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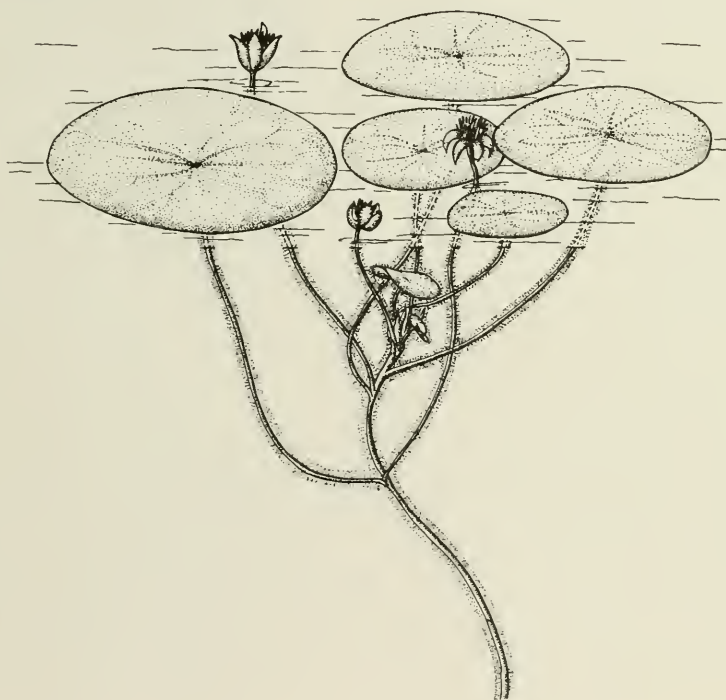
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**Aquatic Vascular Plants of New England:
Part 7. Cabombaceae, Nymphaeaceae,
Nelumbonaceae, and Ceratophyllaceae**

by

C. B. Hellquist and G. E. Crow



**NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE 03824**

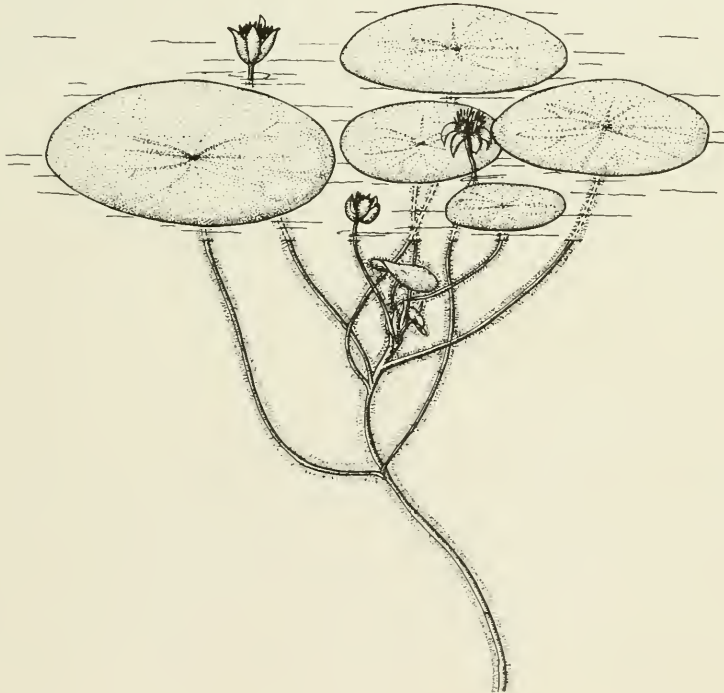
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ABSTRACT

This paper is the seventh in a series of reports on the aquatic and wetland flora of New England. It treats all species of the Cabombaceae, Nymphaeaceae, Nelumbonaceae, and Ceratophyllaceae occurring in New England and includes keys, comments on taxonomy and nomenclature, habitat and distributional information, water chemistry data, illustrations, and dot maps. Those species regarded as rare and endangered in the New England Region or in one or more of the six New England States are also noted. One species, *Nymphaea tetragona*, is presently under consideration by the U.S. Fish and Wildlife Service for listing under the Endangered Species Act of 1973.

KEY WORDS: Aquatic Plants, New England Flora, Taxonomy, Cabombaceae, Nymphaeaceae, Nelumbonaceae, Ceratophyllaceae, *Cabomba*, *Brasenia*, *Nymphaea*, *Nuphar*, *Nelumbo*, *Ceratophyllum*, Fanwort, Water-shield, Water-lily, Pond-lily, Yellow Water-lily, Spatterdock, Cow-lily, Lotus, Water Chinquapin, Coontail, Hornwort.

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Aquatic Vascular Plants of New England: Part 7. Cabombaceae, Nymphaeaceae, Nelumbonaceae, and Ceratophyllaceae

by

C. B. Hellquist and G. E. Crow¹

INTRODUCTION

This is the seventh in a series of reports on the aquatic and wetland flora of New England. These reports are intended to aid conservationists, fish and game personnel, consultants, botanists, and students in the identification of aquatic plants. The coverage is strictly New England but is of value throughout the northeast. Data have been gathered from herbaria in New England and from personal field work.

The chemical data included represent samples from many waters throughout New England. The alkalinity readings are total alkalinity, expressed as milligrams per liter (mg/l) CaCO₃. The number of observations is given in parentheses following alkalinity and pH values. Since pH and alkalinity vary greatly during the day, the values are only indicative of the water quality.

The rare and endangered plant lists referred to are those prepared for each of the six New England states by the New England Botanical Club in cooperation with the United States Fish and Wildlife Service, Office of Endangered Species, Newton Corner, MA (RI — Church and Champlin, 1978; MA — Coddington and Field, 1978; VT — Countryman, 1978; ME — Eastman, 1978; CT — Mehrhoff, 1978; NH — Storks and Crow, 1978). Taxa indicated as rare, threatened or endangered for the entire New England Region are also noted (Crow *et al.*, 1981, *Rhodora* 83: 259-299).

We invite comments and/or criticisms on this treatment. Information on any species omitted or any additional localities will be welcomed. If anyone is interested in specific localities of any of the species indicated on the dot maps, please contact us.

¹Dr. C. Barre Hellquist, Department of Biology, North Adams State College, North Adams, MA 01247.

Dr. Garrett E. Crow, Department of Botany and Plant Pathology, Nesmith Hall, University of New Hampshire, Durham, NH 03824.

CABOMBACEAE

1. Submersed leaves opposite, dissected into linear segments (fig. 1); floating leaves small, inconspicuous, oblong to linear-elliptic, peltate, less than 2 cm long, subtending flowers (fig. 1); submersed portions of plants lacking mucilaginous coating; flowers white to pinkish; stamens 3-6.
 1. *Cabomba*
1. Submersed leaves absent, except on young plants, then alternate (fig. 2B); floating leaves prominent, peltate, elliptical, 2-10 cm long (fig. 2); submersed portions of plants typically with a mucilaginous coating; flowers red-purple; stamens 12 or more.
 2. *Brasenia*

Cabomba (Fanwort)

Perennial, arising from short rhizomes with fibrous roots; submersed leaves opposite, petioled, fan-like, with finely dissected divisions; floating leaves alternate, small, oblong to linear-elliptic, peltate; flowers usually solitary, borne in axils of floating leaves; perianth white to pinkish, about 12 mm long; carpels (2-)3(-4), separate; fruit leathery, indehiscent, 3-seeded follicle.

1. *Cabomba caroliniana* Gray Fig. 1, Map 1

Locally abundant and weedy in acidic waters of southern New England. This aggressive weed was first reported in New England from Cranston, Rhode Island in 1933. Herbicides and mechanical harvesting have proven completely ineffective for controlling this species. Range extends from southern New Hampshire and Massachusetts west to New York, Pennsylvania, southern Michigan, southern Illinois, and Missouri, south to Florida, eastern Oklahoma, and eastern Texas.

alkalinity: mean 15.8; range 3.5-35.0 mg/l; (13)

pH: mean 6.5; range 5.9-6.8; (10)

Brasenia (Water Shield)

Perennial, arising from creeping rhizomes; all leaves floating (submersed leaves present only on young plants), elliptic, peltate; submersed parts typically covered with a thick, mucilaginous coating; flowers solitary, axillary; perianth red-purple, 12-20 mm long; carpels 4-10, separate; fruit a leathery, indehiscent, 1-2 seeded follicle.

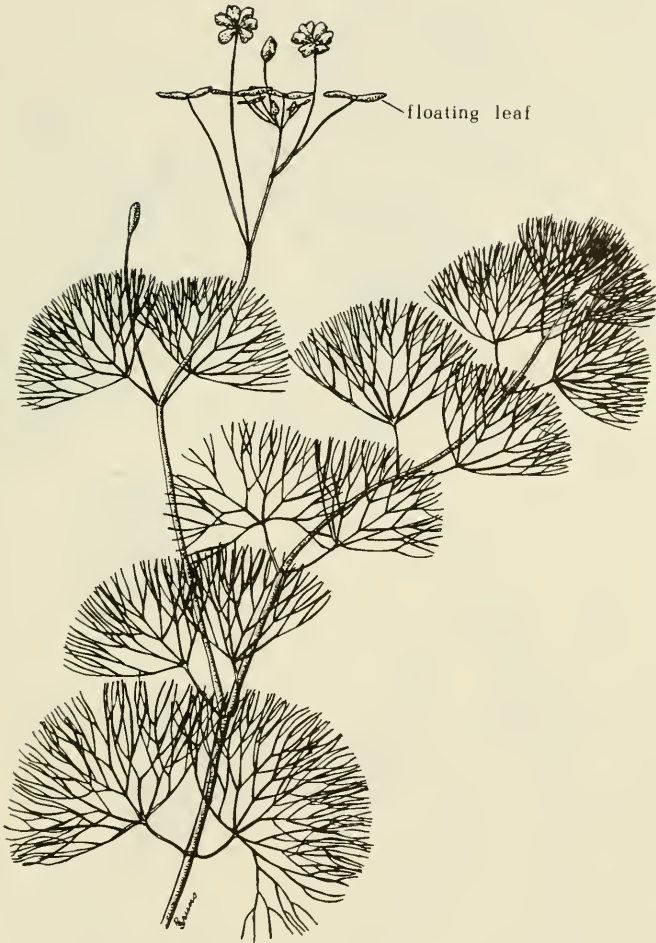
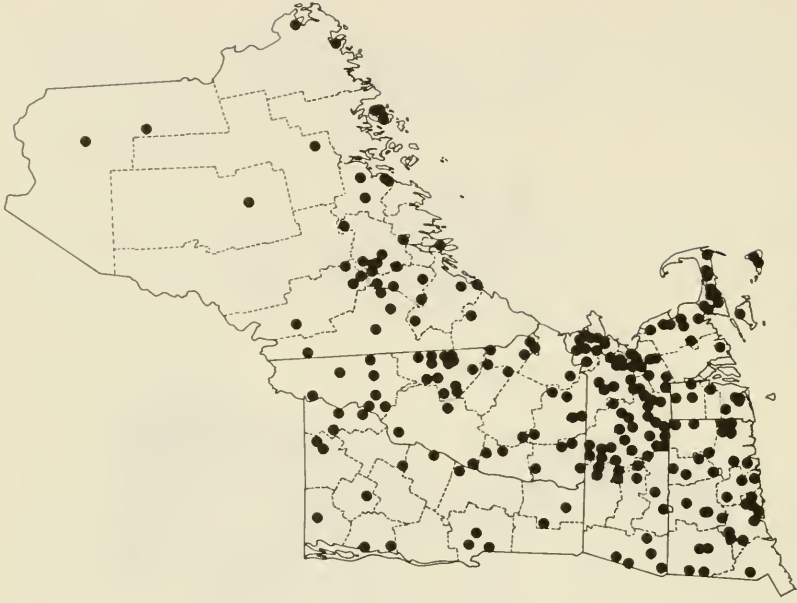
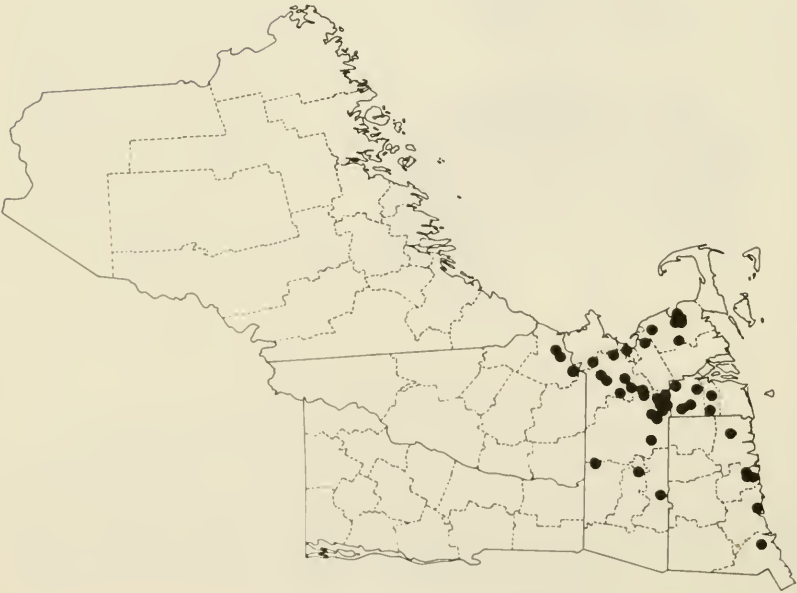


Figure 1.
Cabomba caroliniana: habit $\times \frac{1}{2}$.



Map 2.
Brasenia schreberi



Map 1.
Cabomba caroliniana

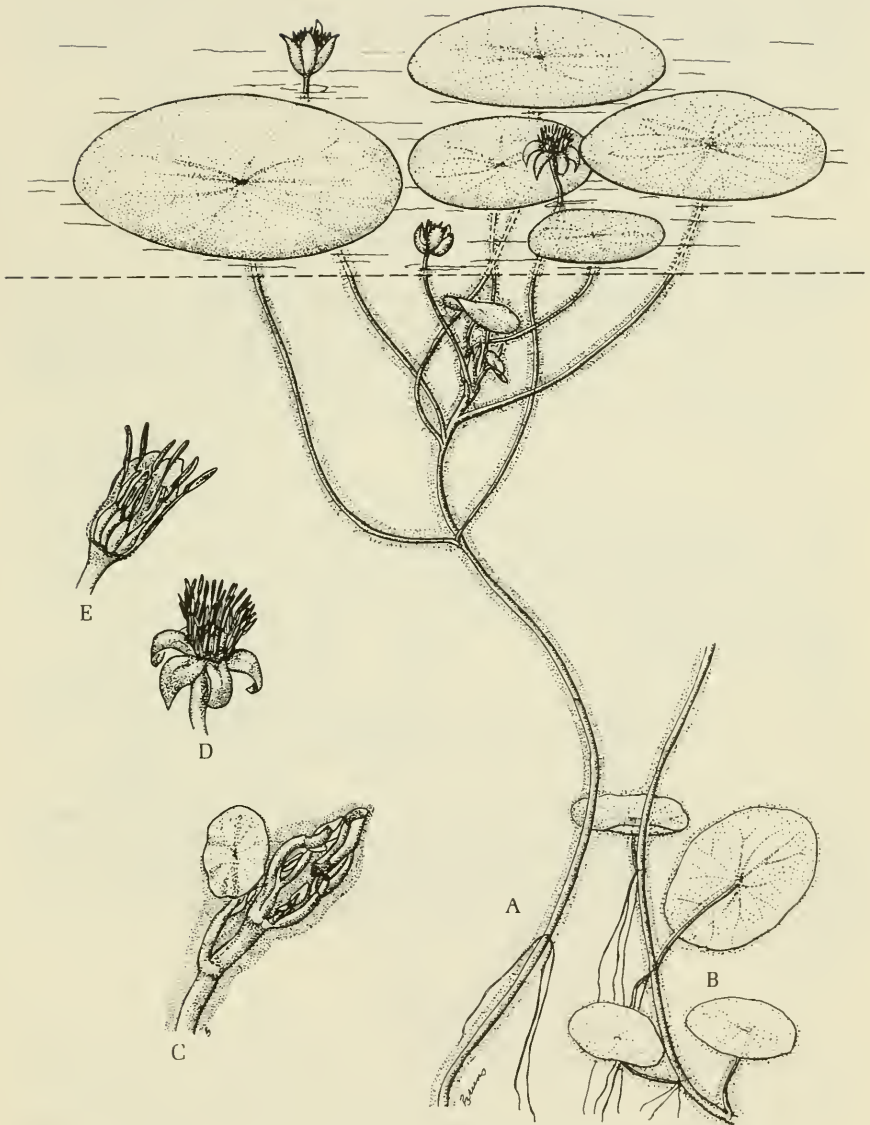


Figure 2.
Brasenia schreberi: A. habit $\times \frac{1}{2}$. B. submersed leaves of young plant $\times \frac{1}{2}$. C. winter bud with thick mucilaginous coating $\times \frac{1}{2}$. D. flower $\times 1$. E. section of flower showing separate carpels $\times 1\frac{1}{2}$.

1. *Brasenia schreberi* Gmel. Fig. 2, Map 2

Common in slow moving and standing waters throughout New England. Range extends from Prince Edward Island west to southern Quebec, southern Ontario, and Minnesota, south to Florida and Texas; southern British Columbia to Oregon; Mexico and Central America.

alkalinity: mean 15.9 mg/l; range 2.5-111.5 mg/l; (53)

pH: mean 6.6; range 5.7-9.5; (51)

NYMPHAEEACEAE

1. Flowers white to pinkish, broadly open (figs. 3,4); sepals 4, greenish; petals numerous, conspicuous, elliptic to spatulate to oblanceolate; stigmas radiate from globose ovary summit extending into linear, incurved sterile appendages; leaves orbicular, lobes with recurved tips (fig. 3A,D), venation essentially palmate (fig. 3A,D).

..... 1. *Nymphaea*

1. Flowers yellow, sometimes greenish or reddish, subglobose (fig. 7); sepals 5-6(-9); petals numerous, strap-like, usually shorter than, but resembling the stamens, recurved; stigmas sessile, radiate on a disc (fig. 7), appendages lacking; leaves orbicular-reniform, ovate to oblong, lobes rounded at tip (figs. 5,6), venation essentially pinnate (fig. 5B,D).

..... 2. *Nuphar*

Nymphaea (Water-lily, Pond-lily)

Perennial, arising from rhizomes; leaves submersed, floating and/or emergent, deeply cleft, long-petioled; flowers showy; sepals 4, greenish; petals numerous, white to pink, the inner ones usually transitional to stamens; fruit a leathery berry; seeds arillate, maturing underwater.

Key to Species

1. Leaves orbicular to ovate in outline, 7-30 cm wide, sinus typically narrow or closed (fig. 3A,D); flowers 7-30 cm broad, petals 17-32.

2. Petioles green, not striped; lower surface of leaf red to purple (rarely green); petals elliptic, subacute at tip (fig. 3B,C).

..... 1. *N. odorata*

2. Petioles green with brown-purple stripes; lower surface of leaf green (rarely faint red-purple); petals spatulate to oblanceolate, rounded at tip (fig. 3E,F).

..... 2. *N. tuberosa*

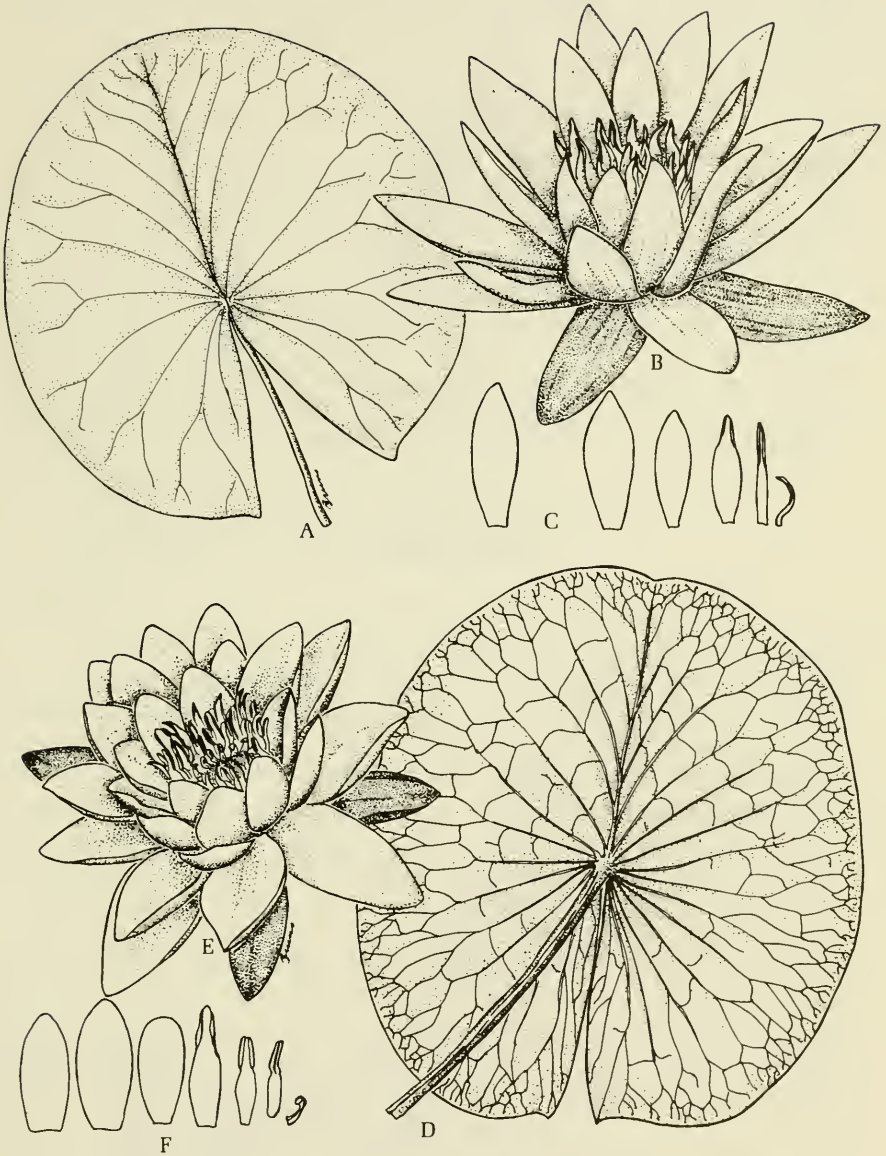
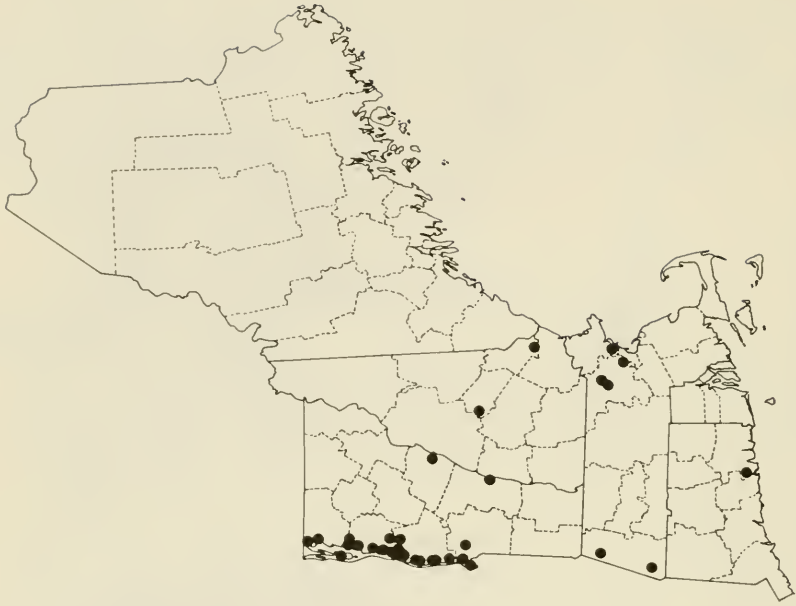


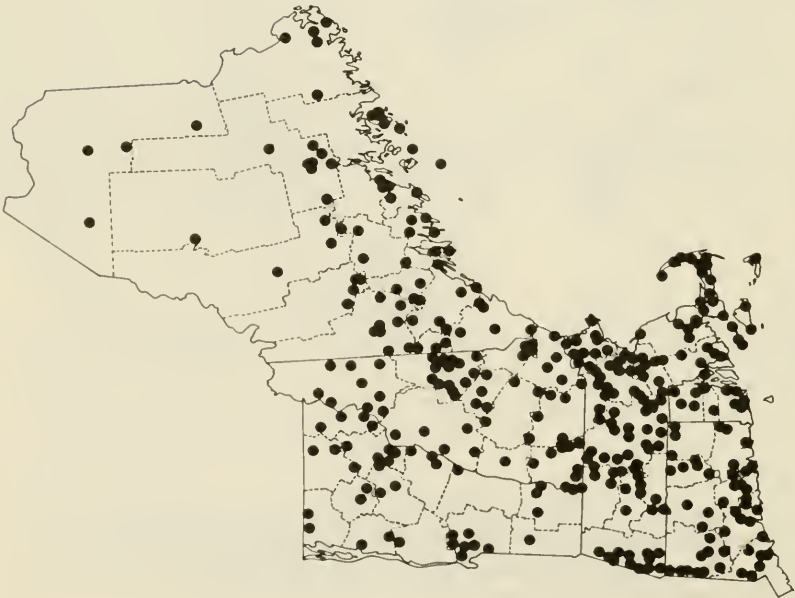
Figure 3.

Nymphaea odorata: A. leaf $\times \frac{1}{2}$. B. flower $\times \frac{1}{2}$. C. series showing transition from petals to stamens $\times \frac{1}{4}$.

Nymphaea tuberosa: D. leaf $\times \frac{1}{2}$. E. flower $\times \frac{1}{2}$. F. series showing transition from petals to stamens $\times \frac{1}{4}$.



Map 4.
Nymphaea tuberosa



Map 3.
Nymphaea odorata

1. Leaves ovate to obovate in outline, 4-9 cm wide, sinus typically open with widely divergent lobes (fig. 4); flowers 3.3-8 cm broad, petals 8-17.

..... 3. *N. tetragona*

1. *Nymphaea odorata* Ait. Fig. 3, Map 3

Extremely common throughout New England in sluggish streams, ponds, and lakes. Light pink-flowered individuals are frequently encountered and are treated by some authors as forma *rubra* Guillon. Occasionally plants with dark pink to light red flowers are found which are likely to be the European *Nymphaea alba* L. forma *rosea* Hartm., differentiated from *N. odorata* by having 20-24 petals which are rounded at the tips. *Nymphaea odorata* has 17-32 petals which gradually taper to subacute tips. Range extends from Newfoundland and southwestern Quebec west to Ontario, Minnesota, and Manitoba, south to Florida, Iowa, Nebraska, Kansas, Oklahoma, Texas, and Arizona.

alkalinity: mean 25.0 mg/l; range 2.0-141.5 mg/l; (121)

pH: mean 7.0; range 5.3-9.5; (117)

2. *Nymphaea tuberosa* Paine Fig. 3, Map 4

Common in alkaline waters of the Lake Champlain Valley of Vermont, uncommon elsewhere in New England, but sometimes planted as an ornamental. Floating leaves are often very large (up to 40 cm wide) and plants along the shoreline may have leaves elevated above the surface. Two characters often utilized to distinguish *N. odorata* and *N. tuberosa* are time of day flowers are open and the degree of flower odor. Neither of these traits are reliable. Population and transplant studies by Williams (1970) suggested that characters distinguishing *N. tuberosa* from *N. odorata* may not be constant. In calcareous waters of the Lake Champlain Valley the two taxa are easily distinguished. Likewise, introduced plants of *N. tuberosa* in acidic waters of eastern New England retain their distinctive features. Hence, we presently continue to recognize them as two species. Range extends from southwestern Quebec west to northern Ontario, Minnesota, and Nebraska, south to Maryland, Ohio, Indiana, Illinois, Arkansas, and northeastern Oklahoma.

Rare and endangered plant lists: Massachusetts, Connecticut

alkalinity: mean 59.0 mg/l; range 10.0-153.0 mg/l; (21)

pH: mean 7.6; range 6.8-8.6 (21)

3. *Nymphaea tetragona* Georgi Fig. 4, Map 5

Rare, in quiet streams and protected waters of moderate alkalinity of northern and northwestern Maine. The North American taxon

is subsp. *leibergii* (Morong) Porsild. Range extends from Quebec and northern Maine west to Isle Royale, Michigan, Saskatchewan, Northwest Territories, Alaska, and British Columbia, south to northwestern Montana, northern Idaho, and Washington.

Rare and endangered plant lists: Maine, New England; under consideration by the U.S. Fish and Wildlife Service, Office of Endangered Species for listing under the Endangered Species Act of 1973.

alkalinity: mean 24.8 mg/l; range 13.5-40.0 mg/l; (4)

pH: mean 7.1; range 7.0-7.3; (4)

Nuphar (Yellow Water-lily, Spatterdock, Cow-lily)

Perennial, arising from large, cylindrical, creeping rhizomes; leaves submersed when young, becoming floating and/or erect, blades deeply cleft, with long petioles; flowers globose, floating or elevated above surface; sepals 5-6(-9), yellow, sometimes greenish or reddish tinged; petals numerous, yellow, small, strap-like resembling the stamens; stamens numerous, filaments flat; stigmas sessile, radiate on a disc; fruit an ovoid, leathery berry, with numerous non-arillate seeds per locule, maturing above the water surface.

The treatment of *Nuphar* by E. O. Beal (1956), not followed here, recognized only one species, *N. lutea* (L.) Sibth. and Smith, in the world, with nine subspecies.

Key to Species

1. Leaf blades of mature plants 3.5-20 cm long, 3.5-14.5 cm wide; fruit conspicuously constricted below the stigmatic disc (fig. 7B,D).
 2. Flowers 2 cm or less wide; stigmatic disc with 6-10 deep crenations (fig. 7B), leaf blades 3.5-10 cm long, 3.5-7.5 cm wide; blade notch two-thirds or more the length of the midrib (fig. 5A).
..... 1. *N. pumila*
 2. Flowers 3 cm or more wide; stigmatic disc with 8-15 shallow crenations (fig. 7D); leaf blades 5-20 cm long, 4.5-14.5 cm wide; blade notch one-half the length of the midrib (fig. 5B).
..... 2. *N. ×rubrodisca*
1. Leaf blades of mature plants 7.0-40 cm long, 4.0-25 cm wide; fruit only slightly constricted, or not constricted below the stigmatic disc (fig. 7F,H).
 3. Petiole strongly flattened above and winged (fig. 6B); leaves usually floating (fig. 6A); fruit and inner surface of sepals often maroon or red.
..... 3. *N. variegata*

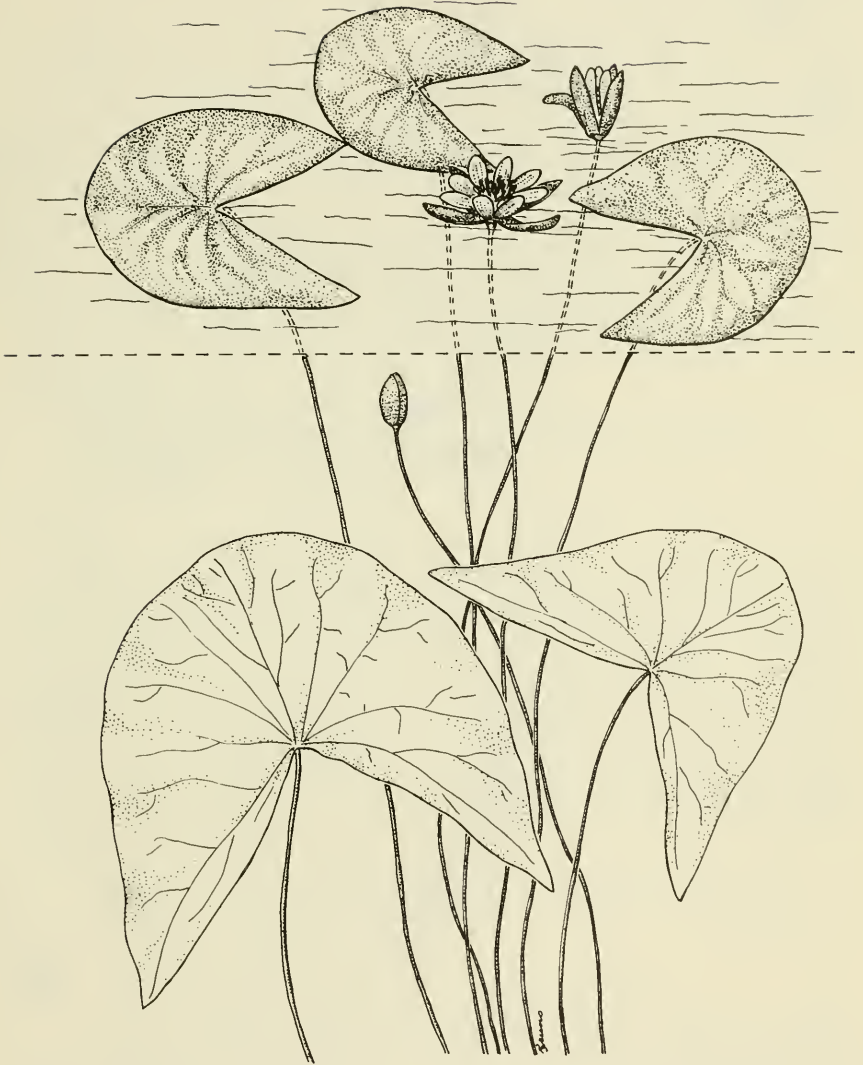
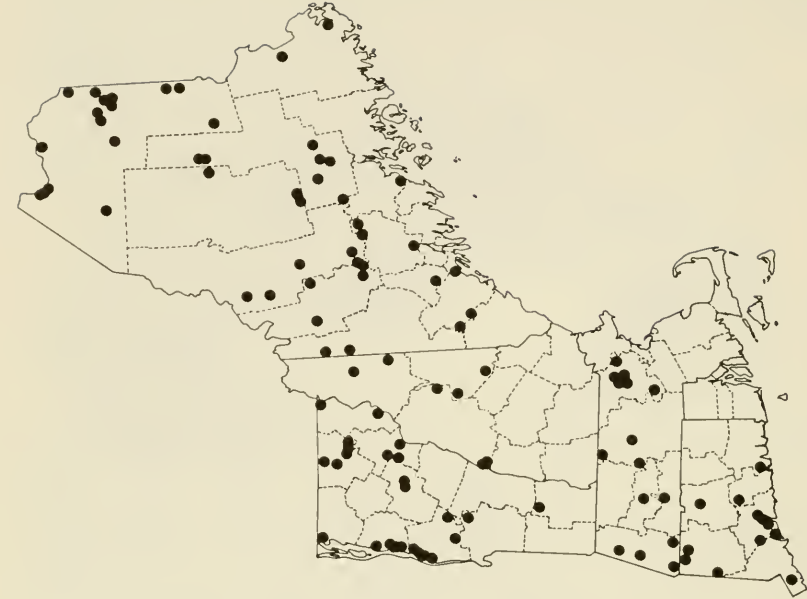
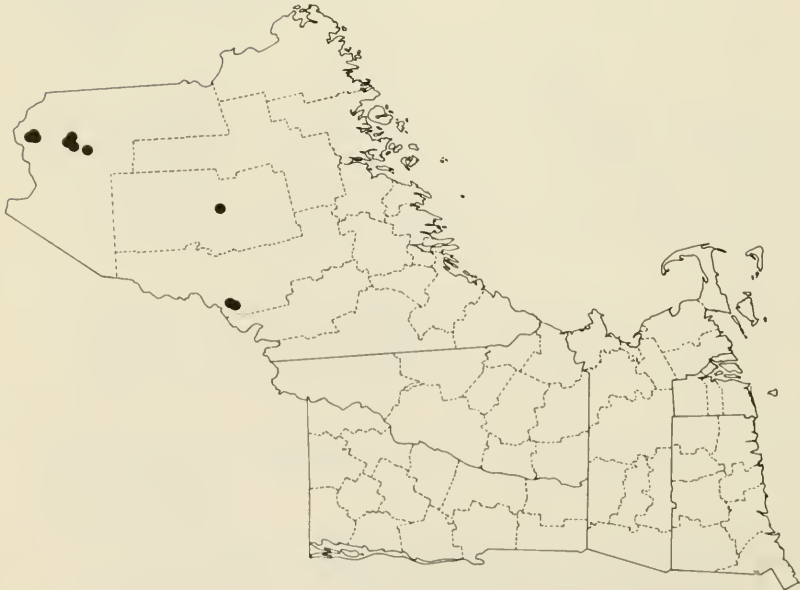


Figure 4.
Nymphaea tetragona: habit showing both floating
leaves and submersed leaves $\times \frac{1}{2}$.



Map 6.
Nuphar pumila



Map 5.
Nymphaea tetragona

3. Petiole terete, not winged (fig. 5D); leaves mostly erect, elevated above the water surface (fig. 5C); inner surface of sepals and fruit green and/or yellow.

..... 4. *N. advena*

1. *Nuphar pumila* (Timm) DC. Figs. 5, 7, Map 6

Widely scattered in quiet waters of northern portions of Maine, New Hampshire, and Vermont; rare elsewhere in New England. This species once occurred more frequently throughout the region, but recent attempts to relocate it in southern New England have been unsuccessful. This taxon has long been treated as *N. microphyllum* (Pers.) Fern. More recently Beal (1956) has treated this as *N. lutea* subsp. *pumila* (Timm) Beal which also occurs in northern Europe. Range extends from Newfoundland west to Manitoba, south to Nova Scotia, northern Michigan, northern Wisconsin, and northeastern Minnesota.

Rare and endangered plant list: Maine

alkalinity: mean 36.1 mg/l; range 3.5-103.5 mg/l; (9)

pH: mean 7.4; range 6.5-9.5; (8)

2. *Nuphar* × *rubrodisca* Morong Figs. 5, 7, Map 7

Widely scattered in quiet waters throughout New England, but especially common in the Lake Champlain Valley of Vermont. This taxon is believed to be a fertile hybrid between *N. pumila* and *N. variegata*. The stigmatic disc of the flower and fruit is usually bright red. Young plants of *N. variegata* may be mistaken for *N. ×rubrodisca*. Range extends from Newfoundland west to eastern Ontario, south to Nova Scotia, Connecticut, New Jersey, eastern Pennsylvania, New York, northern Michigan, northern Wisconsin, and eastern Minnesota.

Rare and endangered plant list: Vermont

alkalinity: mean 31.3 mg/l; range 3.5-57.5 mg/l; (8)

pH: mean 7.4; 6.7-8.2; (8)

3. *Nuphar variegata* Durand Figs. 6, 7, Map 8

Extremely common in slow moving waters throughout New England. This is one of the most common aquatic species in the region. Beal (1956) treated this taxon as *N. lutea* subsp. *variegata* (Durand) Beal. Range extends from Newfoundland and Labrador west to Yukon, south to Delaware, northeastern Pennsylvania, northern Ohio, northern Indiana, northern Illinois, South Dakota, Nebraska, and Montana.

alkalinity: mean 27.7 mg/l; range 2.0-132.5 mg/l; (186)

pH: mean 7.0; range 5.0-9.8; (181)

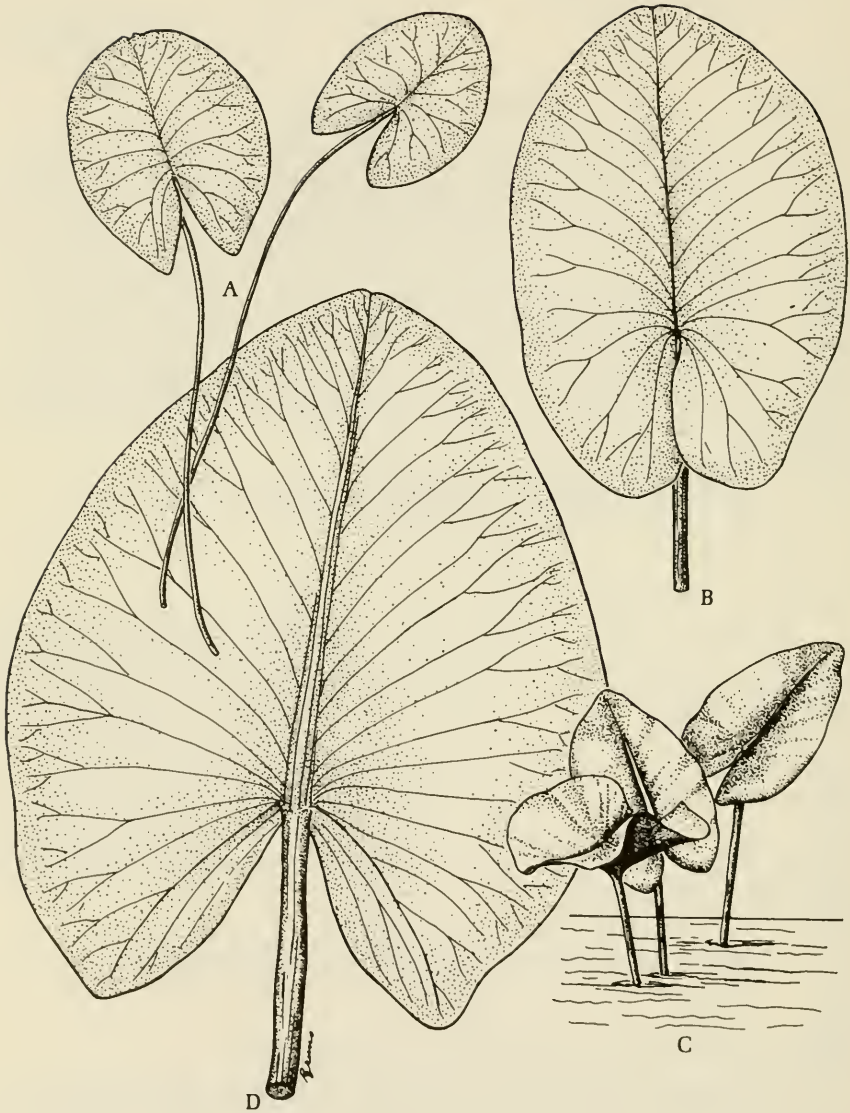


Figure 5.

Nuphar pumila: A. leaves $\times \frac{1}{2}$.

Nuphar rubrodiscalis: B. leaf $\times \frac{1}{2}$.

Nuphar advena: C. habit showing characteristically emergent leaf blades. D. leaf $\times \frac{1}{2}$.

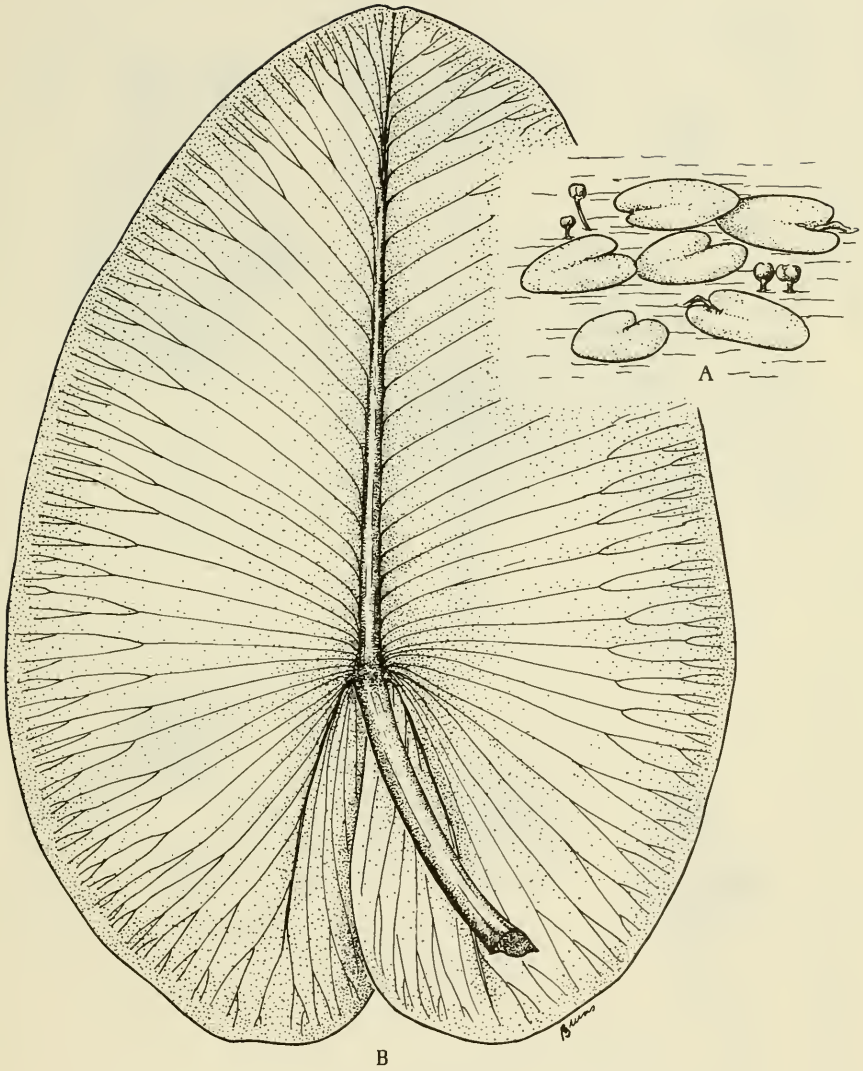


Figure 6.
Nuphar variegata: A. habit showing characteristically
floating leaves. B. leaf $\times \frac{1}{2}$.

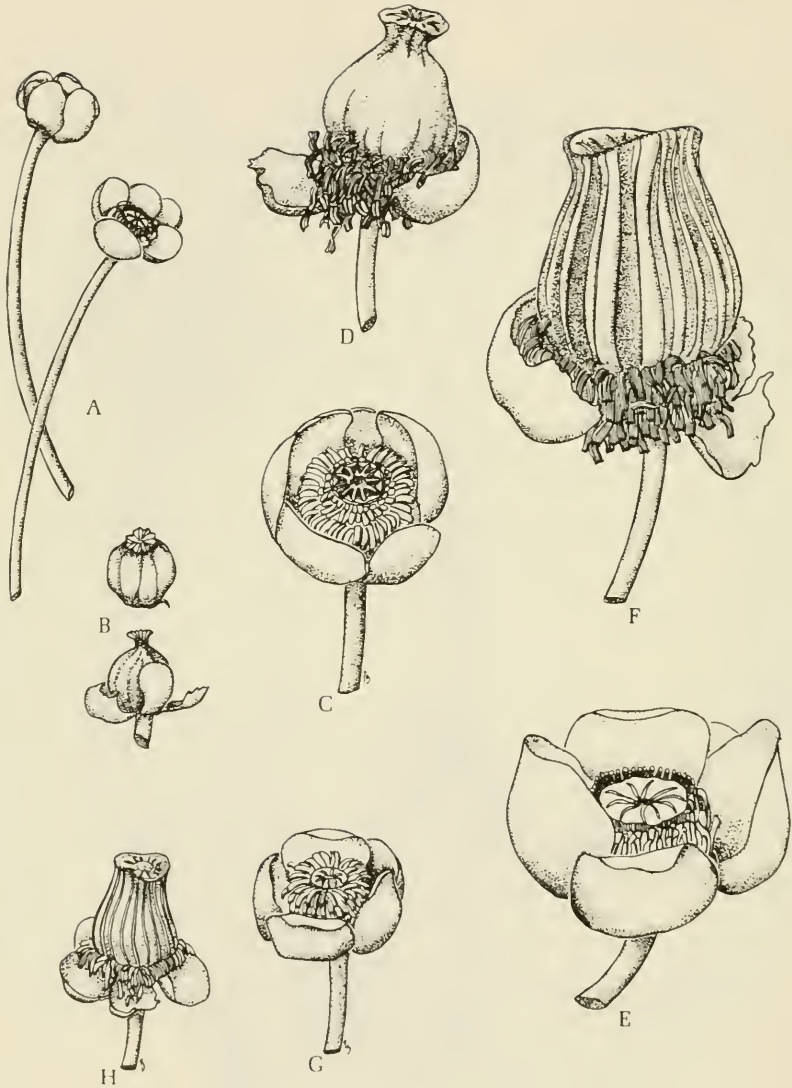


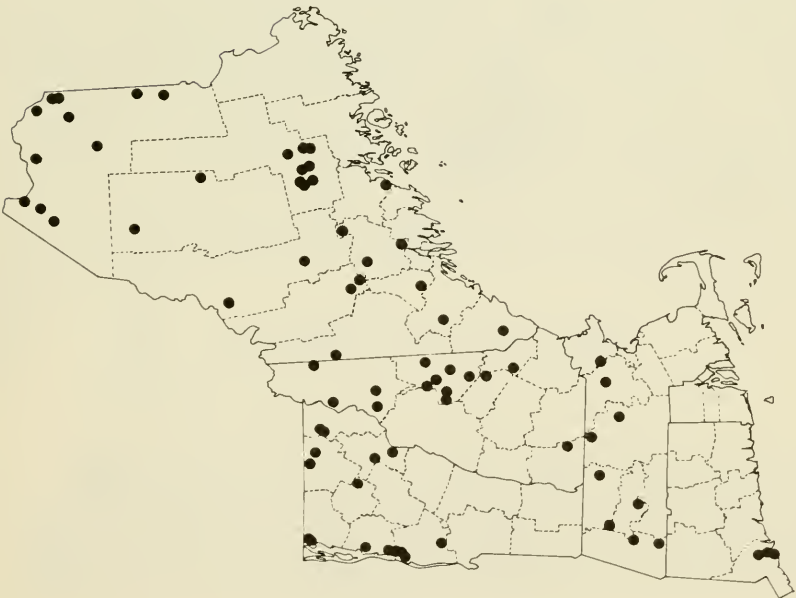
Figure 7.

Nuphar pumila: A. flowers $\times \frac{1}{2}$. B. fruits $\times \frac{1}{2}$. Both redrawn from Fassett.

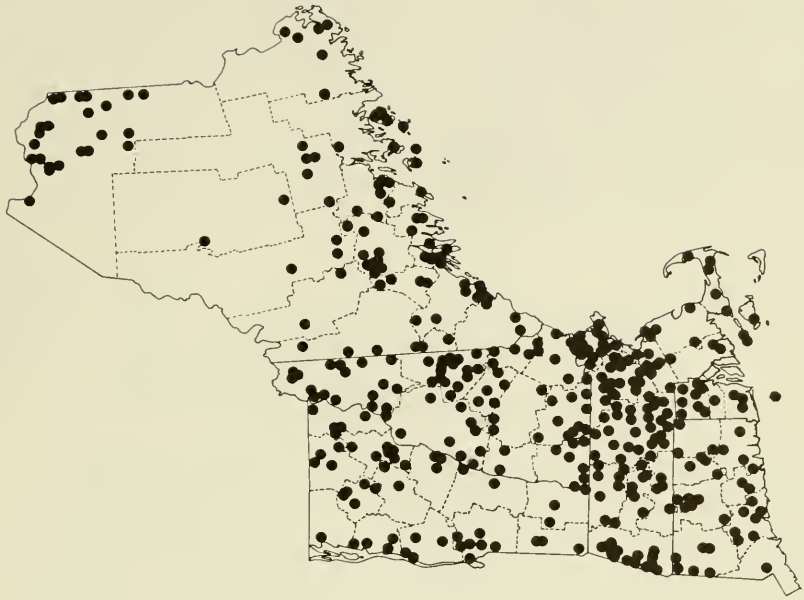
Nuphar rubrodisca: C. flower $\times 1$. D. fruit $\times 1$, redrawn from Fassett.

Nuphar variegata: E. flower $\times 1$. F. fruit $\times 1$. Both redrawn from Fassett.

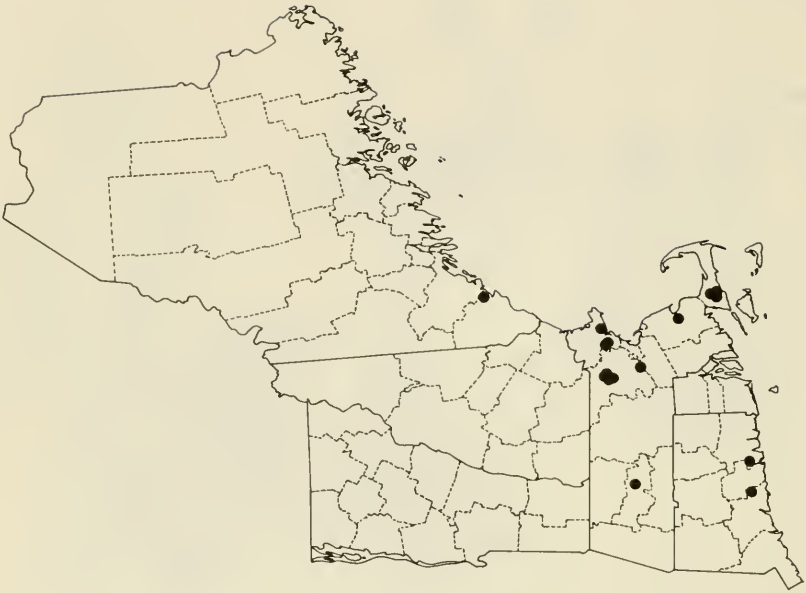
Nuphar advena: G. flower $\times \frac{1}{2}$. H. flower $\times \frac{1}{2}$.



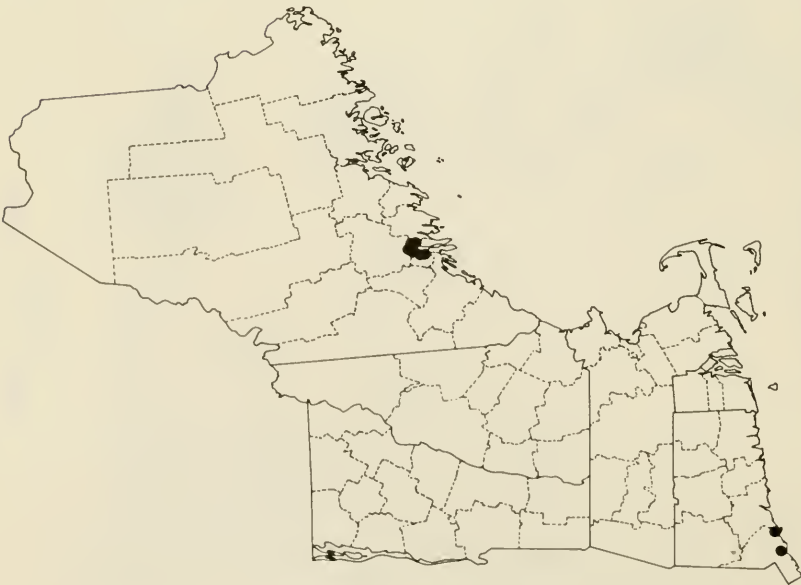
Map 7.
Nuphar x rubrodisea



Map 8.
Nuphar variegata



Map 10.
Nelumbo lutea



Map 9.
Nuphar advena

4. *Nuphar advena* (Ait.) Ait. f. Figs. 5, 7, Map 9

Locally abundant in the intertidal zone of Merrymeeting Bay, Sagadahoc Co., Maine and at a few locations along the coast of Connecticut. Beal (1956) recognized this taxon as *N. lutea* subsp. *macrophylla* (Small) Beal. Range extends from southern coastal Maine and coastal Connecticut west to central New York, Pennsylvania, Ohio, southern Michigan, southern Wisconsin, and southeastern Nebraska, south to Florida, Texas, and eastern Mexico.

NELUMBONACEAE

Nelumbo (Lotus, Water Chinquapin)

Perennial, arising from rhizomes; leaves large, circular, peltate, elevated high above the water (fig. 8) or floating; flowers large, showy; perianth sulfur-yellow, 12-25 cm broad, elevated above the water; stamens numerous, readily deciduous; carpels numerous, separate, imbedded in a broad, flat-topped receptacle; fruits indehiscent nutlets, often remaining in cavities of the woody receptacle.

1. *Nelumbo lutea* (Willd.) Pers. Fig. 8, Map 10

Widely scattered throughout southern New England in shallow ponds and along shores. The localities in New England are probably the result of introductions or escapes from cultivation. A large population occurs at the Great Meadows National Wildlife Refuge, Concord, Massachusetts. Ward (1977) notes that because the name *Nelumbo pentapetala* (Walt.) Fern. is of uncertain application, nomenclatural stability is better served by the use of *Nelumbo lutea* (Willd.) Pers. for the American Lotus. Range extends from southeastern Maine and Massachusetts west to New York, southern Ontario, Minnesota, and Iowa, south to Florida, Oklahoma, and eastern Texas.

CERATOPHYLLACEAE

Ceratophyllum (Coontail, Hornwort)

Perennial, free-floating submersed aquatic, lacking roots; leaves whorled, sessile or with short petioles, dichotomously divided into narrow segments (seedling leaves often opposite, simple); plants monoecious; flowers unisexual, axillary, one to several per node; fruit a 1-seeded, ovoid-oblong achene.

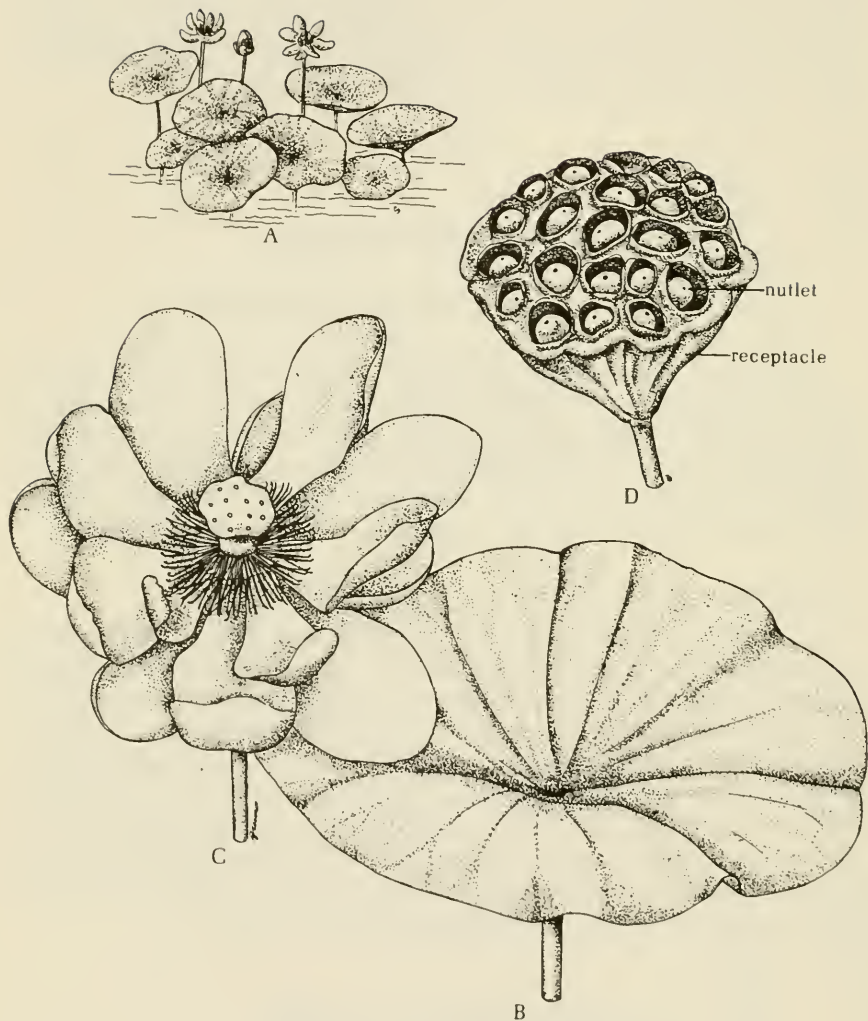


Figure 8.
Nelumbo lutea: A. habit. B. leaf $\times \frac{1}{8}$. C. flower $\times \frac{1}{4}$. D.
 woody receptacle with fruits $\times \frac{1}{4}$.

Key to Species

1. Principal leaves forked no more than two orders (no pair of ultimate segments results from more than two consecutive forkings of the leaf axis) (fig. 9B); leaf segments with distinct serrations (fig. 9B), the marginal teeth with wide bases (fig. 9C); fruit smooth or slightly warty, with two basal spines, marginal spines lacking (fig. 9D); first seedling leaves simple.

..... 1. *C. demersum*

1. Principal leaves often forked 3-4 orders (ultimate segment pairs result from up to 3-4 consecutive forkings of the leaf axis) (fig. 9E,F); leaf segments lacking distinct serrations, marginal teeth, when present, with narrow base (fig. 9F); first seedling leaves at least once divided.

..... 2. *C. echinatum*

1. *Ceratophyllum demersum* L. Fig. 9, Map 11

Common in shallow quiet waters throughout New England. Fruit on this and *C. echinatum* are uncommon, hence the vegetative characters are frequently used for identification. Range extends from Quebec and Maine west to northern British Columbia, south throughout the United States to Mexico.

alkalinity: mean 51.6 mg/l; range 5.5-151.0 mg/l; (64)

pH: mean 7.3; range 5.9-8.9; (62)

May 1st 1985

2. *Ceratophyllum echinatum* A. Gray Fig. 9, Map 12

Locally abundant in quiet waters of southern New England. Although Lowden (1978) regards this taxon as conspecific with the Old World *C. muricatum* Cham., recent studies by Donald Les (pers. comm.) have supported the recognition of the two taxa as distinct species. Range extends from southwestern New Brunswick and central Maine west to New York, Ohio, Michigan, Illinois, and Minnesota, south to Florida, Iowa, Missouri, Arkansas, and Texas.

Rare and endangered plant list: Vermont

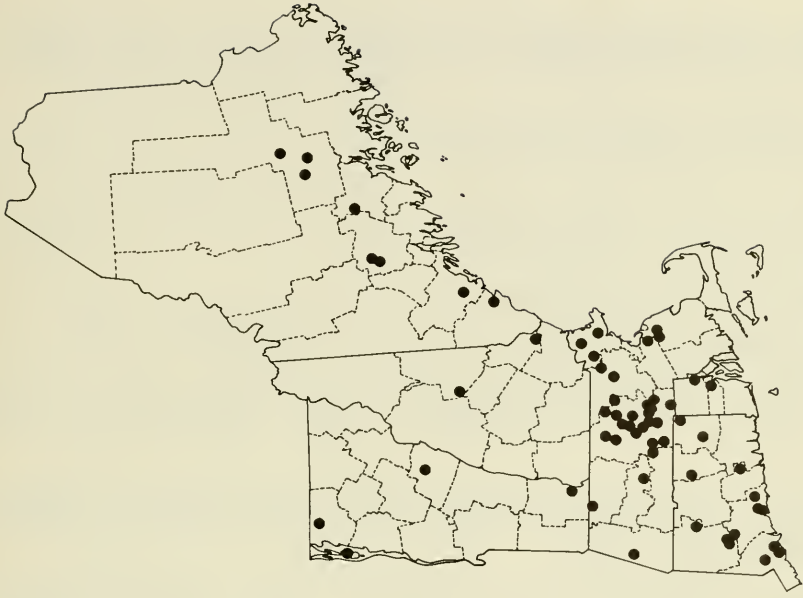
alkalinity: mean 25.1 mg/l; range 6.0-120.0 mg/l; (7)

pH: mean 6.8; range 5.7-7.8; (6)

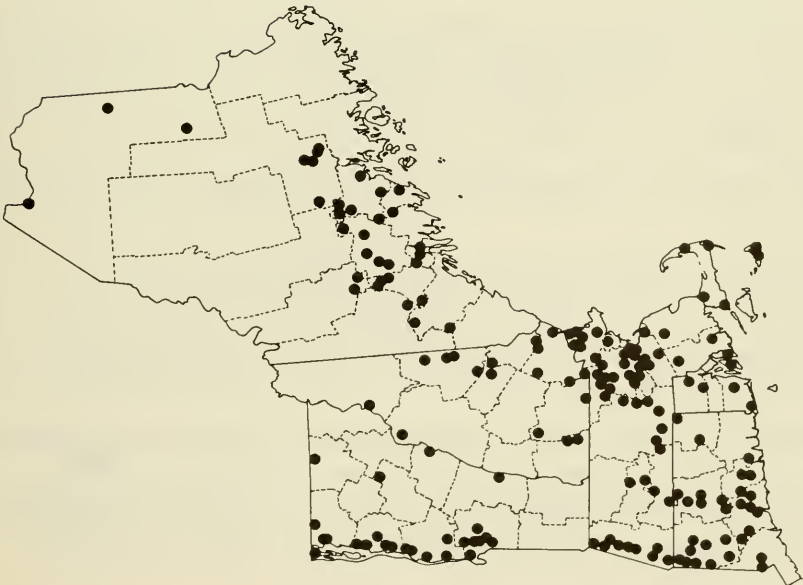


Figure 9.

Ceratophyllum demersum: A. habit $\times \frac{1}{2}$. B. leaves $\times 1\frac{1}{2}$.
 C. leaf segment showing broad-based marginal tooth
 $\times 4\frac{1}{2}$. D. fruit $\times 3$.
Ceratophyllum echinatum: E. leaf $\times 1\frac{1}{2}$. F. spinulose
 leaf segment $\times 4\frac{1}{2}$. G. fruit $\times 3$.



Map 12.
Ceratophyllum echinatum



Map 11.
Ceratophyllum demersum

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ERRATUM — Aquatic Plants of New England:
Part 6. Trapaceae, Haloragaceae, Hippuridaceae

Page 2, lines 2-3 should read:

“adventitious roots opposite, finely dissected”

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