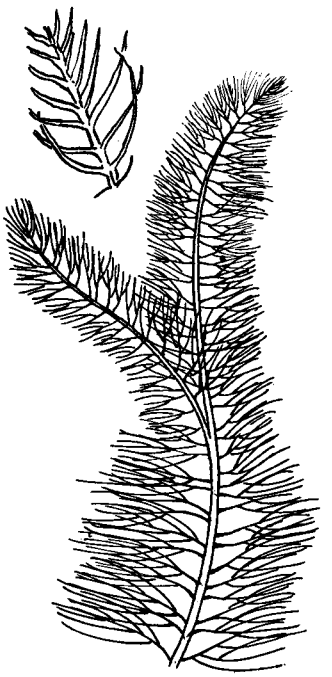
Sago Pondweed

Bushy Naiad

Mud Plantain



Hornwort



Water Milfoil

Elodea

THE subject of the special educational insert just before this one was cats. We tried to be neutral in our judgment of the merit of cats. While we received a number of letters supporting the view that cats might be undesirable members of a community, we also got the most vitriolic letter that this series has stimulated from a lady who resented a passing comment on a use of cats in zoological laboratories. We feel safe, this time, that we are writing about a subject that will elicit no such violent reaction. This is not to assume that underwater pond plants are not controversial. In some circles they are. In fact, their role in underwater economy has been almost completely reversed in the past two decades when we consider them as related to managed farm fish ponds.

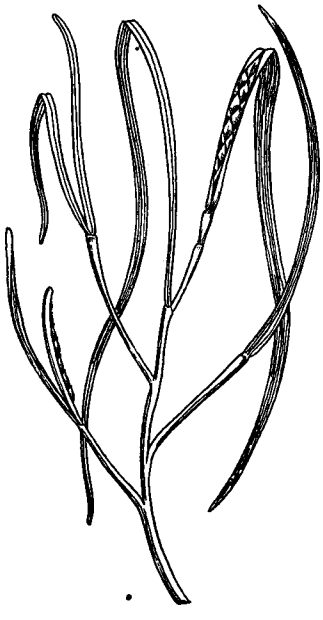
This insert is a part of a series that has considered the story of the shallower fresh waters. Other units bearing on this subject that you may wish to consult are:

#1. Some Common Fresh-water Insects. #14. Marshes and Their Environs. #38. Sea Weeds. #56. Pond Surface Plants. #59. Mollusks of Land and Fresh Waters. #60. On the Level. #69. Fresh-water Algae. #70. More Water Insects. #79. Aquarium Fishes.

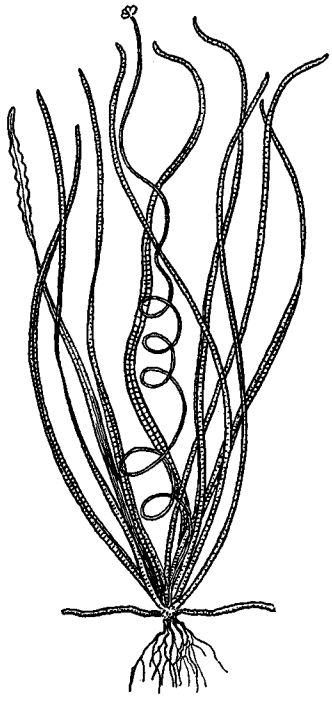
If you are interested in maintaining an aquarium, establishing a farm fish pond, managing a shallow body of fresh water, or just knowing about the plants that usually grow a few feet under the surface of any such shallow waterway, we hope that you will find this insert worth-while.

Basic in the appreciation of these plants is some understanding of how they may affect you and your neighbors. They may clog a swimming area, may influence the number of fishes available to fishermen, or the number of ducks available to sportsmen. They may affect the taste and safety of drinking water, the navigability of a canal or other body of water used in transport. They may affect the turbidity, alkalinity, temperature, odor, color and other characteristics of water. They may be associated with the number of mosquitoes in the neighborhood, and with the stench so often noticeable along shores. They may even affect the real estate value of property near a body of water that supports these plants. They may attract large wildlife species out of protective cover, may

create fatal hazards to swimming mammals, whether man or beast. They may affect water sports, or the loss of water by evaporation in areas where such loss may be critical to local economy and survival. They may add beauty to an aquarium, and, by increasing the oxygen content of the water, may reduce the labor attendant on the maintenance of an aquarium. They may provide a source of food to man and beast, and, in the past at least, may have yielded materials of direct economic importance. Thus it must be evident that these plants are not wholly inconsequential.



Sea Wrack



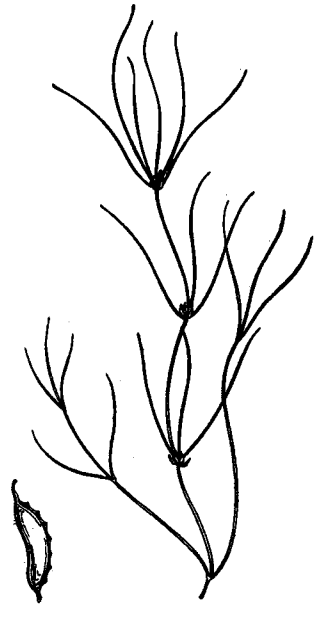
Wild Celery

As explained in the 39th insert, these plants support organisms that may have a profound effect on public health and have been important in maintaining an effective war potential in some foreign lands. There is little likelihood that they will be less important to man in the future than they have been in the past, or that they will fail to continue, in their own inexorable way, to influence important changes in the nature of the surface of the earth. Any well-informed person should have some appreciation of the role played by these organisms on a local or on a world-wide basis.

Much of the detailed information necessary for understanding these plants is provided in the chart section of this insert, or in the bibliography on page 385, but a sketchy review of the high points involved seems to be needed.

Let us define our group first. Essentially, we are dealing with those flowering plants that live in fresh or brackish water, and that may be submerged almost wholly for much of their lives. We have included one or two that may have floating or "emergent" parts, but for the most part these plants live and die beneath the surface of fresh water. Those that are conspicuous for their floating parts were considered in the 56th insert.

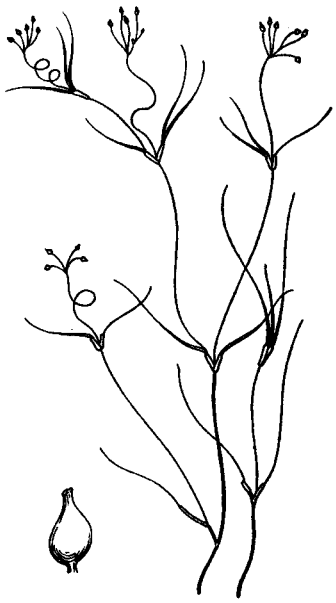
Ecologists agree that the nature of the surface of the earth is often changed effectively by the plants and animals that live on it. Commonly ponds and streams, over long periods of time, are recognized as being of a temporary nature. Streams, by cutting down and by building up deposits, change their whole nature. Some ponds and lakes become filled with sediments of many sorts and thus cease to be pools. The plants discussed here play an important role in this story. Many ecologists recognize about five stages in the evolution of a newly formed pool into a bit of forest land. In the first of these, the bottom of the pond is essentially free of conspicuous vegetation. In the second, submerged vegetation is dominant. Following this, there comes a stage in which the vegetation reaches the surface and extends above it, although surrounded by free water. Later, with the accumulation of sediments, the pond may be restricted in size and may even be merely temporary. Finally, the pond disappears and the surface is taken over by land forms. In this story, the plants in which we are now interested are dominant in the second stage and give way to competition in the third.



Horned Pondweed

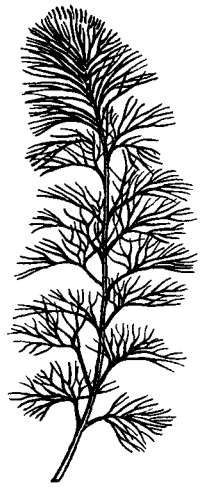
Arrowhead

If the pond in which our plants grow has no outlet, obviously it will fill gradually with the accumulation of sediments without the plants doing much about it. However, if the pond is merely a part of a river, or if there is an outlet, the plants speed up the filling process by anchoring sediments that may be suspended in the water. Many of these plants are



Widgeon Grass

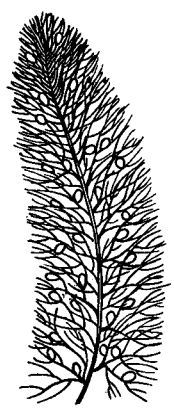
Mermaid Weed



Cabomba

Curly Pondweed

Water Fennel



Bladderwort

covered with a jelly-like coating to which the sediments cling.

Through the year there is usually less violent change of temperature and of light in a pond than there is on open ground. In other words, it rarely reaches the extremes of cold and heat that is found on dry land. Possibly because of this, the plants are not forced to survive by seeds that can normally survive difficult conditions. Anyway, our pond plants are mostly perennials, many of which continue growth through the year, while others go through the difficult season with the help of buried tubers, rootstocks and other vegetative parts. There is, however, a seasonal cycle caused by changes in temperature, and to some extent caused bv the cutting off of light bv snow-covered ice. In some ponds the decay ot plants during this period so exhausts the oxygen from the water that many fishes are killed. This may be a factor in the relative success of farm fish ponds in both the North and South.

Most of our pond plants have weak stems. When they are taken from the water, they cannot remain erect. This weakness, however, is in a way a strength. Were they stiff they could not resist so easily the movement of the water that surrounds them. When wind blows over the surface of a pond, it may set up currents of water beneath the surface. Plants that can respond to this movement of the water may well survive. Plants growing on the mud bottoms of ponds may, like those growing on the ground, seek the light. This means that if they have devices filled with air that will lift parts of the plants towards the surface, it will be helpful. Many of our water plants have these devices and if crushed under water may be seen to free the air. Mucilaginous coating of the underwater parts may help to hold this air within the plants. Such surfaces are found on many of the plants we consider here. This air may be of value, also, to some animals that live much of their lives under water.

The light problem is important in what happens to ponds, and to our plants that are growing in them. The depth to which light penetrates is determined largely by the clearness of the water. Silt held in suspension may easily reduce the depth to which adequate light for plant growth will penetrate. If we need the plants, we might want the light to penetrate deeply. If we wanted to destroy the plants, we might do this by cutting off the light in some way. Modern fish pond management calls for doing just that. However, instead of cutting off the light by increasing the silt in suspension, this is done by increasing the minute plants and animals that may live near the surface of the water. This is done by increasing the food available to them and often this is supplied by the use of artificial fertilizers. The minute plants and animals that make up this "plankton" area are preyed upon by smaller animals that live beneath them. These, in turn, are preyed upon by the larger animals such as fishes that we may wish the pond to produce.

In managing fish ponds, it is usually the practice to prevent the plants featured in this insert from growing, but where we cannot add artificial food to normal ponds the plants may be useful. They (*continued on page 368*)

COMMON NAME SCIENTIFIC NAME	GRASS WRACK. SEA WRACK. EEL GRASS *Zostera marina*	SAGO PONDWEED *Potamogeton pectinatus*	CURLY PONDWEED *Potamogeton crispus*	CLASPING-LEAVED PONDWEED *Potamogeton perfoliatus*
DESCRIPTION	Stems, weak, branched, to 55 feet long, with thick rootstocks. Leaves, ribbon-like to 6 feet long and to 1/3 inch wide, with 3-7 principal nerves, with unnotched margins. Stem is sheathed by leaf bases. Leaves, blunt at the free end and in general appear coarser than those of *Vallisneria*.	Stems, to more than 20 feet long, heavily branched, being repeatedly branched into 2 parts. Leaves, narrow and almost hair-like, but somewhat stiff, with sharp, rather stiff ends, with 1 main nerve and few cross nerves. Stipules fast to stems for ½ their length, to 1 inch long, with chaff-like margins, and sharp-tipped.	Stems flattened, branched. Leaves alternate and 2-ranked, making whole plant appear as a flattened plane at times, with crisped margins, to 4 inches long and ¾-inch wide, from 3 to 7 nerves, with stipules at the base that do not remain long on the plant.	Stems, branched, slender. Leaves all submerged, round to narrow, with minute teeth in margins near the tips, although this may be obscured, heart-shaped at base and surrounding the stem, margins wavy and with 11 to 21 nerves, membranous, to 3 inches long and 1 inch wide.
RANGE AND RELATIONSHIP	Order Najadales. Family Zosteraceae. Usually completely submerged in brackish water up to 25% that of normal sea water. In temperate regions on Atlantic or Pacific Coasts, the Pacific Coast form having leaves to ¾ inches wide and 10-13 nerves. Bays and inlets Greenland to Florida and Alaska to California.	Order Najadales. Family Zosteraceae. In water from 2 to 5 feet deep, or more, over muddy or sandy bottoms. Ranges from southern Alaska to Newfoundland and south into Mexico, with greatest abundance from central New York west to Nevada and southeastern British Columbia. Found also in Europe, Britain and Australia.	Order Najadales. Family Zosteraceae. Ranges from Massachusetts to Virginia along the coast and extending erratically west to the coast where it is found in California, also in Utah, Wyoming, Oklahoma and South Dakota. It is also found in Europe, and has been introduced in other parts of the world.	Order Najadales. Family Zosteraceae. In brackish or calcareous waters from Newfoundland to Alaska, and south to Florida and central California, except area including southwest California, Arizona, New Mexico, Nebraska, Missouri and southern Appalachian highlands.
REPRODUCTION	Reproduces by seeds or by division of rootstocks. Plants bear flowers in crowded structure, which is about 1 to 2½ inches long and bears 10 to 20 staminate and a similar number of pistillate structures. Seed is about ⅛-inch long and bears 20 ribs and is blunt at each end.	Flowers borne in loose spikes of 2 to 6 flowers, flower whorls at or just above water surface. Fruits are nutlets to 1/6-inch long with 2 obscure ridges and rounded on the back. Embryo in the seed is in a complete spiral, or sometimes incomplete. Flowering time is July and August.	Flowers are borne in spike each about ½-inch long that has a bristle-like appearance. Fruits have a slightly soft exterior, a face that is somewhat curved, with 3 keels on the back, the middle one of which is the longest. The rather persistent style about equals the rest of the fruit in length.	Flowers borne in 2 to 8 whorls, on spikes just above water, the spikes being to nearly 1 inch long and 1/3-inch thick. Fruits are to ⅛-inch long and 1/10-inch in diameter and appear to be broad. Normal propagation is by segments of the rootstocks, by seeds, and by cuttings.
ECOLOGY	Possibly most widespread seed plant in temperate brackish waters, being found in Europe as well as in America. One of most important sources of duck food, and when plants began to disappear in 1930 from Atlantic Coast waters the duck problem increased. A fungus is greatest enemy of Atlantic coast forms.	Can grow in water with salt content 44% that of sea water and remain healthy, and can withstand high degree of alkalinity. This species is possibly the most important duck food in western alkaline lakes, and is probably the most important duck food on the continent, equalling all other pondweeds combined.	Does rather well in waters more polluted than those that will support some other pondweeds. For this reason this species may be more abundant near cities than some others. Normally winter is survived by peculiar winter buds that form, but these have food value to waterfowl.	Best growth takes place in waters with concentrations about 12% that of average sea water, but may survive in waters of to 25% the concentration of sea water. This plant usually does best over mucks or sands, and will do well either in still or in moving water.
ECONOMY	Industries used dried plants for stuffing cushions and for soundproofing, but had to suspend operations with disappearance of plant. Introduction of Pacific Coast form that resists enemy attack may restore the plant to its important economic place. Known as barnacle-grass, turtle-grass, drew, widgeon-grass.	Excellent food for ducks, muskrats, deer, moose, beaver and shore birds. The tubers, seeds and rootstocks constitute the bulk of the food eaten, but other parts of the plant serve also. Rated by aquarists as of high value in raising oxygen content of water in aquarium. Tubers are high in starch content.	Not very important as a species of pondweed, but can grow where others cannot, and for this reason serves a rather unique function. The flowers appear in August and the fruits persist long after that month.	This ranks high among the pondweeds, having value as food for waterfowl. It is rather regularly planted in waterfowl management programs.

DITCH-GRASS. WIDGEON GRASS. *Ruppia maritima*	HORNED PONDWEED *Zannichellia palustris*	BUSHY NAIAD *Najas flexilis*	ARROWHEAD. DUCK POTATO *Sagittaria cuneata*	ELODEA, WATERWEED. DITCH MOSS *Elodea canadensis*
Stems branching, threadlike, to more than 3 feet long, often whitish, with irregular internodes. Leaves, threadlike, to 4 inches long, alternate, sheathing stems at base with free part of stipule shorter than sheathing portion, or absent. Leaves of related alkaline-tolerant *R. occidentalis*, to 1½ feet long, and plant larger.	Stems almost threadlike, branching abundantly, weak, arising from extensive creeping rootstocks. Leaves opposite rather than alternate as in *Potamogeton* and longer, narrower and less crowded than in *Najas*. Leaves to 3 inches long and with membranous sheathing stipules at base.	Stems, to 20 feet long, slender, brittle commonly branched. If growing in shallow water, plants may appear bushy. Leaves slender, opposite, to 1 inch long and 1/10-inch wide, curled, light translucent green, crowded in upper ends of stems, tapering at base. Roots, fibrous. Annual.	Height, to 16 inches or even more, with leaves arising in clusters from buried tubers. When submerged, the leaves may be slender but when they come above the water they produce arrowhead-shaped blades that are 8 or 9 inches long and nearly as broad on occasion. Leaves are variable in shape.	Length, to more than 3 feet, with short internodes. Stems weak, brittle. Leaves, in whorls of 3s or 4s or even 2s, to ½-inch long, with finely irregular margins, usually bright green and translucent, broadest at base, to 1/5-inch wide. Stems may grow without roots, or roots may form at joints.
Order Najadales. Family Zosteraceae. Does well in lagoons where salt concentration is high. Most alkali resistant of flowering plants. Can live in fresh waters as well as saline or alkaline. Widely distributed over northern hemisphere. British Columbia to southern California on West Coast.	Order Najadales. Family Zosteraceae. May do best in fresh spring water, but can survive salinity to 1/3 that of sea water. Found from Gulf of St. Lawrence to Yukon and south into Mexico. Relatively common anywhere in the United States in suitable habitats, particularly in waters over rich soils. Found in Old World.	Order Najadales. Family Najadaceae. Ponds, streams and other fresh waters throughout most of North America. Also found in Europe. Most abundant in Great Lakes area. Uncommon in Texas, Colorado, Utah, Nevada and to the south. Five species in eastern areas. Some found in brackish water but most inland.	Order Najadales. Family Alismataceae. This species ranges from Newfoundland to central British Columbia and south to California, Kansas, and north of the Ohio and east through Pennsylvania. This is commonly lower than the related *S. latifolia*, and it bears tubers that are smaller. About 40 species.	Order Najadales. Family Hydrocharitaceae, The Frogbits. Native of North America, where it is found from coast to coast from Gulf of St. Lawrence to southern British Columbia to central California, central Texas and South Carolina. Introduced into England in 1847 by Babington, it quickly became a pest but subsided.
Reproduced normally by seeds or vegetative parts. Seeds borne in straight or hooked fruits in clusters to more than 1 inch long. Flowers in long clusters that become coiled into loose spirals at maturity. Some variation in nature of fruits and of fruit-bearing structures. Artificial propagation by cutting requires that cuttings come in contact with the soil.	Fruits, borne in clusters of 2 to 6, in axils of leaves and under water. Both staminate and pistillate flowers are borne under water. Mature fruits show a distinct horn, are short stalked or stalkless and fruit is around 1/10-inch long. The appearance of the fruit is responsible for the common name "horned."	Fruits borne in axils of leaves, singly, papery walled and enclosing a single seed, which tapers at each end and has long persistent style attached to enclosing fruit. Common propagation by fracture of plants, with broken sections forming new plants. Cutting may be tied to small stones and planted.	Reproduction, vegetatively by means of submerged tubers. Corolla, to 1 inch broad. Pistils and stamens, in separate flowers. Fruiting heads are crowded with seed-like structures with thickened wings and small beak. Flowering time is from July through September, and fruit bodies persist later.	Pistillate flowers, on long slender stems that reach water surface, with sepals to 1/10-inch long. Staminate flower with sepals to 1/5-inch long. Pistillate plant commonly has leaves crowded at branch tips. Fruit, small, oblong, few-seeded. Books contain conflicting statements about reproductive nature.
Excellent food and shelter for fishes of many kinds. Ducks also feed on fruits and vegetative parts. This is important in waters too brackish to support other food plants that can survive only in fresh waters. However, without this plant and a few others, many brackish and alkaline waterways would be deserted.	Fruits and foliage are eaten readily by wildfowl. In brackish waters this may be important in waterfowl management. The plants are considered as fair sources of food for trout in farm fish ponds managed for the raising of trout. The trout, of course, feed on organisms that feed on *Zannichellia*. Is propagated rather easily.	Can grow in waters to 20 feet deep if pollution is not too great. Can survive loss of light better than most associated plants. Does best in water from 1 to 4 feet deep. May grow over mud, or, better, over sandy bottom. Some species like *N. marina* favor brackish waters. Some do well on tidal flats.	A rather important duck food according to early estimates, but it is now believed to be less significant. The tubers are valuable for ducks but are commonly buried too deeply in the mud to be available. May be eaten by muskrats The seeds may be eaten by a number of animals.	Found commonly in fresh waters rich in lime, usually in ponds and slow streams. One common name, choke pondweed, gives some concept of its behavior. When introduced into Europe, it multiplied in 5 years to a serious abundance only gradually to become extinct, rare or harmlessly abundant on its own.
Seeds of ditch grass are harvested in late summer and are planted in late fall. Seeds stored over winter may become too dry and may lose their vitality. Fall plantings may be harvested by migrating birds, and so spring plants may be favored where labor is not competitive with common farm practices.	Ducks known to feed on this plant are black duck, pintail, mallard, gadwall, redhead, ringneck, bluebill, shoveller, widgeon and green-winged and bluewinged teals. Landscape designers working with ponds do not favor *Zannicellia* because it lacks beauty. It does best in waters under 3 feet deep.	Stems, fruits and foliage may be a favored food for ducks wild and domesticated, with *N flexilis* apparently most popular with mallards. Makes good food and excellent shelter for fish and for fish food such as insects and small fishes. One of the better duck forage food in managed areas.	Aquarists like to grow some species of *Sagittaria*, in part because they seem to contribute a high amount of oxygen to the water. When they get too abundant they may merely be pulled out.	Ducks feed on fruits and leaves. May supply quick food to domestic ducks. Also eaten by horses and cattle where it is available. Leaves are a popular subject for study in biology classes because of transparent nature, which permits easy observation of streaming in protoplasm under a microscope.

COMMON NAME SCIENTIFIC NAME	WILD CELERY, TAPE GRASS, EEL GRASS *Vallisneria americana*	MUD PLANTAIN. WATER STARGRASS *Heteranthera dubia*	HORNWORT. COONTAIL *Cerotophyllum demersum*	CABOMBA, CAROLINA WATER SHIELD *Cabomba caroliniana*
DESCRIPTION	Stems, horizontal and buried in mud, the runners producing tufts of narrow, thin, 5-nerved leaves, to 20 feet long and to ¾-inch wide with the marginal nerves inconspicuous. Leaves, like pale green ribbons borne in tufts at intervals along the stem. New buds may be delicious to ducks and to man.	Length, to more than 3 feet. Stems, branching, slender, flattened, rooting at the joints. Leaves, flat, grasslike, parallel-veined, may turn to color of dying grass and may appear to be silt-covered, possibly giving the common name of mud plantain to it. Leaf sheaths are thin.	Stems, weak, to more than 20 feet long, without roots of any kind at any time. Leaves, in whorls of 5 to 12, 2 to 3 times divided, with the segments stiffly rigid and toothed-margined, to ¾-inch long, brittle, conspicuously crowded at branch tips particularly late in the season. Early season plants upright.	Stems, branched, weak, slender, gelatine-covered, to several feet long. Leaves opposite or whorled, divided into fine sections and arranged fan-like. Upper leaves sometimes alternate, some with floating blades but mostly submerged. Leaf sections, narrowly oblong. Leaves, to 2 inches broad.
RANGE AND RELATIONSHIP	Order Najadales. Family Hydrocharitaceae. From Nova Scotia to the Dakotas, and south to Texas and Florida. The closely related *V. spiralis* is found in Europe, and the two were once considered possibly the same. There is still some confusion on their status as species.	Order Xyridales. Family Pontederiaceae. Found often in great abundance in shallow fresh water of lakes, slow rivers and ponds, usually where water is hard. Ranges through most of the United States, but most common in East and mid-West. Quebec to Oregon and south to Cuba and Mexico. May grow in wet mud.	Order Ranunculales. Family Ceratophyllaceae. Found in every State of the Union and throughout most of North America, except in extreme north and Cuba. Most abundant in eastern United States in ditches, shallow pools and sluggish streams. Known also in Europe. Two species with inconspicuous differences are known.	Order Ranunculales. Family Nymphaceae. Found in fresh water ponds and slow streams. East of line running from Michigan through Illinois, Missouri, Arkansas, Louisiana and Texas and north to New Hampshire and south to Florida. Commonly found in aquarium supply stores over the country.
REPRODUCTION	Staminate flowers borne submerged, but break off and float to surface. Pistillate flowers, on long stalk, which reaches to surface where pollination takes place. Following this, the fruit stalk contracts in a spiral, permitting maturity to take place under water. Fruit, to ½-inch long.	Flowers, relatively inconspicuous, borne singly at end of thread-like tube. Pale yellow, of 6 parts, with stamens longer than included pistil. Fruit, a one-celled. many-seeded capsule. More likely to flower when stranded in mud than in open water. Flowers from July through October.	Clusters of 8 to 20 staminate flowers, each consisting of a stamen, are surrounded by 10-12 bracts that are forked; are found in whorls. Anthers float to surface, free pollen, which sinks to submerged pistillate flowers, which are borne at stem joints. Fruit, to ¼-inch long with 1 seed to a fruit.	Flowers, to ¾-inch across, white or yellow, somewhat like a little water lily, borne on long stems from bases of uppermost leaves. Petals and sepals, 3. Stamens, 3 to 6, with slender filaments. Carpels 3 and seeds 3. Ripened carpels may tend to separate. Flowers from May through August.
ECOLOGY	Flowering takes place from August to September, with mature fruits being present in the North from September to November, and in the South as late as December. Fruits, leaves and wintering buds provide superior food for ducks, particularly canvasbacks, which feed on them readily.	Provides food for small water animals that provide food for useful fishes. Plants may also provide cover for the smaller fishes. In some areas, is considered valuable as duck food, but certainly is not the best for this purpose. Some closely related species do not have the narrow leaves.	Fresh water shrimps and other small water animals abound in masses of hornwort and provide food for nearby fishes. Requires little light, but may pollute water and form almost inpenetrable barriers. Branch tips become crowded with leaves in fall, break from plant and sink to bottom for winter.	Eaten sparingly by waterfowl and not considered a superior duck food. When grown in aquariums, seems to be free of offensive odors common to many other water plants, and leaves are likely to produce less aquarium trash than most plants. Wide leaves lend great beauty to aquarium set-up.
ECONOMY	Can be transplanted successfully and this is done in wildlife management practices. Also eaten by moose, muskrats, deer and fishes of many kinds. Worthy of study and management.	Rarely, if ever, becomes the menace to traffic through water that the related water hyacinth does. The rather long list of ducks that feed on it indicates that it is useful in spite of its contribution to the water pollution problem.	Poor aquarium plant but grows rapidly. May give off bad odor. Muskrats and some ducks, such as black duck, redhead, ringneck, bluebill and wood duck known to feed on the plant. Brash nature of plants makes them harsh and uncomfortable to swimmers who may come in contact with them.	Aquarium plants do not commonly produce the floating leaves or the flowers, so their prosperity is probably seriously limited under aquarium conditions. Plants are set in aquariums by weighting sections of stems, or sinking them in earth on bottom. Known as fanwort and fishgrass in trade.

WATER FENNEL. WATER STARWORT *Callitriche palustris*	WATER MILFOIL *Myriophyllum exalbescens*	MERMAID WEED *Proserpinaca palustris*	MARE'S-TAIL, BOTTLE-BRUSH *Hippuris vulgaris*	BLADDERWORT *Utricularia vulgaris*
Stems, to 10 inches long submerged or rising weakly over mud flats. Submerged leaves are slender 1-nerved, to nearly 1 inch long, opposite. Floating leaves are broader, dotted with scales. Some forms show no floating leaves whatever. Length of stems may vary with depth of water.	Stems, to about 3 feet long, branched or unbranched. Leaves, submerged, in whorls of 3 to 5, to 1½ inches long, divided like parts of feather into about a dozen pairs of hair-like segments, with central axis about the width of the segments. Leaves near the flowers entire and whorled.	Stems, branched or unbranched, to 20 inches long or longer under water, smooth. Leaves those growing out of water to 2 inches long and ½-inch wide with sharply toothed margins. Submerged leaves alternate, with parts like those of a feather and with segments rather stiff and with a narrow black spine in axils.	Stems, to 2 feet long, or longer, unbranched, smooth, completely submerged or with two to 6 inches raised above water surface. Roots freely at the joints in lower areas of the stems. Leaves, in whorls of 16 to 12, narrow, without petioles, to 1 inch long and ⅛-inch wide, pointed at the free end.	Stems float horizontally beneath the surface of the water and extend 3 feet or more, branching sparingly. Leaves, alternate, to 2 inches long, divided into 2 at base and repeatedly twice-divided. Some leaf segments are bladders that assist in flotation and in food getting. No roots.
Order Geraniales. Family Callitrichaceae. More than 40 species found almost worldwide in distribution except in South Africa. This species ranges through most of the United States, except the southeastern area and is found in Europe, Asia and South America. The West lists 5 species, the East, 4.	Order Myrtales. Family Haloragaceae. Native of North America, but also found in Europe and Asia. Listed West Coast species, 2; East Coast species, 8 varying with the authors, with this species appearing on West Coast by some as a variety. Found mostly in warmish ponds and streams. 20 species in all.	Order Myrtales. Family Haloragaceae. Two species in United States, *P. palustris* ranging from Wisconsin to Oklahoma and Texas east to Georgia and Maine, and *P. pectinata* ranging through seashore States from Texas to Maine. Both in shallow ponds and streams often in shaded areas.	Order Myrtales. Family Hippuridaceae. Ranges from Alaska to southern California and east to the Atlantic north of Mason-Dixon line. Also found in Europe, Asia and Patagonia. In fresh water, usually with considerable current, favoring hard waters. Essentially a northern species.	Order Polemoniales. Family Lentibulariaceae. One fossil species known, but living species are found almost worldwide in distribution, with bladder-bearers in Northern Hemisphere. Some forms live out of water. This species ranges from Yukon to Lower California and east to Newfoundland and Maryland.
Flowers are borne in the axils of the leaves. There is no calyx or corolla. There is one stamen and 1 4-celled pistil, with one seed in each cell. Fruits are compressed, with winged lobes and in this species with 2 bracts about 1/10-inch long and about twice that broad. Flowers appear in July to September.	Flowers held above water in spikes bearing whorl of short leaves. Spike with flowers is to 3 inches long. The 4 petals in each flower drop early. Stamens, 8. Fruit small, bearing a wide groove between 2 ridges. Lower flowers, pistillate; upper, staminate. Flowers appear from July through September.	Flowers, solitary or in small groups, borne stalkless in axils of leaves that are above water. Fruits, to ¼-inch wide with concaved sides and thin or winged angles, sometimes pyramidal in shape. Flowers bear both stamens and pistils, lack petals and bear a 3-sided calyx tube. Stamens, 3 and stigmas 3. Green-white flowers.	Flowers, with stamens or pistils or both. Petals lacking. Calyx, tubular or barrel-shaped and adhering to mature fruit, which may be 1/10-inch long. Flowers, in middle or upper leaf axils. Fruit, nut-like and one-celled with the stigma persisting. Seeds apparently hollow.	Flowers borne 6 to 20 on stems to 8 inches long which extend above water surface. Flowers, yellow, to 5/6-inch long with broad lower lip, 3-lobed border. Blooms from May through August. Fruit, a several-seeded capsule and borne on recurved flower stalks.
This species is found mostly in cool quiet water, or even in cold running water. It appears at its best during spring and early summer, and will grow through the winter, even in ice-covered water. The leaves appear refreshingly bright green in such cold water. Upper leaves may be at surface.	Cannot tolerate 1500 parts of alkali to 1,000,000 parts of water. *M. scabratum* can survive in mud after water level has dropped exposing the plants. Plants are eaten by waterfowl, muskrats and moose, but on the whole are relatively unimportant sources of food to them.	Seeds are reported as a minor food for wildfowl. Rarely eaten by swans and sparingly eaten by muskrats. 15 species of ducks have been known to feed on the fruits, with mallards leading the list, one of which ate 220 for a single meal. In Connecticut, is considered important to black duck, wood duck and teal.	Fruits known to be eaten by 23 species of ducks and 2 species of geese, but most favored by bluebills and mallards. One pintail took 640 fruits for one meal; a bluebill, 970; a mallard, 1090. Because of northern range is important food in the major duck breeding grounds.	Found in waters up to 3000 parts alkali to 1,000,000, or twice alkalinity of hornwort. Bladders capture minute water animals such as water fleas that enter an opening, are held and die. Physiological story of use made of this is not wholly understood, but it is assumed that the fleas feed the bladderwort.
Gland-like structures under the leaves become inflated with air and float upper parts to surface where pollination takes place. The plant is of some value to aquarists, but requires cold water. It may multiply too rapidly for comfort. It has been reported as food of some kinds of ducks.	Provides excellent shelter for small organisms that serve primarily as food for fishes, but may also provide shelter for mosquito larvae. Because of dainty beauty is popular with aquarists, who propagate the plant by breaking off sections and fastening them to the bottom.	Aquarists consider the plants as valuable because of hardiness and because of obvious strong powers in adding oxygen to waters in which they grow. The beauty of the plants also makes them popular to aquarium fans.	Aquarists like beauty of plant, but it exhausts oxygen from water up to time of flowering, when it sinks to bottom and should be removed. Transplanted easily by breaking roots and planting segments. Known as cat's-tail, knotgrass, joint-weed, paddock pipe and witches' milk.	Moose, deer and many aquatic birds that feed on plants feed readily on bladderwort. Is eaten only sparingly by muskrats. Provides excellent cover for fishes, and organisms on which they feed. Nutritive value for ducks has been questioned. Some species are popular aquarium plants.

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serve in this way by providing food for the animals on which the fishes feed. They also provide cover for the fishes, and for the animals on which they feed.

Managed fish ponds usually are so constructed that there is little shallow water around the margins. A common test as to how murky the water should be to keep these plants under control is to observe if one's fingers can be seen if the arm is thrust down into the water as far as the elbow. If the fingers cannot thus be seen, it is generally accepted that the light will not penetrate deeply enough to support the plants.

There are reasons, however, why in some ponds these plants should be encouraged. For instance, they provide food for ducks, for large animals such as moose and deer, or for some of the furbearers such as muskrats and beavers. This means that if we are to manage a pond we might first make up our minds for what purposes we wish to manage it. Ducks and furbearers may be as valuable as a few crappies or bluegills, or even a few trout. In the 60th special insert, entitled "On the Level," we pointed out how important it might be to manage the margin of a body of water for wildlife, flood control, power and recreation. There we showed that in some cases failure to manage such an area might well demand complete removal of the fish and wildlife so popular with most persons.

Water, of course, is also valuable for drinking purposes and for irrigation. In these cases, it is important to keep it pure and free from contamination. When plants are present in too great abundance and begin to decay, they may foul the water and make it undesirable. Accumulation of wastes may also increase the number of animals that feed on these wastes. Sometimes this is not desirable, as in the case of some noxious insects, some pond snails that may carry diseases, and some fishes that thrive on wastes but are useless to man and injurious to the more desirable kinds of fishes.

As is shown in the chart section, some of these plants are resistant to pollution and can thrive where others cannot. If, in the future, more and more of our streams become polluted with domestic wastes, it is possible that these plants may find a function not now appreciated.

The chemical nature of waterways obviously varies greatly. Contamination with wastes from civilization and from industry may affect the prosperity of some plants and animals. Also the amount of salt, alkali and lime in water may determine seriously the value of a body of water. Those of our plants that can

Clasping-leaved Pondweed

Mare's Tail

live in waters varying greatly in the concentration of some of these things may make them much more valuable than those plants that are more specific in their requirements. This is true not only in areas where fresh waters meet salt waters along our coasts, but inland, where many ponds become dry in summer and rapid or prolonged evaporation may change critically the concentration of salts in the water. Where these changes are likely to take place, some reasonable management may be effected by the introduction of species not affected seriously by a wide range of concentration of salt, alkali or lime.

As is shown in the chart section, some of our shallow water plants have direct economic value to man. Sea wrack has been harvested extensively for use in filling pillows, and for sound insulation. With the destruction of this plant by disease, this industry was practically wiped out. It would not be surprising if some day we found real food value in some of these plants that grow in areas not now producing plant food for consumption by man. If you have ever nibbled some of the tubers of arrow leaf, or the winter storage units in eel grass, you will realize that food is to be found in these plants if you know how to get at it.

Of course, there is always the value of these plants to students that should be recognized. What would high school biology be without elodea? Scholars who know these plants well have been able, through studies of the food found in ducks, to get some clues as to the paths followed by these birds in migration. This may be important in planning harvesting programs that are reasonable and that will guarantee the continued existence of these birds, which so many of us enjoy just seeing.

More mundane may be the importance of these plants in affecting traffic along waterways. Outboard motors may be effective in some waters, but in a waterweed-clogged stream they may be useless. Unless some of our waterways can be kept open to traffic it may be difficult to service some humans who live in areas not accessible by ordinary highways. Then, too, such waterways become too plant-crowded even to support fish populations. Some have recognized value in powerful animals such as alligators, which can make their way through such plant masses and, incidentally, assist in keeping open a path that may be followed by boats.

One thing is certain that increased knowledge and understanding of these plants may have a profound effect on our ability to make the best use of areas covered by fresh water.