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A PRELIMINARY STUDY OF
The Larger Aquatic Plants of Oklahoma
WITH SPECIAL REFERENCE TO
Their Value in Fish Culture

By
James H. E. de Gruchy

Stillwater, Oklahoma

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THE LARGER AQUATIC PLANTS OF OKLAHOMA

With Special Reference to Their Value in Fish Culture

Reynolds Lake, Reynolds, Oklahoma, May 31, 1936. One of the oldest artificial lakes in Oklahoma; built in 1871. The water willow, **Dianthera americana,** has become dominant after a period of sixty-six years.

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The main object of this paper is to make available practical general knowledge relative to the larger aquatic plants, knowledge based upon notes gathered through the author's personal observations. The desirable and undesirable qualities, with the relative values for each plant, are given with the hope that they may be of some aid in selecting plants with which to stock ponds.

In order to understand fully the part played in fish life by the larger plants, a thorough study should be made of the long chain of relations which connect aquatic plants and animals. In this chain, larger aquatic plants constitute an important link in the line of food relations that extend from the water and the soil to the higher fishes. Directly or indirectly, plant life is necessary for the support of fish. As long as a good food supply is maintained the fish will continue to increase. It is to all of the aquatic plants that one must look for the maintenance of this food supply.[1]

Since the larger aquatic plants are so important for their food value as well as for other functions, the following discussion is devoted to them. In the study of each plant the following properties have been considered:

General habitat. (See Table, col. B.) The fluctuating water conditions found in Oklahoma make it difficult to classify aquatic plants according to their relative positions in respect to the water line. However, a rough grouping as to their places of growth will give some idea of the particular situation of each plant. These groups commingle, especially when competition is low, making a sharp line of demarcation impossible. The following groupings give approximate locations:

[1] *PEITERS, A. J.* The plants of Western Lake Erie with observations on their distribution. Bull. U. S. Comm. Fish and Fisheries, vol. 21, p. 57-79. 1903.

(1) Water's Edge. Water-soaked soil to soil covered with water to depth of eighteen inches.

(2) Shallow Water. Soil covered with water from a film to a depth of three feet.

(3) Deep Water. Soil covered with water from two feet to ten feet or more in depth.

Growth type. (See Table, col. C.) In considering the different growth types, five general classifications were used:

(1) Floating. The major portion of the plant, including vegetative and reproductive structures, floats freely on top of the water.

(2) Wholly Submersed. Vegetative and reproductive structures all appear under water.

(3) Partially Submersed with Floating Leaves. Vegetative structures are found below water, leaves floating on water, and reproductive structures either above or below water.

(4) Partially Submersed with Aerial Leafy Stems. Vegetative structures are found below or above water in an upright position, with reproductive structures above water.

(5) Sometimes Submerged with Aerial Leafy Stems. The plant generally grows on land at the water's edge but sometimes is submerged during times of high water.

Hydrogen ion concentration. (See Table, col. D.) This rating is given to the acidity of the soil taken from beneath the plant or its immediate vicinity

Shade. (See Table, col. E.) Values for shade are given the plant according to the manner in which it shields the water, and the life therein, from the rays of the sun. It should be understood that plants with foliage which completely shades the water are undesirable since they seriously lower the oxygen content of the water.

Food. (See Table, col. F.) Since the food of the game fish consists chiefly of the smaller fish and aquatic animals, we cannot classify the larger aquatic plants directly as food for desirable pond fish. However, there are some fish such as the blackhead or fathead minnow (*Pimephales promelas*) and the

golden shiner or roach (*Notemigonus crysoleucas*) that feed directly on the lower forms of plant life[2] and possibly on the fragments and tender shoots of the larger aquatic plants. This is also true of the lower forms of aquatic animal life such as the insects and entomostraca. Food ratings are given on observed relative tenderness of the plant with consideration also given to the animal life found on it.

Ornamental properties. (See Table, col. G.) These ratings are based on the appeal which the color, fragrance, and other aesthetic qualities of the plant made to the author.

The plant's value as an oxygenator. (See Table, col. H.) This has been determined more or less by its growth type, assuming that plants which grow wholly submersed, or nearly so, are the best oxygenators; those partly submersed with few floating leaves, fair; and those with floating leaves, poor oxygenators.[3]

Ability to increase fertility of water. (See Table, col. I.) Since most of the fish food is derived indirectly from the vegetable plankton that float in the water and since these organisms can receive the necessary elements only from their surroundings, it is of the utmost importance that these elements be present in the water. The larger-rooted aquatic plants probably play their most important role in providing these elements. The following quotation bears out this statement:

> These rooted aquatics are important contributors to the plankton food supply, because when living they organize matter that may be used as food and in death they yield important salts and organic substances to the water. Artari (1901) finds that certain algae prefer organic nourishment, and it is quite possible that many of the forms so abundant on wounded and decaying portions of the larger plants derive considerable nourishment therefrom.[4]

The plant's rankness of growth, and the fact that it is a rooted or unrooted plant, is used to determine its importance in increasing the fertility of the water in which it grows.

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[2] *DAVIS, H. S., and WEIBE, A. H.* Experiments in black bass and other pond fish. U. S. Fish. Bur. Rept., pp 123-147. 1930-31.

[3] *ROACH, L. S.,* and *WICKLIFF, E. L.* Relationship of aquatic plants to oxygen supply, and their bearing on fish life. Bureau of Scientific Research, Ohio Division of Conservation. Trans. Fish. Soc. 64:372-374. 1934.

[4] *POND, R. H.,* The biological relation of aquatic plants to substratum. U. S. Comm. Fish and Fisheries Rept. p. 522. 1930

Ability to prevent silting and erosive wave action. (See Table, col. J.) This value is based upon the following qualities: sturdiness of stem, place of growth, relative height, presence and position of matted rhizomes, and the soil-binding qualities of the roots. In general, the ability of the plant to retard the movement of the water determines its importance.

Protection. (See Table, col. K.) Large fish eat the small fish, the small fish eat the fingerlings, and the fingerlings eat the fry. The smaller fish are also attacked by other animals, such as turtles and snakes. The protective value of the plant varies somewhat with the size of the plant and the size of the fish. Small fry need a plant growth that is more or less closely matted. As the fish grow older, a more open vegetation of a sturdy nature is desirable. This gives the small fish more freedom of movement and still keeps it from being an easy prey of the larger fish.

Drouth resistance. (See Table, col. L.) The spring and summer of 1936 offered an excellent opportunity to determine the ability of plants to withstand drouth conditions, since this period was the most severe of any on record. Ratings on drouth resistance are based on the plant's ability to remain alive at low water during the dry weather and to resume normal activity when conditions permit.

Water-clarifying qualities. (See Table, col. M.) These qualities are determined by the rapidity with which water in ponds containing the plant clarifies as compared with ponds in the same locality that do not contain the plant.

Tolerance for turbidity. (See Table, col. N.) Ratings are founded upon the ability of the plant to withstand the muddying action of lakes and streams.

SUMMARY OF SPECIES HAVING OUTSTANDING VALUES

The accompanying table* gives one a fair estimate of the number and variety of types of the larger aquatic plants found growing in Oklahoma. Some of these species intermix or are found in the different habitats; and, as a general rule, these species are better fitted for the Oklahoma climate since they can adapt themselves to the changing conditions. As previously stated, Oklahoma climatic conditons are extremely variable. This means that there is a widely fluctuating water line in the lakes and streams. Therefore one should choose plants that are fairly versatile in their needs for a water environment, plants that can stand a drouth and return to their normal activity when conditions permit.

The native water willow, *Dianthera americana* (Frontispiece) is probably the best all-'round aquatic plant for Oklahoma. It has been found in good condition after having experienced a siege of seven months dry weather during which only 2.97 inches of rain had fallen. The water in this lake (Dow Lake) had receded to a distance of at least 100 feet (Fig. 2). At State Fish Hatchery No. 4, water willows that were allowed to dry for forty days resumed growth when they were again covered with water. The plant grows in a more or less open manner near the edge of the deep water (Frontispiece). This is a very desirable quality since it provides a hiding place for the smaller fish and thus protects them from the larger ones. This factor is quite essential in bass-culture ponds, where the young fish soon assume cannibalistic habits, the larger ones devouring the smaller. C. N. Davidson at State Fish Hatchery No. 4, from observations extending over a period of three years, states that the ponds containing the water willow produce at least one-third more fish than other ponds in the hatchery. He adds that the water in these ponds will clarify more quickly after a rain. The plant's inability to grow in water over a depth of three feet, and rarely over a depth of thirty inches, is favorable to the angler, since the plant cannot close the best fishing waters which are generally found in the upper end of a lake (Frontispiece). Its purple-centered white blossom also adds to its attractiveness and value.

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* See envelope inside of back cover.

Probably the most hardy species of aquatic plants occur in the semi-aquatic knotweeds with *Polygonum hydropiperoides* (Fig. 13) and *Polygonum lapathifolium* (Fig. 4) leading the list. These plants will grow equally well in or out of water and are resistant to the killing action of our muddy streams. They have several valuable properties and should not be overlooked in stocking a pond. Other hardy plants that will probably prove of great value in fish culture are the yellow pond lily, *Nymphaea advena* (Fig. 50); primrose willow, *Jussiaea diffusa* (Fig. 42); water starwort, *Callitriche heterophylla* (Fig. 33); arrow-heads, *Sagittaria latifolia* (Fig. 11); *S. lancifolia* (Fig. 1); *S. graminea* (Fig. 32); water plantain, *Alisma plantago-aquatica* (Fig. 9); creeping bur-head, *Echinodorus radicans* (Fig. 6); Chilean water milfoil, *Myriophyllum proserpinacoides* (?) (Fig. 34); and the sedges, *Cyperus strigosus* (Fig. 48) and *C. erythrorhizos* (?) (Fig. 3).

The sedges, *Cyperus strigosus* and *C. erythrorhizos,* probably will rank first in ability to increase the fertility of the water. These rapidly growing plants follow the water line as it gradually recedes during dry weather. The plant is killed when it is again covered with water. Its rapid decomposition in shallow water gives to the water the minerals essential to the growth of the vegetable plankton.

Our best food makers are found in the submerged association with the following species: the hornwort, *Ceratophyllum demersum* (Fig. 38); the pondweeds, *Potamogeton crispus* (Fig. 40), *P. pectinatus* (Fig. 24), *P. foliosus* (Fig. 22), *P. pusillus* (Fig. 30); the naiads, *Naias flexilis, N. guadalupensis* (Fig. 37); the water weeds, *Elodea canadensis, E. minor* (Fig. 39); the water milfoils, *Myriophyllum spicatum* (Fig. 16), *M. heterophyllum, M. scabratum;* the water crowfoot, *Ranunculus aquatilis* (Fig. 14); the water stargrass, *Heteranthera dubia* (Fig. 31); and the alga, *Chara fragilis* (Fig. 23). These plants are excellent oxygenators and provide a good shelter for fry.

The water weed, *Elodea minor* (Fig. 39), and the aforementioned water willow make up the plant list known to the author for their clarifying qualities. *Elodea minor* has been observed by V. C. Graham in the ponds at State Fish Hatchery No. 3, and his observations covering a period of years indicate that water in ponds containing these plants will clear more

quickly after a rain than water in other ponds in the hatchery. This quality is quite essential in fish culture since material held in suspension reduces to a minimum the amount of light that penetrates the lower portions of the water. This does not seriously reduce the production of the vegetable plankton[5] but is decidedly destructive to the larger submersed aquatic plants.

The beauty of our ponds and streams can be improved by some of the following ornamentals: white water lily, *Castalia tuberosa* (Fig. 19); pickerel weed, *Pontederia cordata* (Fig. 10); powdery thalia, *Thalia dealbata* (Fig. 20); wing-angled loosestrife, *Lythrum alatum* (Fig. 52); yellow water lily, *Nymphaea advena* (Fig. 50); lotus, *Nelumbo lutea* (Fig. 12); *Echinodorus radicans* (Fig. 6); *Myriophyllum proserpinacoides* (Fig. 34); *Sagittaria graminea* (Fig. 32); and the button bush, *Cephalanthus occidentalis* (Fig. 17). By their color and fragrance, the flowers attract many flying insects which may fall in the water and add to the food of the fishes.

On the other hand we have plants like the cat-tails, the lotus (Fig. 8), the water lilies, and some of the pondweeds of such exuberant growth that their closely matted rhizomes and floating leaves crowd out beneficial plants (Fig. 7). *Heteranthera dubia* and most of our submersed varieties can become a nuisance when they close the boat landings (Fig. 5). This difficulty can be overcome by placing the boat landings in deep water or by digging out deep channels through which the boats may be brought to shore.

Care should be taken in selecting the plants to be introduced into a new lake. No particular species of plant can be said to be always desirable. The fertility and kind of soil, size and depth of lake, the depth at shoreline, the steepness of slope, type of banks, landscaping, fluctuation of water level, and isolation from the rest of the lake are factors that need to be taken into consideration. An intimate study of these and other factors is necessary to determine the proper plant to introduce into each specific local condition.

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[5] *WIEBE, A. H.* Investigations on plankton production in fish ponds. U. S. Fish. Bur. Bul. 46:137-176. 1930-31.

ACKNOWLEDGMENTS

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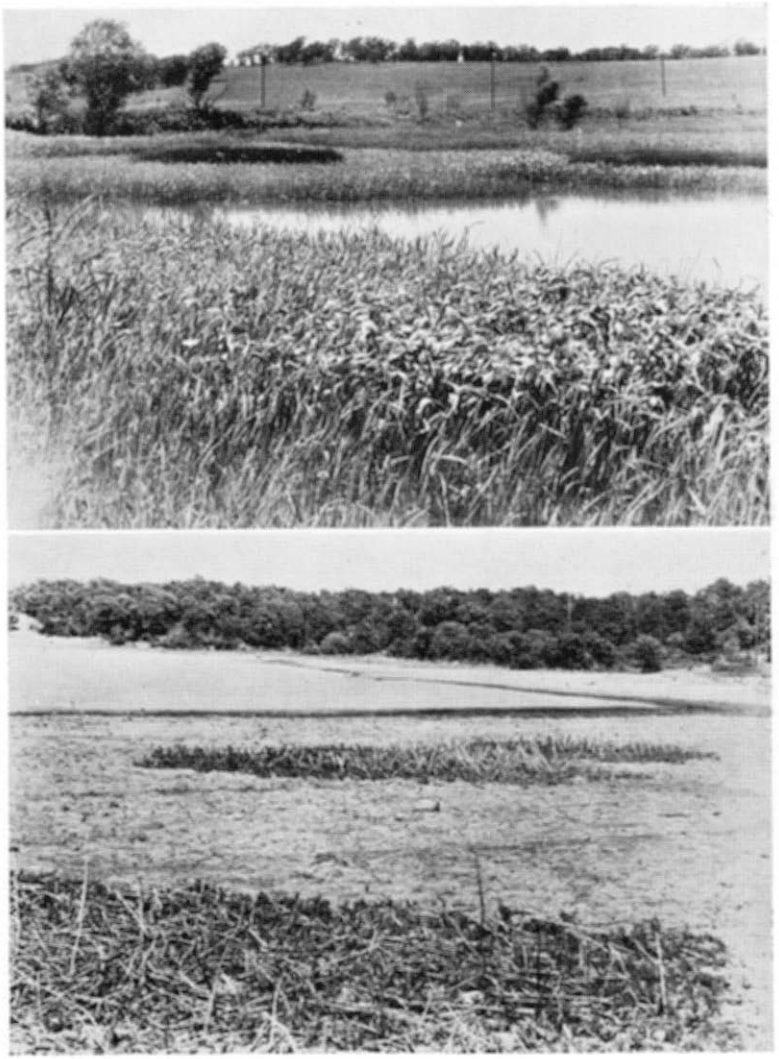

Figure 1.—Fish Hatchery, McAlester, Okla. June 19, 1936. *Sagittaria lancifolia* (dominant) with small patch of *Eleocharis mamilliata* holding its own in the background.

Figure 2.—Dow Lake, Dow, Okla. June 19, 1936. After seven months dry weather the water-willow, *Dianthera americana,* was found in a condition able to resume growth when again covered with water

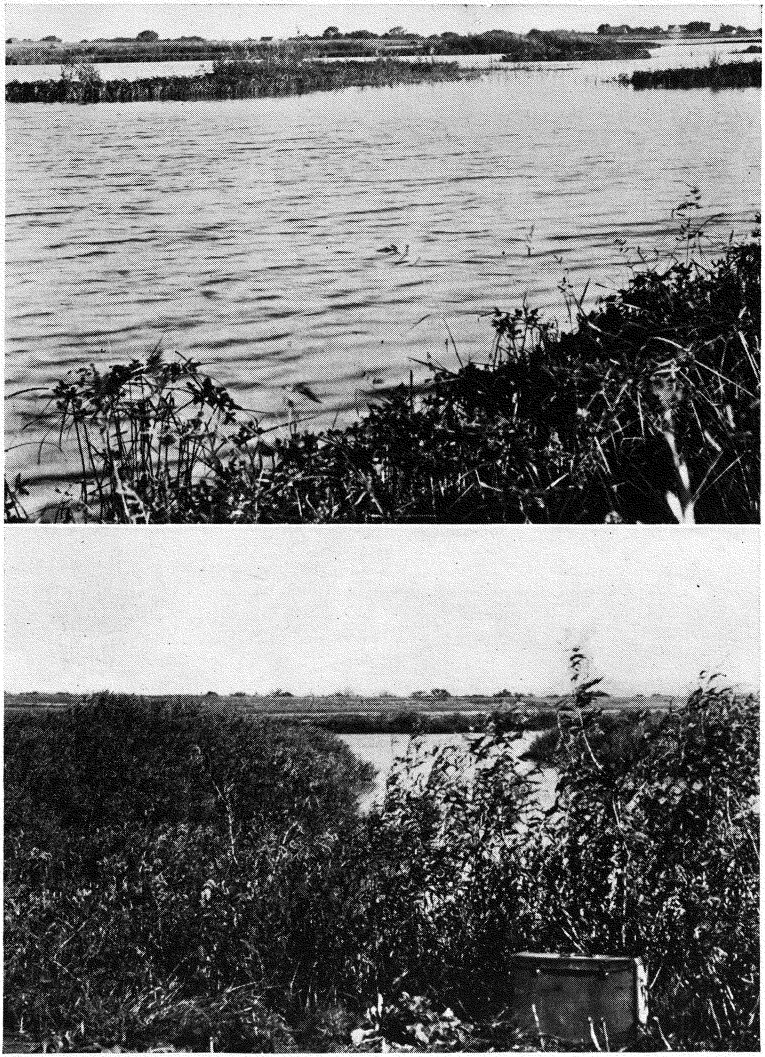

Figure 3.—Boomer Lake, Stillwater, Okla. Sept. 15, 1934. A few sprigs of barnyard grass mixed with the dominant *Cyperus* covered nearly the entire shore line area during the year. In the distance, out in the water, are willow sprouts that furnish protection to growing fish. At this time only a small bed of the knotweed, *Polygonum lapathifolium,* was noted.

Figure 4.—Boomer Lake, Stillwater, Okla. Sept. 25, 1937. Three years later in the same lake the knotweed, *Polygonum lapathifolium,* becomes dominant showing a complete change in vegetation. Note its rankness of growth and ability to grow in shallow water.

Figure 5.—Spavinaw Lake, Spavinaw, Okla., July 7, 1930. Removing *Heteranthera dubia* from around the boat landings.

Figure 6.—State Fish Hatchery, Heavener, Okla. June 20, 1936. Creeping bur-head, *Echinodorus radicans*. Beautiful as well as beneficial.

Figure 7.—Cache Creek, Cache, Okla. May 26, 1936. The long-leaved pondweed, *Potamogeton americanus*, crowds out the beneficial white-flowered water-crowfoot, *Ranunculus aquatilis*.

Figure 8.—Country Club Lake, Stillwater Okla., June 25, 1934. The broad-leaved cat-tail, *Typha latifolia* and the American lotus, Nelumbo lutea, have completely closed this section of fishing water.

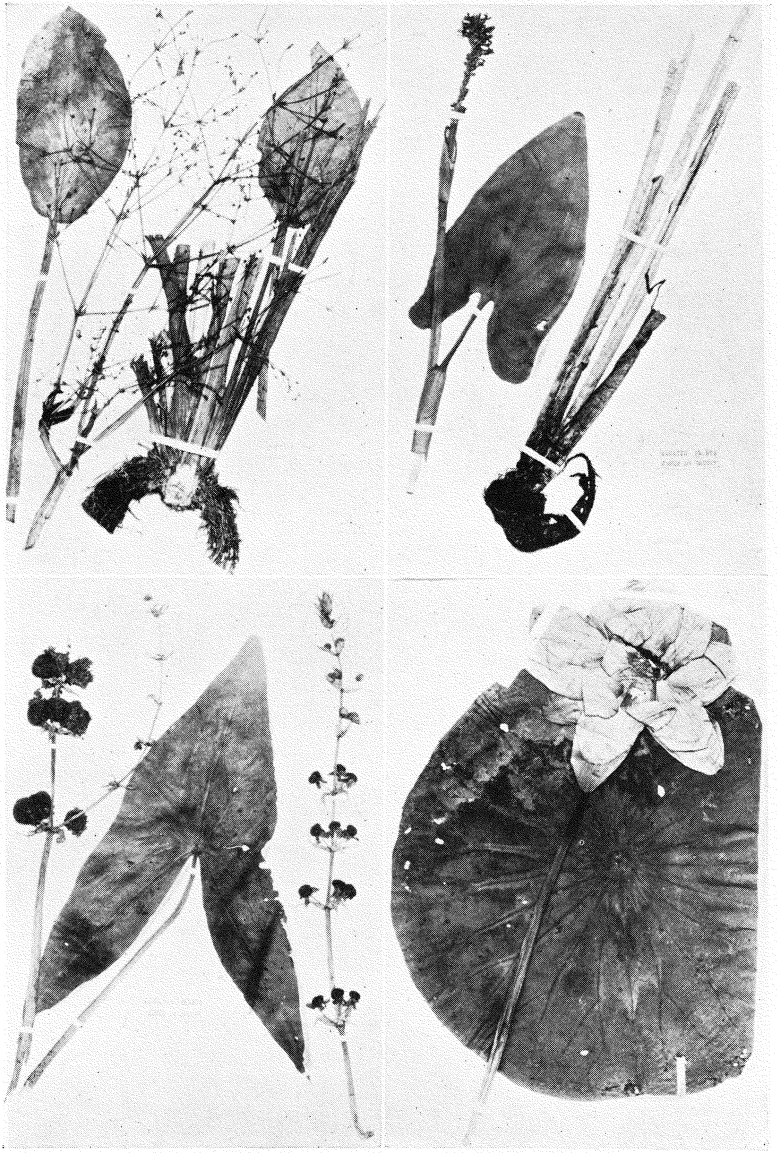

Figure 9.
Water Plantain.
Alisma plantago-aquatica.

Figure 10.
Pickerel Weed.
Pontederia cordata.

Figure 11.
Broad-leaved Arrow-head.
Sagittaria latifolia.

Figure 12.
American Lotus.
Nelumbo lutea.

Figure 13.
Mild Water Pepper.
Polygonum hydropiperoides.

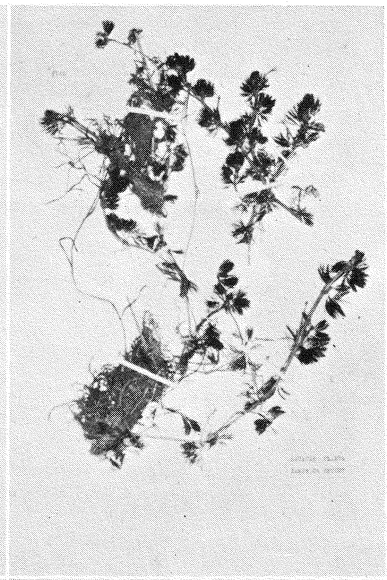

Figure 14.
Common White Water-crowfoot.
Ranunculus aquatilis.

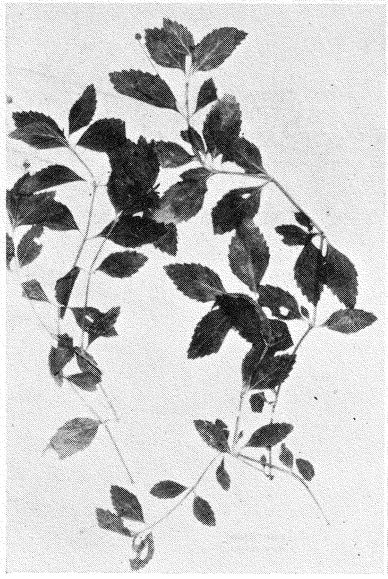

Figure 15.
Fog Fruit.
Lippia lanceolata.

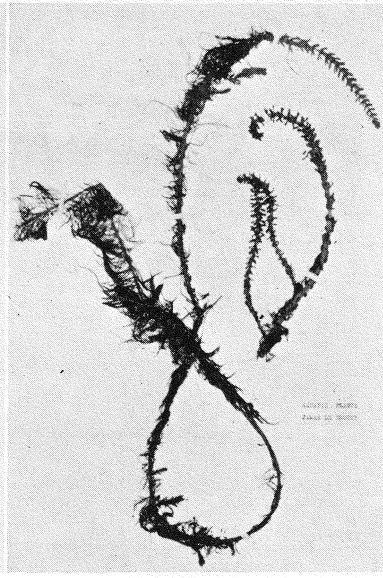

Figure 16.
Spiked Water Milfoil.
Myriophyllum spicatum.

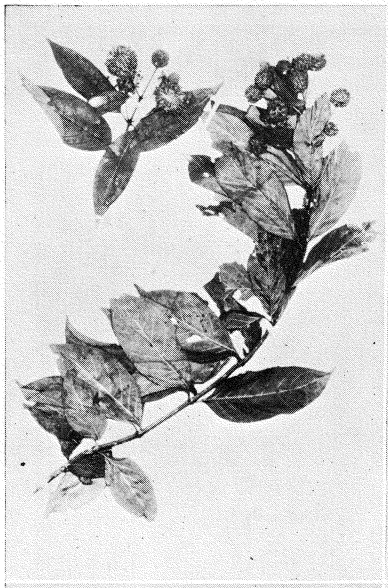

Figure 17.
Button Bush
Cephalanthus occidentalis

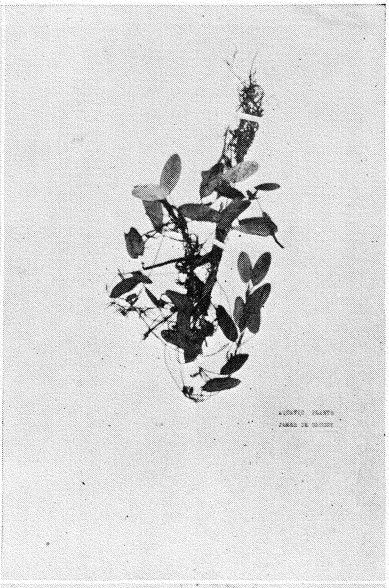

Figure 18.
Spiral Pondweed.
Potamogeton dimorphus.

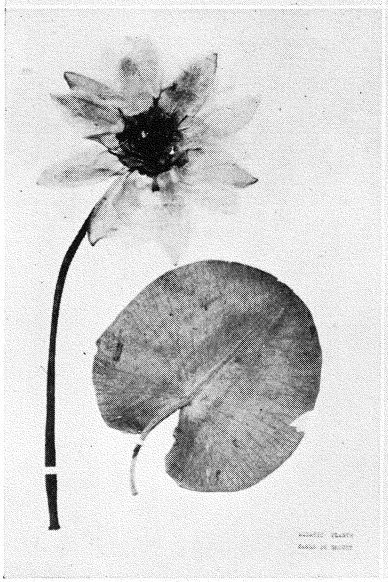

Figure 19.
Tuberous White Water Lily.
Castalia tuberosa.

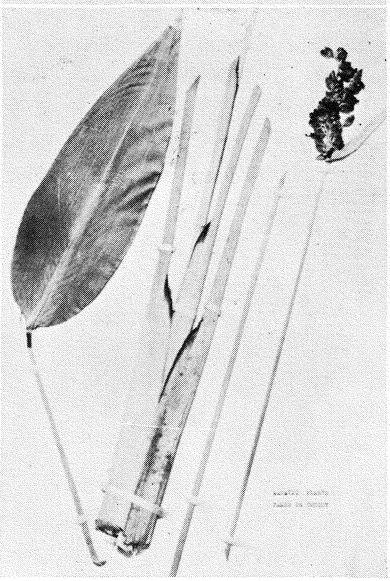

Figure 20.
Powdery Thalia.
Thalia dealbata.

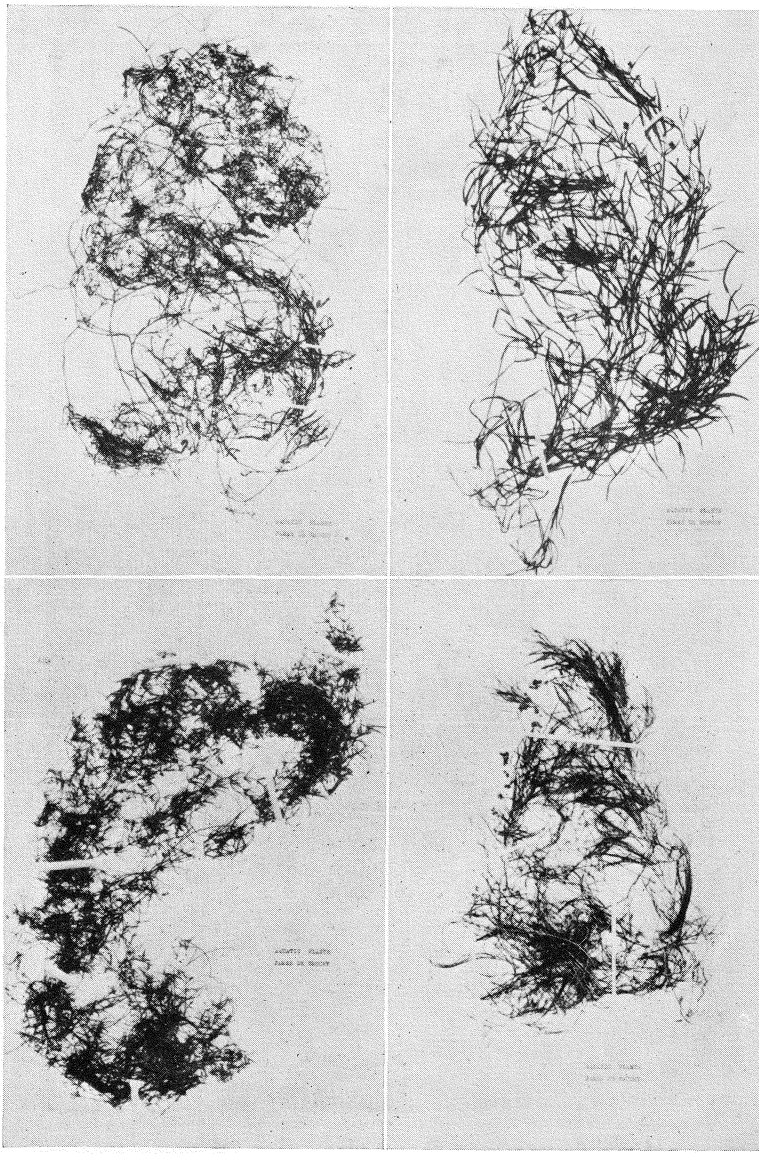

Figure 21.
Horned Pondweed.
Zannichellia palustris.

Figure 22.
Leafy Pondweed.
Potamogeton foliosus.

Figure 23.
Stonewort.
Chara fragilis.

Figure 24.
Fennel-leaved Pondweed.
Potamogeton pectinatus.

Figure 25.
Upright Bur-head.
Echinodorus cordifolius.

Figure 26.
Ditch or Virginia Stonecrop.
Penthorum sedoides.

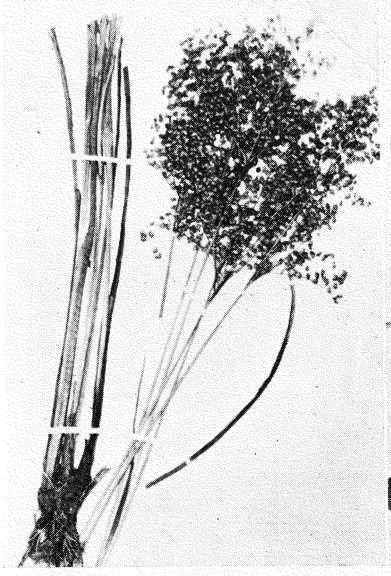

Figure 27.
Stout Rush.
Juncus robustus.

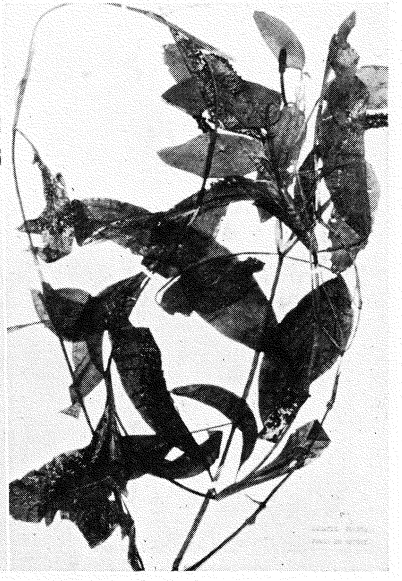

Figure 28.
Shining Pondweed.
Potamogeton lucens.

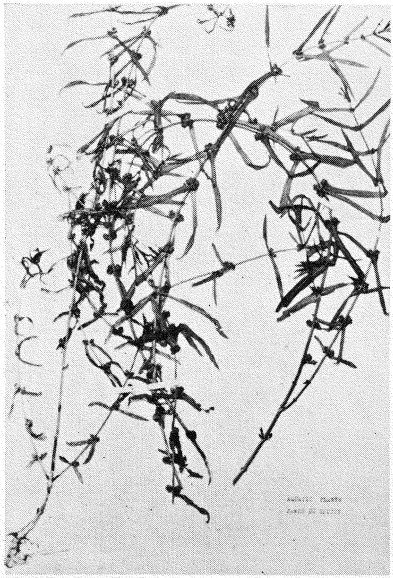

Figure 29.
Long-leaved Ammannia.
Ammannia coccinea.

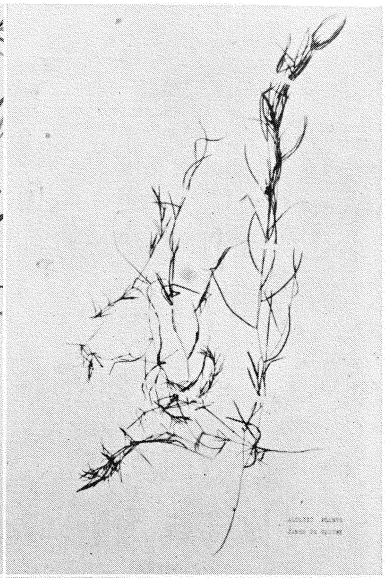

Figure 30.
Small Pondweed.
Potamogeton pusillus.

Figure 31.
Water Star-grass.
Heteranthera dubia.

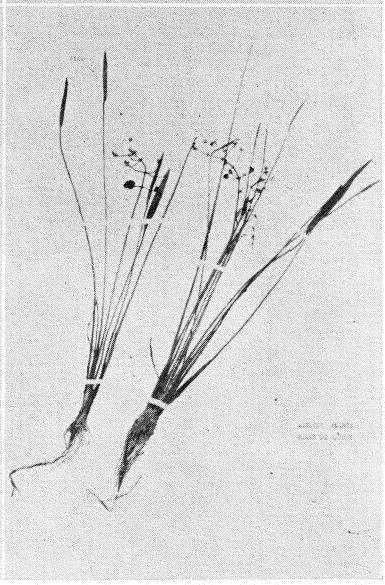

Figure 32.
Grass-leaved Sagittaria.
Sagittaria graminea.

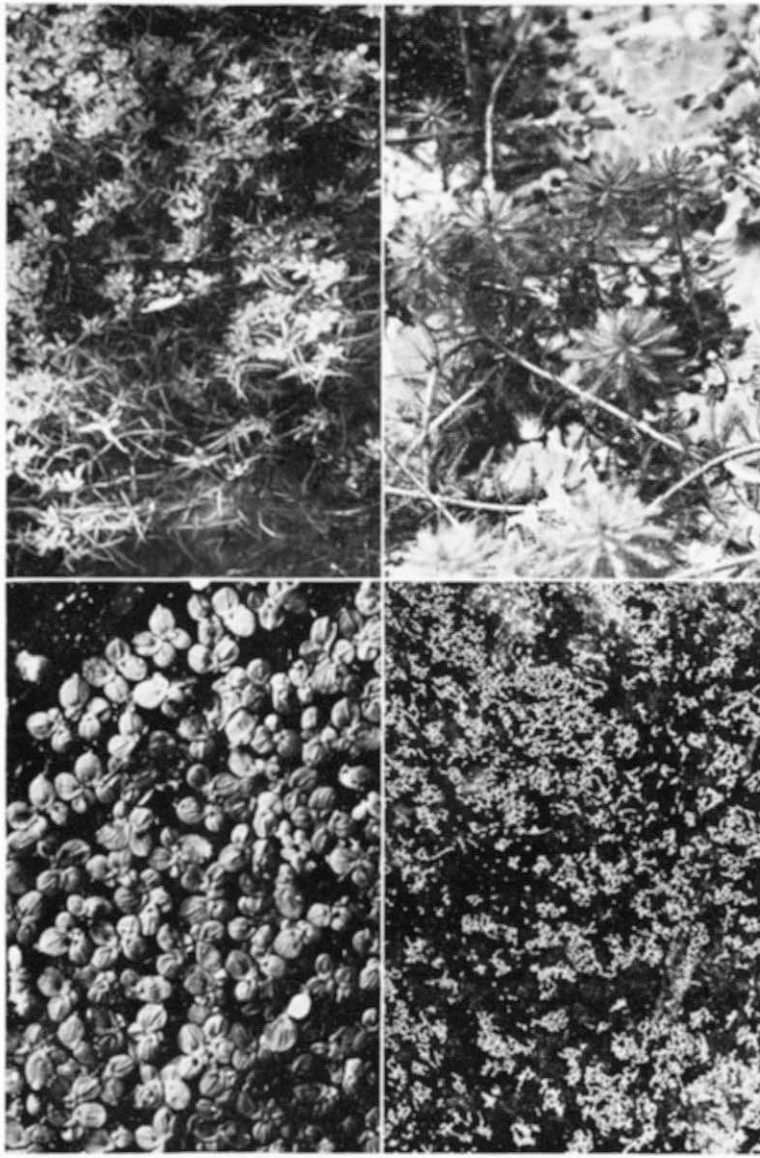

Figure 33.
Large Water-starwort.
Callitriche heterophylla.

Figure 34.
Chilean Water Milfoil.
Myriophyllum proserpinacoides ?.

Figure 35.
Greater Duckweed.
Spirodela polyrhiza.

Figure 36.
Columbia Wolffia.
Wolffia columbiana.

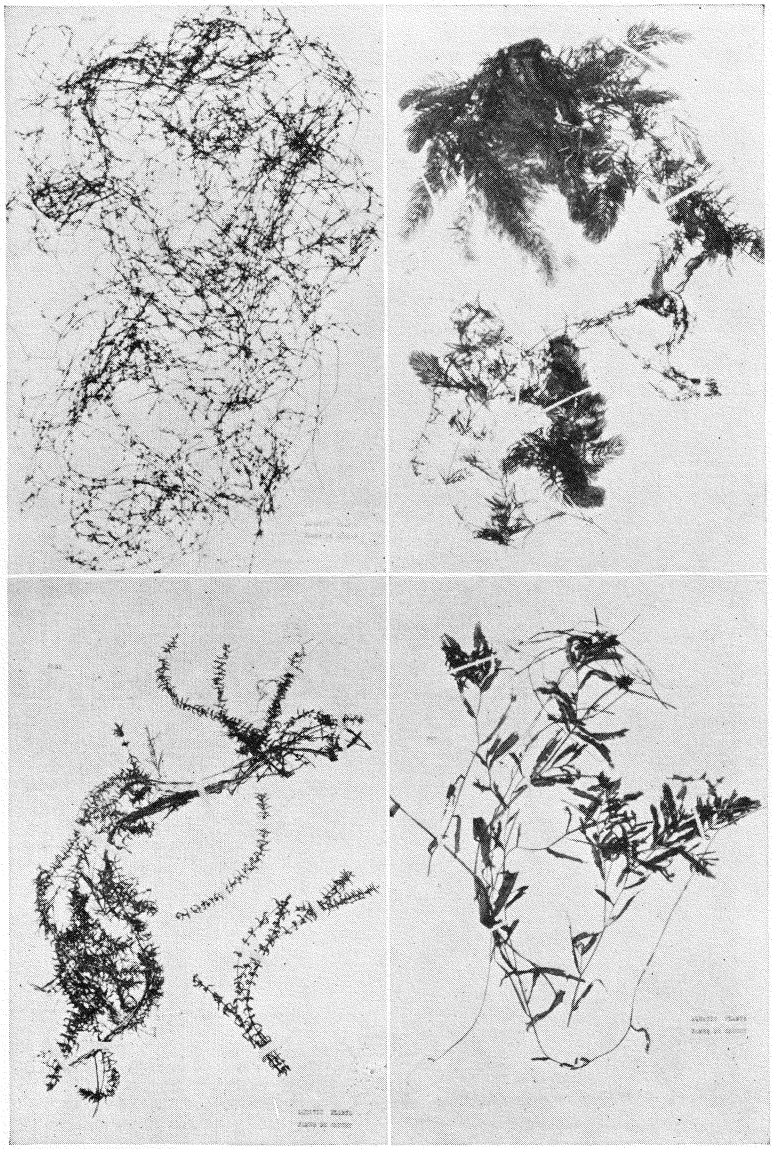

Figure 37.
Guadaloupe Naias.
Naias guadalupensis.

Figure 38.
Hornwort.
Ceratophyllum demersum.

Figure 39.
Lesser Water-weed.
Elodea minor.

Figure 40.
Curly Muck-weed
Potamogeton crispus.

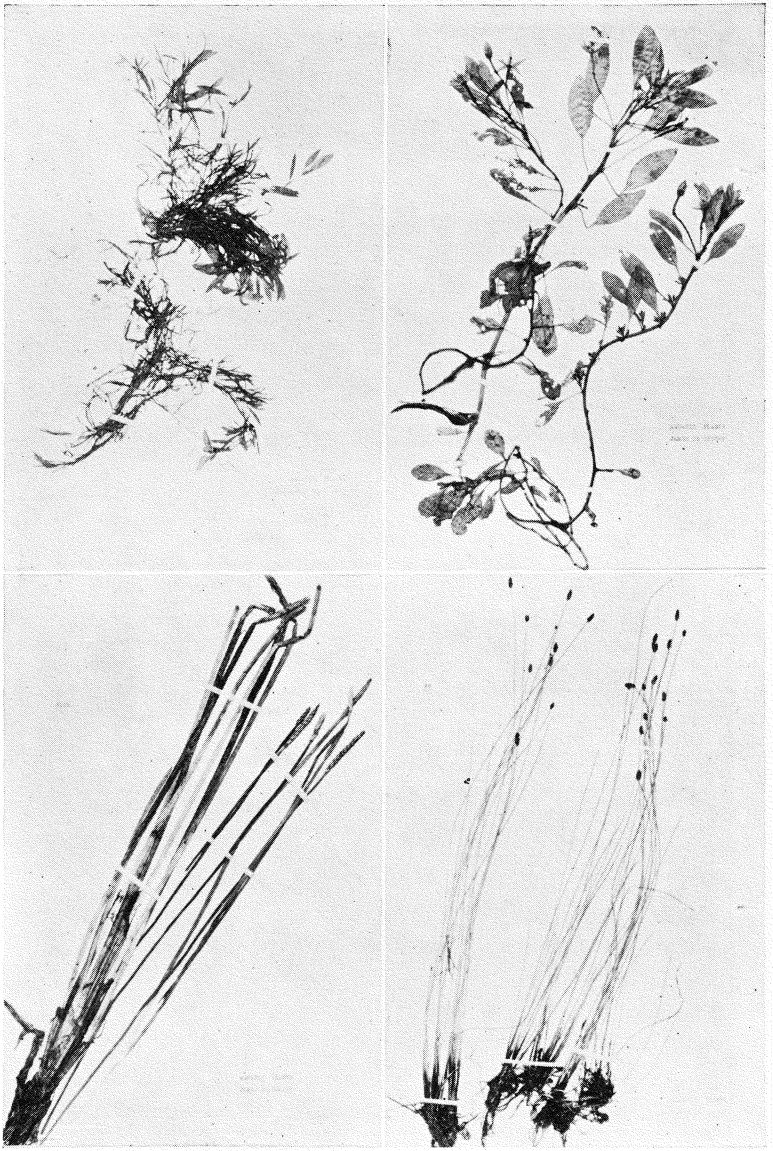

Figure 41.
Rafinesque's Pondweed.
Potamogeton hybridus.

Figure 42.
Primrose-willow.
Jussiaea diffusa.

Figure 43.
Angled Spike-rush.
Eleocharis quadrangulata.

Figure 44.
Creeping Spike-rush.
Eleocharis palustris.

Figure 45.
Spearmint.
Mentha spicata.

Figure 46.
Nuttall's Bur-reed.
Sparganium americanum.

Figure 47.
Water Purslane.
Ludwigia palustris.

Figure 48.
Straw-colored Cyperus.
Cyperus strigosus.

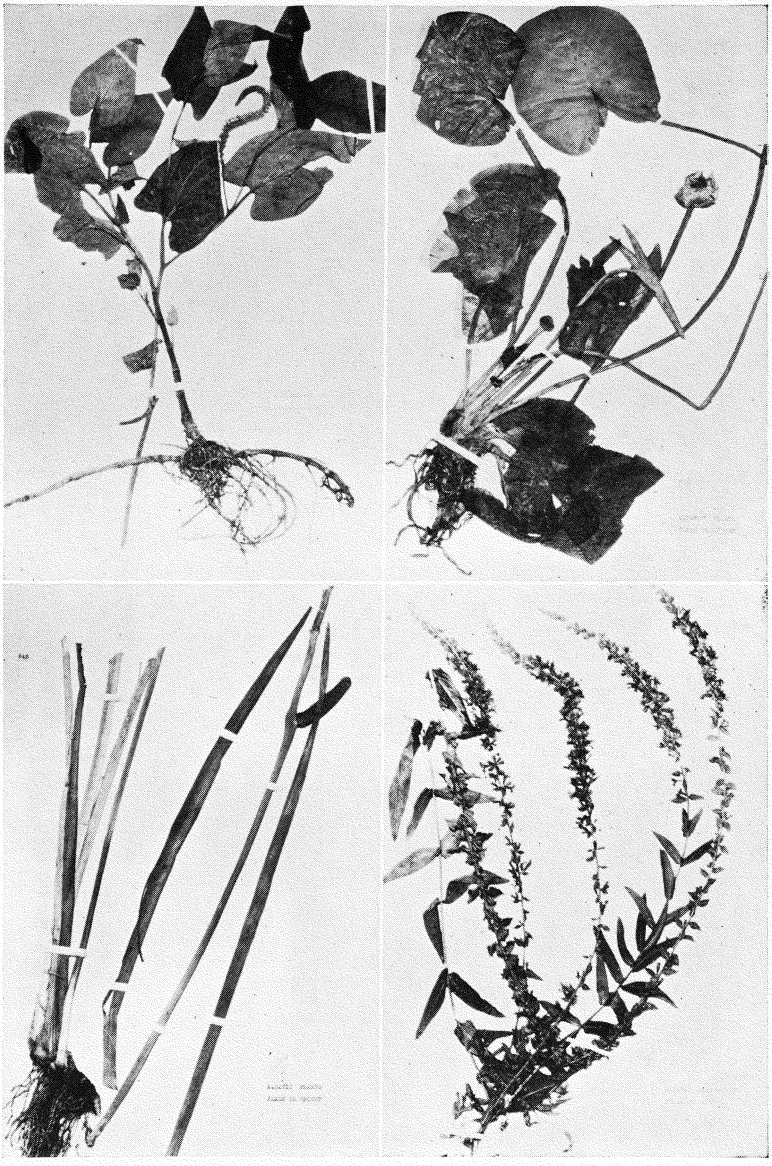

Figure 49.
Lizards-tail.
Saururus cernuus.

Figure 50.
Yellow Pond Lily.
Nymphaea advena.

Figure 51.
Sweet Flag.
Acorus calamus.

Figure 52.
Wing-angled Loosestrife.
Lythrum alatum.

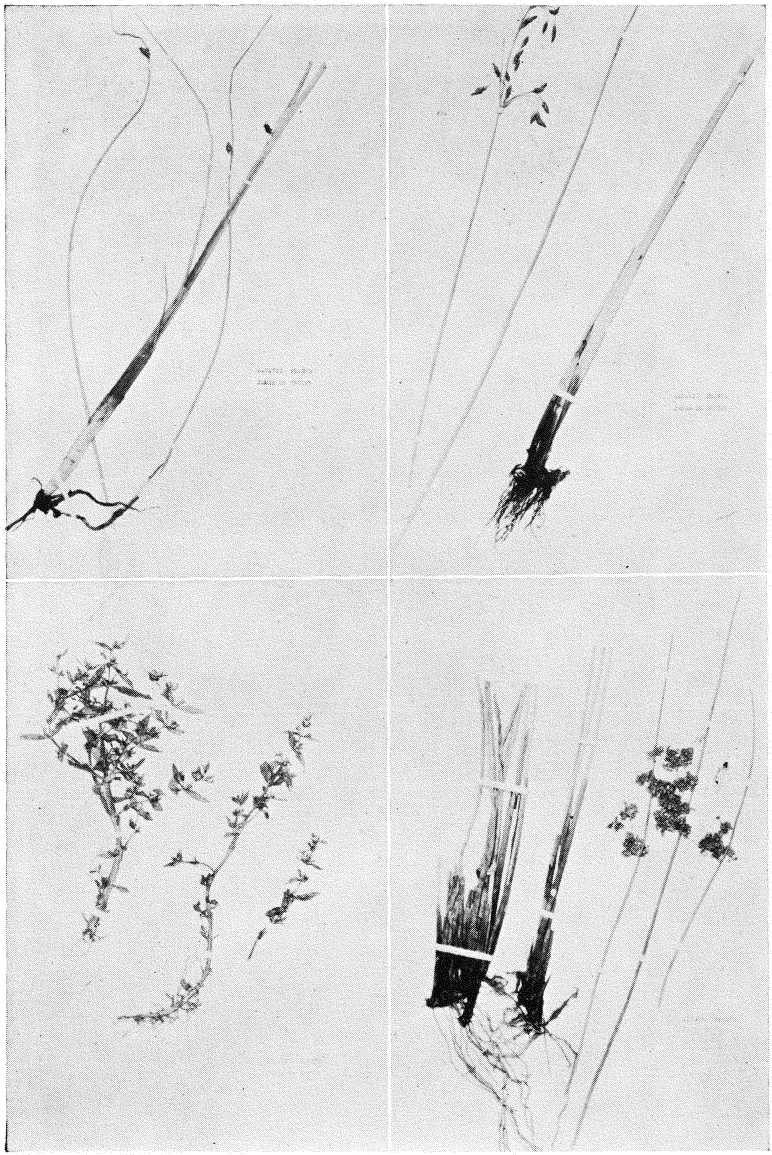

Figure 53.
Chair-makers Rush.
Scirpus lineatus.

Figure 54.
Reddish Bulrush.
Scirpus lineatus.

Figure 55.
Clammy Hedge Hyssop.
Gratiola virginiana.

Figure 56.
Soft or Bog Rush.
Juncus effusus.

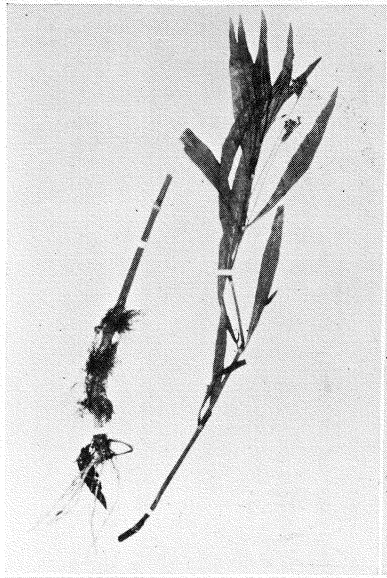

Figure 57.
Water Willow
Dianthera americana.

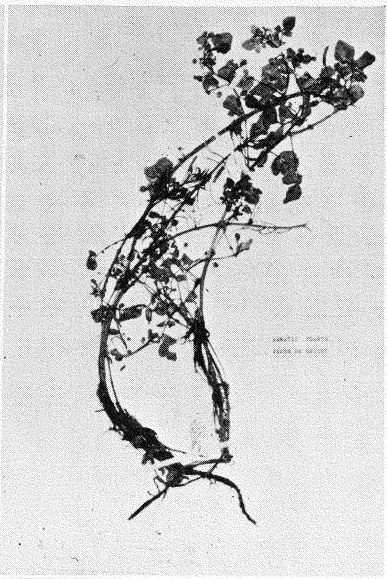

Figure 58.
True Water-cress.
Radicula nasturtium-aquaticum.

Figure 59.
Frank's Sedge.
Carex Frankii.

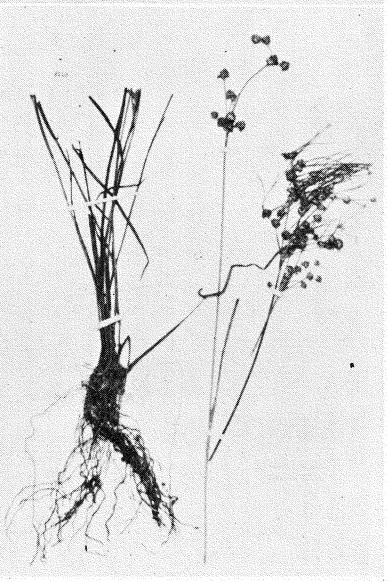

Figure 60.
Sharp-fruited Rush.
Juncus acuminatus.

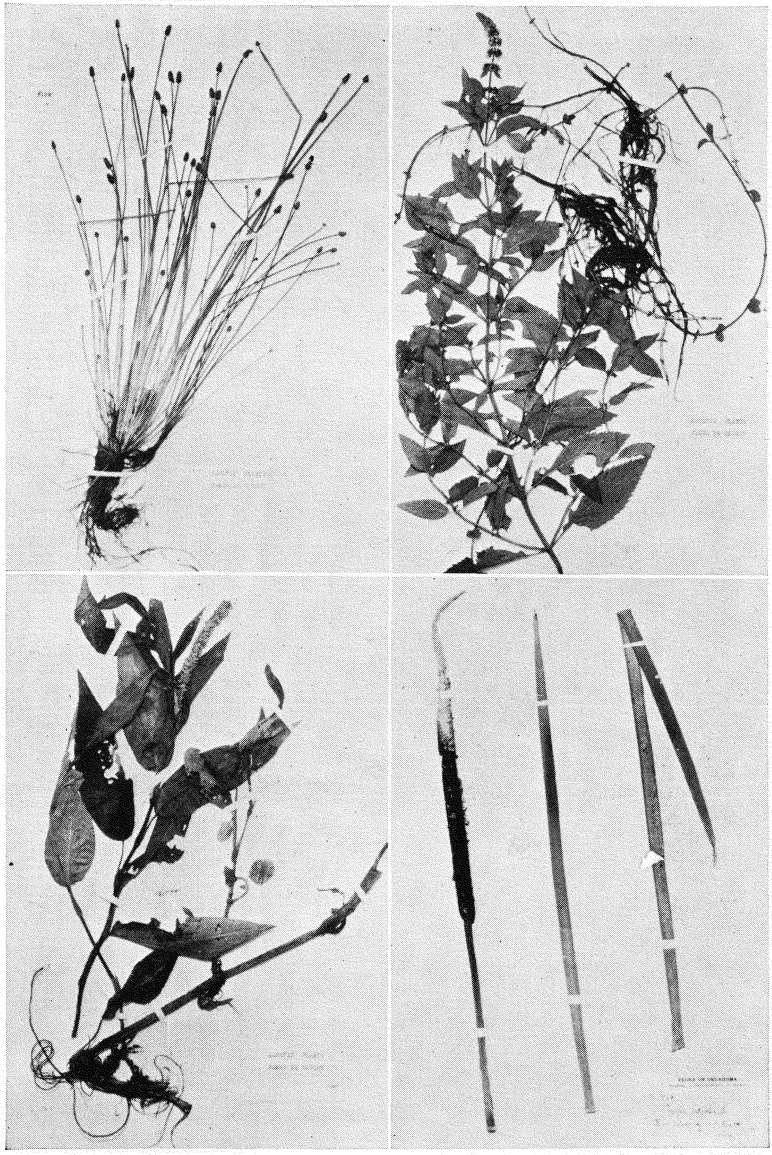

Figure 61.
Blunt Spike-rush.
Eleocharis obtusa.

Figure 62.
Peppermint.
Mentha piperita.

Figure 63.
Swamp Persicaria.
Polygonum Muhlenbergii

Figure 64.
Broad-leaved Cat-tail
Typha latifolia

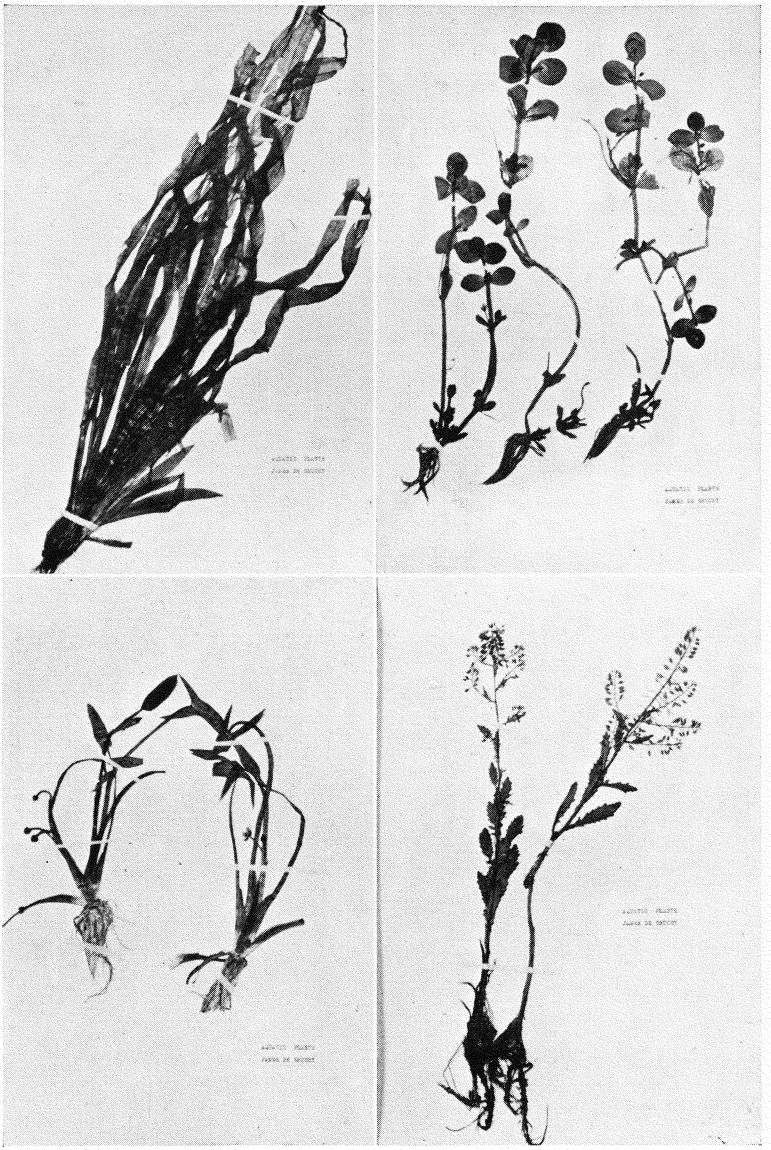

Figure 65.
Tape-grass.
Vallisneria spiralis.

Figure 66.
Round-leaved Water Hyssop.
Macuillamia rotundifolia.

Figure 67.
Large Lophotocarpus.
Lophotocarpus calycinus.

Figure 68.
Yellow Water-cress.
Radicula palustris.

AQUATIC PLANTS — RELATIVE VALUES IN FISH CULTURE*

Technical Name	Common Name	Fig.	A Duration	B Habitat	C Growth Type	Collections	D Known Hydrogen ion range	E Shade	F Food	G Ornamental Value	H Oxygen Value	I Water Fertility	J Silting, Erosion	K Protection: Fry	K Protection: Growing Fish	L Drouth Resistance	M Water Clearing	N Turbidity Tolerance
Acorus Calamus	Sweet Flag	51	Per.	W. E.	P. Sub. A. S.	Cherokee & Comanche Co.	B.—Sl. B.	†	*	‡	†	‡	‡	†	†	?	?	?
Alisma Plantago-aquatica	Water Plantain	9	Per.	W. E.	P. Sub. A. S.	Southern & eastern sections	B.	†	*	†	*	‡	‡	†	†	?	?	?
Ammannia auriculata	Wright's Ammannia	....	An.	W. E.	S. Sub. A. S.	Payne Co.	?	†	*	†	*	†	†	*	*	‡	?	†
" *coccinea*	Long-leaved Ammannia	29	An.	W. E.	S. Sub. A. S.	Central & eastern sections	M. A.	†	*	†	*	†	†	*	*	‡	?	†
Berula erecta	Cut-leaved Water Parsnip	....	Per.	W. E.	S. Sub. A. S.	Woods & Major Co.	?	*	*	†	*	†	†	?	?	?	?	?
Callitriche heterophylla	Large Water Starwort	33	Per.	S. W.	P. Sub. F. L.	Southeastern & southwestern sections	Sl. A.—M. A.	*	†	†	*	†	†	†	*	†	?	?
Carex Frankii	Frank's Sedge	59	Per.	W. E.	S. Sub. A. S.	Le Flore Co.	M. A.	*	*	†	*	†	†	*	*	†	?	?
Castalia Sp.-hybrid	Pond Lily	....	Per.	S. W.	P. Sub. F. L.	Cherokee & Le Flore Co.	B.—Sl. A.	‡	*	‡	*	†	†	†	†	?	?	?
" *odorata*	Sweet-scented Water Lily	....	Per.	S.W. & D.W.	P. Sub. F. L.	East & central sections	B.	†	*	‡	*	‡	†	†	†	?	?	?
" *tuberoso*	Tuberous White Water Lily	19	Per.	S.W. & D.W.	P. Sub. F. L.	Central & northeastern sections	B.—M. A.	‡	*	‡	*	‡	†	†	†	?	?	?
Cephalanthus occidentalis	Button Bush	17	Per.	W. E.	S. Sub. A. S.	Del., Pittsburg, Atoka & Payne Co.	N.	‡	*	‡	*	†	†	*	*	?	?	?
Ceratophyllum demersum	Hornwort	38	Per.	S.W. & D.W.	Wh. Sub.	General	B.—M. A.	†	‡	†	‡	*	*	‡	†	?	?	?
Chara fragilis	Stonewort	23	....	S.W. & D.W.	Wh. Sub.	General	Sl. A.—M. A.	*	‡	*	‡	†	*	†	*	?	?	?
" *sejuncta...?*	Stonewort	....	....	S.W. & D.W.	Wh. Sub.	Pittsburg Co.	Sl. A.	*	‡	*	‡	†	*	†	*	?	?	?
" *vulgaris*	Stonewort	....	....	S.W. & D.W.	Wh. Sub.	Johnston Co.	?	*	‡	*	‡	†	*	†		?	?	?
Chrysosplenum americanum	Water Carpet	....	....	W. E.	P. Sub. F. L.	Major Co.	M. A.	?	†	†	*	*	†	?	?	*	?	?
Cyperus acuminatus	Short-pointed Cyperus	....	An.	W. E.	S. Sub. A. S.	Comanche, Cleveland, Wash. & Le Flore Co.	N.—M. A.	†	*	†	*	†	‡	†	†	?	?	?
" *erythrorhizos..?*	Red-rooted Cyperus	3	An.	W. E.	S. Sub. L. S.	Payne Co.	?	†	*	†	*	†	‡	?	?	?	?	?
" *strigosus*	Straw-colored Cyperus	48	Per..	W. E.	S. Sub. L. S.	Pittsburg Co.	M. A.	†	*	†	*	†	‡	†	†	?	?	?
Dianthera americana	Water Willow	57	Per.	W.E. & S.W.	P. Sub. A. S.	Southern & eastern sections	B.—M. A.	†	*	‡	†	‡	‡	‡	‡	‡	‡	†
Diodia virginiana	Larger Button-weed	....	....	W. E.	S. Sub. A. S.	Ottawa, Cherokee & LeFlore Co.	?	*	*	*	*	†		?	?	†	?	?
Echinochloa crusgalli	Barnyard Grass. Water Grass	....	An.	W. E.	S. Sub. A. S.	Bryan Co.	?	†	*	†	*	†	†	?		?	?	?
Echinodorus cordifolius	Upright Bur-head	25	Per.	W. E.	P. Sub. A. S.	Central, eastern and southern sections	B.—N.	†	*	†	*	‡	‡	†	†	?	?	?
" *radicans*	Creeping Bur-head	6	Per.	W. E.	P. Sub. A. S.	Le Flore Co.	N.	†	*	†	*	‡	‡	†	†	?	?	?
Elatine americana	Mud-purslane	....	An.	W. E.	S. Sub. A. S.	Pittsburg Co.	M. A.	?	†	†	*	*	*		?	?	?	?
Eleocharis albida	White Spike-rush	....	An.	W. E.	S. Sub. A. S.	Cleveland, Pittsburg & Johnston Co.	?	*	*	*	*	†	†	*	*	†	?	?
" *leptos*	Small Spike-rush	....	....	W. E.	P. Sub. A. S.	Pittsburg Co.	M. A.	*	*	*	*	†	†	*	*	†	?	?
" *mamilliata*	Pale Spike-rush	....	....	W. E.	P. Sub. A. S.	Payne, Pittsburg, Bryan & Comanche Co.	B.—Sl. A.	†	*	†	*	†	‡	†	†	†	?	?
" *obtusa*	Blunt Spike-rush	61	An.	W. E.	P. Sub. A. S.	Northeastern & southwestern section	B.	†	*	†	*	†	‡	†	†	†	?	?
" *palustris*	Creeping Spike-rush	44	Per.	W. E.	P. Sub. A. S.	Eastern & northwestern sections	B.—M. A.	†	*	†	*	†	‡	†	†	†	?	?
" *quadrangulata*	Angled Spike-rush	43	....	W. E.	P. Sub. A. S.	Central & eastern sections	N.	†	*	†	*	†	‡	†	†	†	?	?
Elodea canadensis	Water-weed	....	Per.	S.W. & D.W.	Wh. Sub.	Payne Co.	?	†	‡	†	‡	‡	†	‡	†	?	‡	†
" *minor*	Lesser Water-weed	39	Per.	S.W. & D.W.	Wh. Sub.	Cherokee Co.	B.—Sl. A.	†	‡	†	‡	‡	†	‡	†	?	‡	†
Fontinalis novae-angliae	Long-stemmed Water Moss	....	....	S. W.	Wh. Sub.	Comanche Co.	M. A.	*	†	†	†	*	*	*	*	?	?	?
Gratiola neglecta	Hedge Hyssop	....	....	W. E.	S. Sub. A. S.	Cherokee Co.	?	*	*	*	*	†	†	?	?	‡	?	†
" *sphaerocarpa*	Round-fruited Hedge Hyssop	....	....	W. E.	S. Sub. A. S.	Comanche Co.	?	*	*	*	*	†	†	?	?	‡	?	†
" *virginiana*	Clammy Hedge Hyssop	55	An.	W. E.	S. Sub. A. S.	Le Flore Co.	Sl. B.—M. A.	*	*	*	*	†	†	?	?	‡	?	†
Heteranthera dubia	Water Star Grass	31	Per.	S.W. & D.W.	P. Sub. F. L.	Delaware Co.	?	†	‡	†	†	‡	†	‡	†	?	?	?
Hydrodictyon reticulatum	Lace Alga	....	....	S. W.	Wh. Sub.	Cherokee Co.	B.	*	‡	†	‡	*	*	?	?	?	?	?
Ilysanthes anagallidea	False Pimpernel	....	An. or Bi..	W. E.	S. Sub. A. S.	Osage, Ottawa & Pittsburg Co.	?	?	?	†	*	†	†	?	?	†	?	?
" *dubia*	Long-stalked False Pimpernel	....	An. or Bi..	W. E.	S. Sub. A. S.	Northeastern section	Sl. A.	?	?	†	*	†	†	?	?	†	?	?
Iris Shrevei	Flag	....	....	S. W.	P. Sub. A. S.	Ottawa Co.	B.	†	*	†	*	†	‡	†	†	?	?	?
Juncus accuminatus	Sharp-fruited Rush	60	Per.	W. E.	S. Sub. A. S.	Le Flore Co.	M. A.	*	*	†	*	†	†	*	*	?	?	?
" *effusus*	Soft or Bog Rush	56	....	W. E.	P. Sub. A. S.	Eastern section	M. A.	*	*	†	*	†	†	†	†	?	?	?
" *robustus*	Stout Rush	27	Per.	S. W.	P. Sub. A. S.	Eastern section	M. A.	*	*	†	*	†	‡		†	?	?	?
Jussiaea decurrens	Upright Primrose-Willow	....	Per.	W. E.	S. Sub. A. S.	Eastern section	?	†	*	‡	*	†	‡	*	*	?	?	?
" *diffusa*	Floating or Creeping Primrose-Willow	42	Per.	W.E. & S.W.	P. Sub. F. L.	General	B.—M. A.	‡	‡	†	*	‡	†	†	*	?	‡	†
Lemna cyclostasa	Valdivia Duckweed	....	Per.	W.E. & S.W.	Floating	Harper Co.	?	†	†	†	*	*	*	*	*	?	?	?
Lippia cuneifolia	Wedge-leaved Fog-Fruit	....	Per.	W. E.	S. Sub. A. S.	Ellis, Alfalfa & Grant Co.	?	*	*	†	*	‡	†	*	*	‡	?	?
" *lanceolata*	Fog Fruit	15	Per.	W. E.	S. Sub. A. S.	General	B.—M. A.	*	*	†	*	‡	†	*	*	‡	?	†
" *nodiflora*	Spatulate-leaved Fog-Fruit	....	Per.	W. E.	S. Sub. A. S.	Central & southwestern sections	?	*	*	†	*	‡	†	*	*	‡	?	‡
Lophotocarpus calycinus	Large Lophotocarpus	67	Per.	W. E.	P. Sub. A. S.	Comanche Co.	B.	†	*	†	*	‡	‡	†	†	?	?	?
Lycopus virginicus	Bugle Weed	....	Per.	W. E.	S. Sub. A. S.	Le Flore Co.	N.—M. A.	*	*	†	*	†	†	*	*	?	?	?
Ludwigia alternifolia	Seedbox	....	Per.	W. E.	S. Sub. A. S.	East central section	?	*	*	†	*	†	†	*	*	?	?	?
" *palustris*	Water Purslane	47	Per.	W. E.	S. Sub. A. S.	South central & eastern sections	M. A.	†	†	†	*	†	†	*	*	†	?	?
Lythrum alatum	Wing-angled Loosestrife	52	An.	W. E.	S. Sub. A. S.	Woods, Payne & Ottawa Co.	?	†	*	‡	*	†	†	*	*	†	?	?
Marsilea vestita...?	Clover Fern	....	....	S. W.	P. Sub. F. L.	Payne Co.	?	†	†	†	*	†	†	†	*	?	?	?
Macuillamia rotundifolia	Round-leaved Water Hyssop	66	Per.	S. W.	P. Sub. F. L.	Pittsburg Co.	M. A.	*	†	†	*	?	*	*	*	?	?	?
Mentha piperita	Peppermint	62	Per.	W. E.	S. Sub. A.S.	Ottawa, Adair & Cleveland Co.	N.	*	*	‡	*	†	†	*	*	‡	?	?
" *spicata*	Spearmint	45	Per.	W. E.	S. Sub. A. S.	Push., Chero.,Major, Payne & Cotton Co.	M. A.	*	*	‡	*	†	†	*	*	‡	?	?
Myriophyllum heterophyllum	Various-leaved Water Milfoil	....	Per.	S.W. & D.W.	P. Sub. A. S.	Ottawa & Cherokee Co.	Sl. B.—M.A.	†	‡	†	†	‡	†	†	†	?	?	?
" *proserpinacoides*	Chilean Water Milfoil	34	Per.	S. W.	P. Sub. A. S.	Comanche Co.	B.	†	‡	‡	†	‡	†	†	†	?	?	?
" *scabratum*	Pinnate Water Milfoil	....	Per.	S.W. & D.W.	P. Sub. A. S.	Ottawa, Carter, Comanche & Harper Co.	?	†	‡	†	†	‡	†	†	†	?	?	?
" *spicatum*	Spiked Water Milfoil	16	Per.	S.W. & D.W.	P. Sub. A. S.	Murray Co.	B.	†	‡	†	†	‡	†	†	†	?	?	?
Naias flexilis	Slender Naias	....	An.	S.W. & D.W.	Wh. Sub.	Johnston Co.	?	†	‡	†	†	‡	†	‡	†	?	?	?
" *quadalupensis*	Guadaloupe Naias	37	....	S.W. & D.W.	Wh. Sub.	General	B.—Sl. A.	†	‡	†	‡	‡	†	‡	†	?	?	?
Nelumbo lutea	American Lotus or Water Chinquapin	12	Per.	S.W. & D.W.	P. Sub. F. L.	Central & eastern sections	B.—M. A.	‡	*	‡	*	‡	†	*	†	?	?	†
Nepeta hederaceae	Ground Ivy	....	Per.	W. E.	S. Sub. A. S.	Major Co.	M. A.	?	?	†	*	†	*	?	?	?	?	?
Nymphaea advena	Yellow Pond Lily	50	Per.	S. W.	P. Sub. F. L.	Central & southeastern sections	Sl. B.—M.A.	‡	*	†	*	‡	†	†	†	‡	?	†
Pastinaca sativa	Wild Parsnip	....	Bi.	W. E.	S. Sub. A. S.	Blaine Co.	Sl. B.	*	*	†	*	†	†	?	?	?	?	?
Penthorum sedoides	Ditch or Virginia Stonecrop	26	Per.	W. E.	S. Sub. A. S.	Kay, Payne & Pushmataha Co.	?	†	*	†	*	†	‡	*	*	†	?	?
Polygonum Hydropiper	Water Pepper	....	Per.	W. E.	S. Sub. A. S.	General	Sl. A.	†	*	†	*	‡	‡	†	†	‡	?	?
" *hydropiperoides*	Mild Water Pepper	13	Per.	W.E. & S.W.	P. Sub. A. S.	General	N.—M. A.	†	*	†	*	‡	‡	†	‡	‡	?	‡
" *lapathifolium*	Pale Persicaria	4	An.	W. E.	S. Sub. A. S.	General	?	*	*	†	*	‡	‡	†	†	?	?	†
" *longistylum*	Long-styled Persicaria	....	An.	W. E.	S. Sub. A. S.	Central & eastern sections	M. A.	†	*	†	*	‡	‡	†	†	‡	?	‡
" *Muhlenbergii*	Swamp Persicaria	63	Per.	W. E.	S. Sub. A. S.	Pittsburg & Washington Co.	M. A.	†	*	†	*	†	†	?	?	‡	?	?
" *pennsylvanicum*	Pennsylvania Persicaria	....	An.	W. E.	S. Sub. A. S.	General	?	†	*	†	*	‡	‡	†	†	‡	?	†
" *persicaria*	Lady's Thumb. Heartweed	....	An.	W. E.	S. Sub. A. S.	Pittsburg Co.	?	*	*	†	*	‡	†	*	*	‡	?	?
Pontedera cordata	Pickerel-weed	10	Per.	S. W.	P. Sub. A. S.	Ottawa & Cherokee Co.	B.	‡	*	‡	†	‡	‡		†	‡	?	?
Potamogeton americanus	Long-leaved Pondweed	7	Per.	S.W. & D.W.	P. Sub. F. L.	General	B.—S. A.	‡	*	†	*	‡	†	‡	†	?	?	?
" *crispus*	Curly Muck-weed	40	Per.	S.W. & D.W	Wh. Sub.	Delaware, Cherokee & Comanche Co.	B.	†	‡	†	‡	‡	†	‡	†	?	?	?
" *dimorphus*	Spiral Pondweed	18	Per.	S.W. & D.W.	P. Sub. F. L.	Ottawa, Pittsburg & Stephens Co.	Sl. A.	†	‡	†	†	‡	†	‡	†	?	?	?
" *foliosus*	Leafy Pondweed	22	Per.	S.W. & D.W.	Wh. Sub.	General	B.—N.	†	‡	†	‡	‡	†	‡	†	?	?	?
" *hybridus*	Rafinesque's Pondweed	41	Per.	S. W.	P. Sub. F. L.	Le Flore, Pittsburg & Comanche Co.	Sl. A.—M. A.	†	†	†	†	†	†		*	?	?	?
" *lucens*	Shining Pondweed	28	Per.	S. W.	Wh. Sub.	Comanche & Johnston Co.	M. A.	†	†	†	‡	‡	†	†	†	‡	?	?
" *pectinatus*	Fennel-leaved Pondweed	24	Per.	S.W. & D.W.	Wh. Sub.	Alfalfa, Payne & Comanche Co.	B.	†	‡	†	‡	‡	†	‡	†	?	?	?
" *pusillus*	Small Pondweed	30	Per.	S.W. & D.W.	Wh. Sub.	Northern & southern sections	B.—M. A.	†	‡	†	‡	‡	†	‡	†	?	?	?
Proserpinaca palustris	Mermaid-weed	....	Per.	W.E. & S.W.	P. Sub. A. S.	Le Flore Co.	?	†	*	†	†	†	†	†	†	?	?	?
Radicula Nasturtium-aquaticum	True Water-Cress	58	Per.	S. W.	P. Sub. A. S.	Northeastern & western sections	B.—N.	*	†	†	*	†	†	*	*	*	?	?
" *palustris*	Marsh or Yellow Water-cress	68	An. or Bi..	W. E.	P. Sub. A. S.	Northeastern, central & southwestern sections	B.—Sl. A.	*	*	*	*	†	†	*	*	‡	?	†
Ranunculus aquatilis	Common White Water-crowfoot	14	Per.	S. W.	Wh. Sub.	Alfalfa, Major, Comanche & McCurtain Co.	B.—M. A.	†	†	†	‡	†	†	‡	†	?	?	?
" *Cymbalaria*	Seaside Crow-foot	....	Per.	W. E.	S. Sub. A. S.	Beaver, Harper & Custer Co.	B.	?	*	†	*	?	†	?	?	?	?	?
Rotala ramosier	Tooth-cup	....	An.	W. E.	P. Sub. A. S.	Push., Ottawa, Wash., Chero. & Murray Co.	B.	†	†	†	*	†	†	†	*	?	?	?
Ruppia maritima	Ditch Grass	....	....	S.W. & D.W.	Wh. Sub.	Harper, Woods & Kingfisher Co.	?	*	‡	†	‡	†	*	†	*	?	?	?
Rynchospora corniculata	Horned Rush	....	Per.	W. E.	S. Sub. A. S.	Pittsburg Co.	Sl. A.	*	*	†	*	†	*	*	*	?	?	?
Sagittaria graminea	Grass-leaved Sagittaria	32	Per.	W. E.	P. Sub. A. S.	Latimer, Le Flore & Bryan Co.	B.—M. A.	†	*	†	*	‡	‡	†	†	?		?
" *lancifolia*	Lance-leaved Sagittaria	1	Per.	W. E.	P. Sub. A. S.	Comanche & Pittsburg Co.	Sl. A.	†	*	†	*	‡	‡	†			?	?
" *latifolia*	Broad-leaved Arrow-head	11	Per.	W. E.	P. Sub. A. S.	Woods, Ottawa & Seminole Co.	Sl. B.—Sl. A.	‡	*	†	*	‡	‡	†	†	?	?	?
Salix Sp. and others	Willow	....	Per.	W.E. & S.W.	S. Sub. A. S.	General	?	‡	*	‡	*	†	‡	†		‡	?	?
Samolus ebracteatus	Water Pimpernel. Brookweed	....	....	W. E.	S. Sub. A. S.	Woods, Dewey & Kiowa Co.	?	*	†	†	*	*	*	?	?	?	?	?
" *floribundus*	Water Pimpernel. Brookweed	....	Per.	W. E.	S. Sub. A. S.	General	N.	*	†	†	*	*		?	?	*	?	?
Saururus cernuus	Lizards-tail	49	Per.	S. W.	P. Sub. A. S.	Extreme eastern section	B.—Sl. A.	†	*	‡	*	‡	‡	†	†	‡	?	?
Scirpus americanus	Chair-maker's rush	53	Per.	S. W.	P. Sub. A. S.	Western section	B.—Sl. B.	†	*	†	*	‡	†	†	†	?	?	?
" *californicus*	Bulrush	....	Per.	S.W. & D.W.	P. Sub. A. S.	Carter & Cherokee Co.	B.—Sl. A.	†	*	‡	*	‡	†	†	†	?	?	?
" *lineatus*	Reddish Bulrush	54	Per.	S. W.	P. Sub. A. S.	Comanche Co.	Sl. A.—M. A.	†	*	†	*	†	‡	†	‡	?	?	?
" *Torreyi*	Torrey's Bulrush	....	Per.	S. W.	P. Sub. A. S.	Woodward & Alfalfa Co.	B.	†	*	†	*	‡	†	†	†	?	?	?
" *validus*	American Great Bulrush	....	Per.	S.W. & D.W.	P. Sub. A. S.	Major, Cleveland & Ottawa Co.	Sl. A.	†	*	‡	†	‡	†	†	‡	?	?	?
Sium suave	Water Parsnip	....	Per.	W. E.	S. Sub. A. S.	Woodward Co.	?	*	*	†	*	†	†	?	?	?	?	?
Sparganium americanum	Nuttall's Bur-reed	46	Per.	W. E.	P. Sub. A. S.	Le Flore Co.	M. A.	†	*	†	*	†	†	†	*	?	?	?
Spirodela polyrhiza	Greater Duckweed	35	Per.	W.E. & S.W.	Fl.	Woods & Cherokee Co.	Sl. B.	†	†	†	*	*	*	*	*	?	?	?
Thalia dealbata	Powdery Thalia	20	Per.	S. W.	P. Sub. A. S.	Cherokee Co.	B.	†	*	‡	*	†	‡	*	†	?	?	?
Typha angustifolia	Narrow-leaved Cat-tail	....	Per.	W.E. & S.W.	P. Sub. A. S.	General	B.	†	*	*	*	†	‡	†	†	‡	?	?
" *latifolia*	Broad-leaved Cat-tail	8 & 64	Per.	W.E. & S.W.	P. Sub. A. S.	General	B.—M. A.	†	*	†	*	†	‡	†	†	-	?	?
Utricularia biflora	Two-flowered Bladderwort	....	....	S. W.	P. Sub. F. L.	Comanche & Ottawa Co.	M. A.	*	‡	†	‡	†	*	†	*	?	?	?
Vallisneria spiralis....?	Eel-grass. Tape-grass	65	Per.	S.W. & D.W.	Wh. Sub.	Bryan Co.	B.	†	†	‡	‡	‡	†	†	†	?	?	?
Verbesina alba	Crownbeard..	....	An.	W. E.	S. Sub. A. S.	Cleveland, Cherokee & Johnston Co.	?	*	*	*	*	‡	†	*	*	‡	?	†
Veronica peregrina	Purslane Speedwell. Neckweed	....	An.	W. E.	S. Sub. A. S.	General	?	*	*	*	*	†	†	*	*	‡	?	†
Wolffia columbiana	Columbia Wolffia	36	Per.	W.E. & S.W.	Fl.	Cherokee & Kay Co.	B.	†	†	†	*	*	*	*	*	*	?	†
Zannichellia palustris	Horned Pondweed	21	Per.	S. W.	Wh. Sub.	Beaver, Harper & Cherokee Co.	?	†	†	†	‡	†	*	‡	†	?	?	?

KEY TO ABBREVIATIONS

A
- An. —Annual
- Bi. —Biennial
- Per. —Perennial

B
- W. E. —Water's edge
- W.E. & S.W. —Water's edge and shallow water.
- S. W. —Shallow water.
- S.W. & D.W. —Shallow water and deep water.

C
- Fl. —Floating
- Wh. Sub. —Wholly submersed.
- S. Sub. A. S. —Sometimes submerged with aerial leafy stems.
- P. Sub. A. S. —Partially submersed with aerial leafy stems.
- P. Sub. F. L. —Partially submersed with floating leaves.

D
- B. —Basic
- Sl. B. —Slightly basic
- N. —Normal
- Sl. A. —Slightly acid
- M. A. —Medium acid
- St. A. —Strongly acid

*
- ‡—Good
- †—Fair
- *—Poor
- ?—Unknown or doubtful