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New Hampshire Agricultural Experiment Station

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ABSTRACT

This paper is the sixth in a series of reports on the aquatic and wetland flora of New England. It treats all species of the Trapaceae, Haloragaceae, and Hippuridaceae 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.

KEY WORDS: Aquatic Plants, New England Flora, Taxonomy, Trapaceae, Haloragaceae, Hippuridaceae, *Trapa, Myriophyllum, Proserpinaca, Hippuris,* Water Chestnut, Water Milfoil, Mermaid Weed, Mare's-tail.

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Aquatic Vascular Plants of New England: Part 6. Trapaceae, Haloragaceae, and Hippuridaceae

by

G. E. Crow and C. B. Hellquist[1]

INTRODUCTION

This is the sixth 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.

Chemical data presented represent samples from many waters throughout New England. The alkalinity readings are total alkalinity, expressed as milligrams per liter (mg/l) $CaCO_3$. The number of observations are included 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. Chloride values are given where data are available and of value.

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 known localities not documented by us will be welcomed. If anyone is interested in specific localities of any of the species indicated on the dot maps, please contact us.

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TRAPACEAE

Trapa (Water Chestnut)

Floating annual, with slender roots; submersed leaves opposite, finely dissected; floating leaves alternate, blades rhombic, petioles inflated; flowers white, axillary among floating leaves; fruit a large "woody" nut or caltrop with four sharp barbed spines.

1. *Trapa natans* L. Fig. 1, Map 1

Locally abundant, sometimes forming large floating mats, in southern Lake Champlain, Vermont, and in the Sudbury and Concord Rivers, and the Great Meadows National Wildlife Refuge, Concord, Massachusetts. A native of Eurasia, this species has become a noxious weed in the waters where it has become established. This taxon was first introduced into North America about 1874 and was cultivated in Asa Gray's botanical garden at Harvard University in 1877. By 1879 it had escaped to nearby Fresh Pond, Cambridge, Massachusetts (Countryman, 1977). Range extends from Massachusetts to western Vermont, eastern New York, Maryland, and Virginia.

alkalinity: mean 37.7 mg/l; range 12.0-127.5 mg/l; (5)
pH: mean 7.1; range 6.7-8.2; (5)

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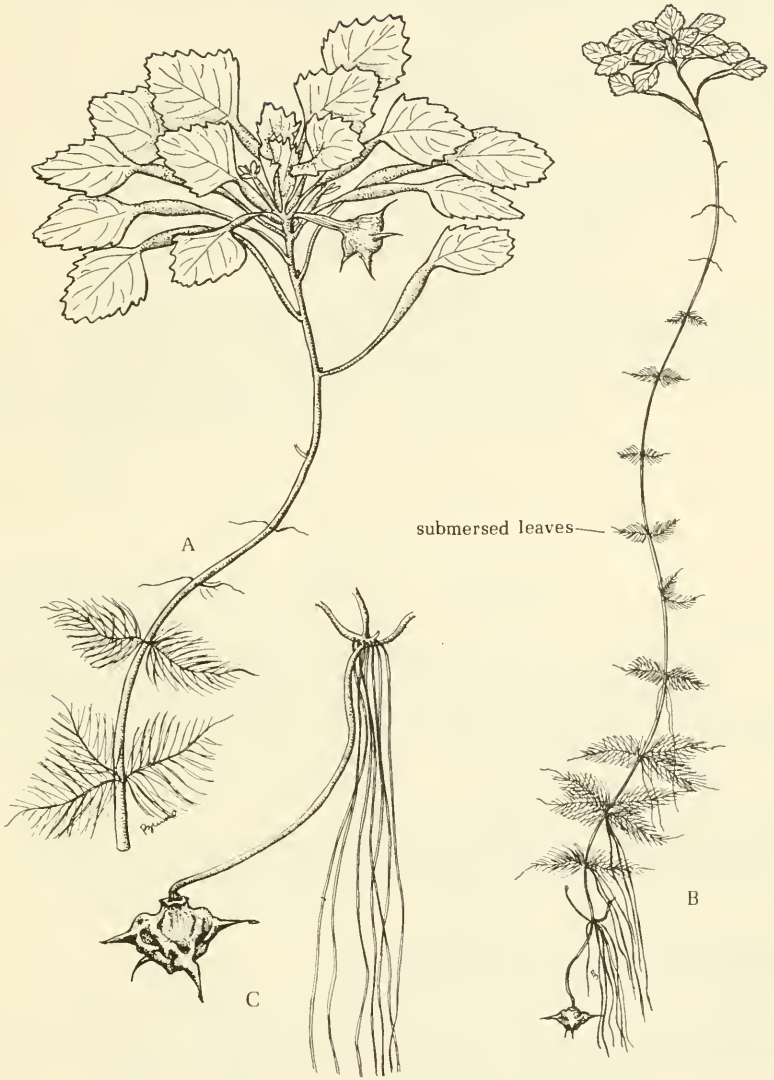
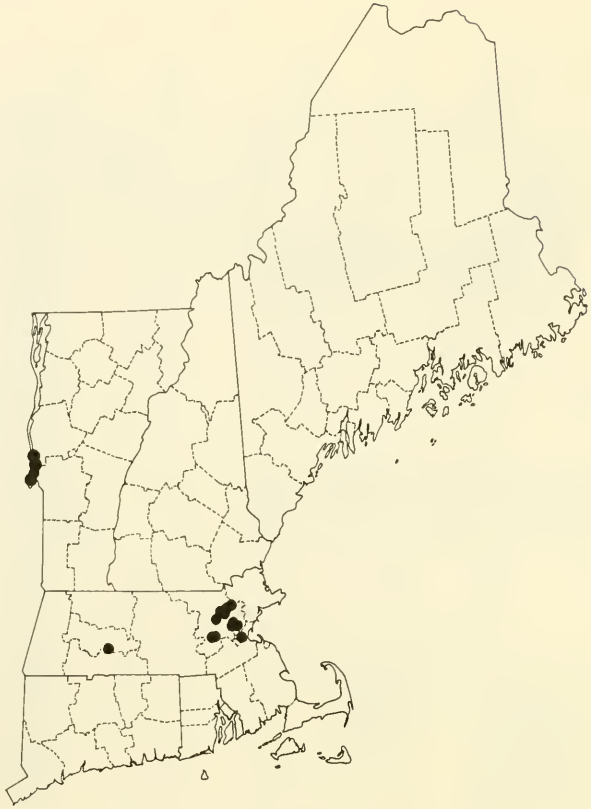
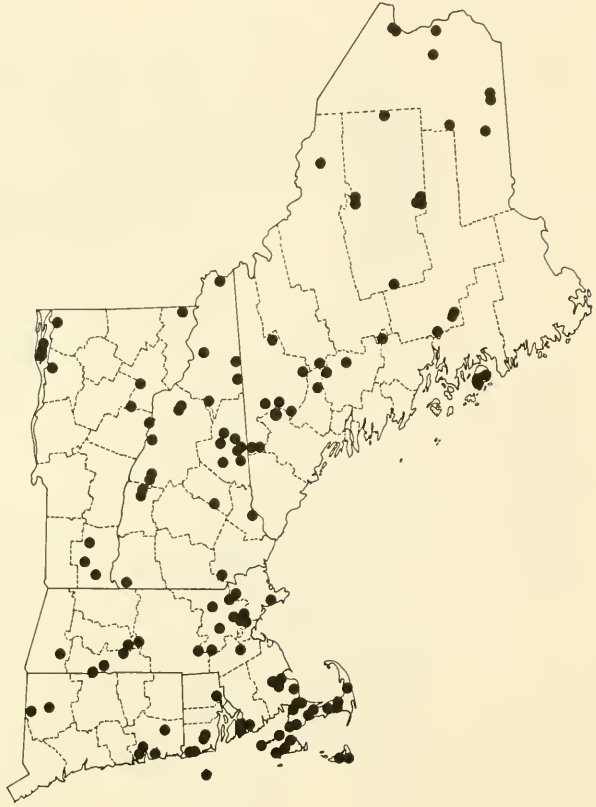


Figure 1.
Trapa natans: **A. habit of upper portion of plant with floating leaves, × ¼. B. habit, × ⅛. C. basal portion with caltrop (nut) attached, × ½.**



Map 1.
Trapa natans



Map 2.
Myriophyllum tenellum

HALORAGACEAE

1. Flower parts in 4's; fruit a schizocarp, splitting into four 1-seeded nutlets (figs. 2-6); emersed leaves reduced, bracteate, less than 1 cm. long.
   ..... 1. *Myriophyllum*
1. Flower parts in 3's; fruit indehiscent, 3-angled (fig. 7); emersed leaves foliaceous, several cm long (fig. 7).
   ..... 2. *Proserpinaca*

Myriophyllum (Water Milfoil)

Submersed or amphibious perennials (overwintering chiefly by turions); leaves cauline, whorled or alternate, usually finely dissected; flowers sessile, single in axils of leaves or bracts; fruit a schizocarp, splitting into 1-seeded nutlets.

Key to Species

1. Leaves scale-like, roundish (fig. 2D) or absent.
   ..... 1. *M. tenellum*
1. Leaves pinnately divided, segments filiform (figs. 3-6).
   2. Flowers and fruits in axils of submersed leaves (fig. 3).
      3. Fruits smooth, rounded on back or minutely papillate (fig. 3B,D), 0.7-1.2 mm long; plants submerged or amphibious; winter buds (turions) absent.
         ..... 2. *M. humile*
      3. Fruits rough with prominent dorsal tuberculate ridges (fig. 3F), 2.0-2.5 mm long; plants always submerged; winter buds (turions) formed in fall.
         ..... 3. *M. farwellii*
   2. Flowers and fruits in axils of emersed bracteate leaves, forming an erect spike (figs. 4C,5A,5G).
      4. Uppermost flowers alternate; leaves alternate or whorled.
         5. Submersed leaves whorled; bracts entire or serrate, no more than twice the length of the flowers.
            ..... 4. *M. alterniflorum*
         5. Submersed leaves alternate; bracts pinnately divided, usually more than twice the length of the flowers.
            ..... 5. *M. pinnatum*
      4. Uppermost flowers opposite; leaves whorled, or pseudo-whorled.
         6. Bracts usually more than twice as long as pistillate flowers.

7. Bracts pectinate to pinnatifid (fig. 5I); winter buds well-formed, clavate, abscissing by early winter and readily dispersed (fig. 5G).
..... 6. *M. verticillatum*

7. Bracts of upper portion of inflorescence serrate (fig. 5C), somewhat pectinate at waterline (fig. 5D); winter buds developed at the base of the stems or on rhizomes, usually remaining attached.
..... 7. *M. heterophyllum*

6. Bracts usually less than twice as long as pistillate flowers.

8. Leaves feather-like; middle leaves with 12 or more segments on each side of rachis (fig. 6B); ends of uppermost leaves flat-topped (fig. 6B); stem diameter below inflorescence thick, up to twice diameter of lower stem; turions not formed.
..... 8. *M. spicatum*

8. Leaves not feather-like, often tangled in drying; middle leaves with 11 or fewer segments on each side of rachis (fig. 6F); ends of uppermost leaves rounded (fig. 6F); stem diameter below inflorescence same diameter as lower stem; turions formed in fall.
..... 9. *M. exalbescens*

1. *Myriophyllum tenellum* Bigelow Fig. 2, Map 2

Common in shallow sandy or muddy margins of ponds and lakes of low alkalinity. This species occurs chiefly in the sterile submersed form, flowering infrequently. Apparently tolerant of some salinity, it has been observed in a coastal pond on Cape Cod, Massachusetts in water with a chloride content of 1201.2 mg/l. The type locality is Fresh Pond, Cambridge, Massachusetts. Range extends from Newfoundland west to Ontario, Michigan, and Minnesota, south to Nova Scotia, New England, Long Island, New York, and eastern Pennsylvania.

alkalinity: mean 7.2 mg/l; range 3.0-19.5 mg/l; (6)
pH: mean 6.6; range 5.9-7.2; (6)

2. *Myriophyllum humile* (Raf.) Morong Fig. 3, Map 3

Common, submersed or amphibious, in shallow acid waters of eastern and southern New England. Extremely variable, three ecological variants have been given nomenclatural recognition at the *forma* rank. Range extends from Nova Scotia west, sparingly, to Minnesota, south to New England, eastern New York, eastern Pennsylvania, and eastern Maryland.

Rare and endangered plant list: Vermont

alkalinity: mean 7.0 mg/l; range 2.5-13.0 mg/l; (19)
pH: mean 6.3; range 5.8-7.0; (19)

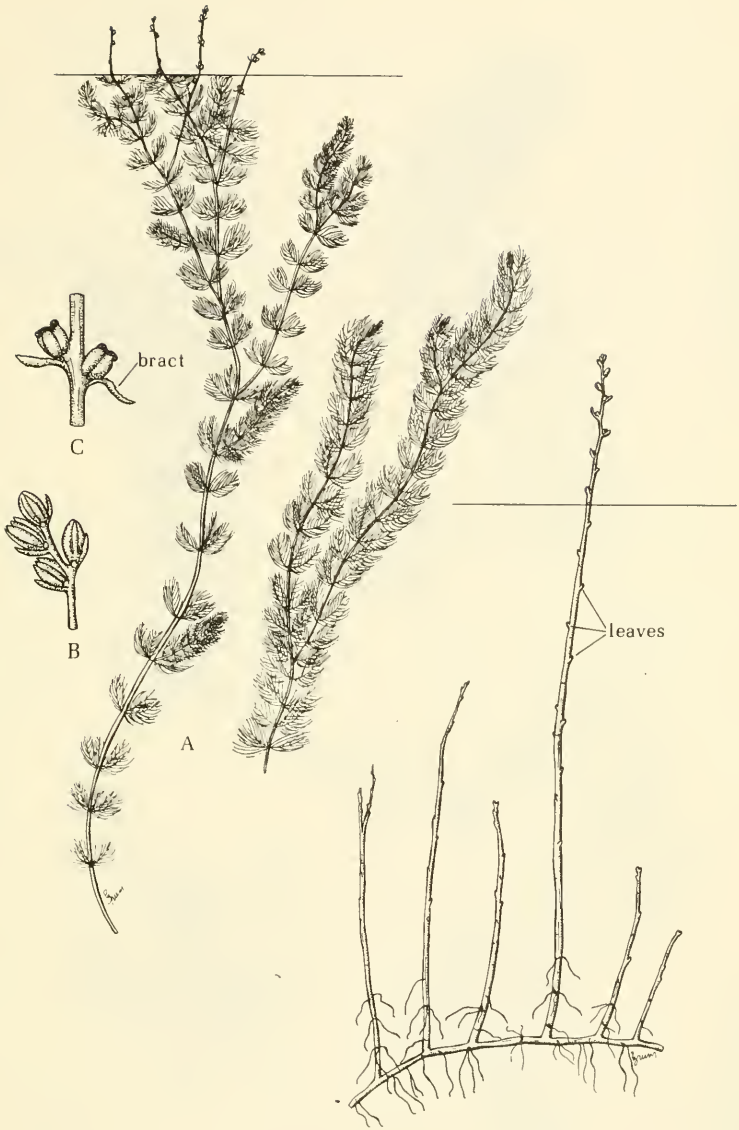


Figure 2.
Myriophyllum alterniflorum: **A. habit, × ½. B. inflorescence, × 5. C. fruit, × 5.**
Myriophyllum tenellum: **D. habit, × ½.**

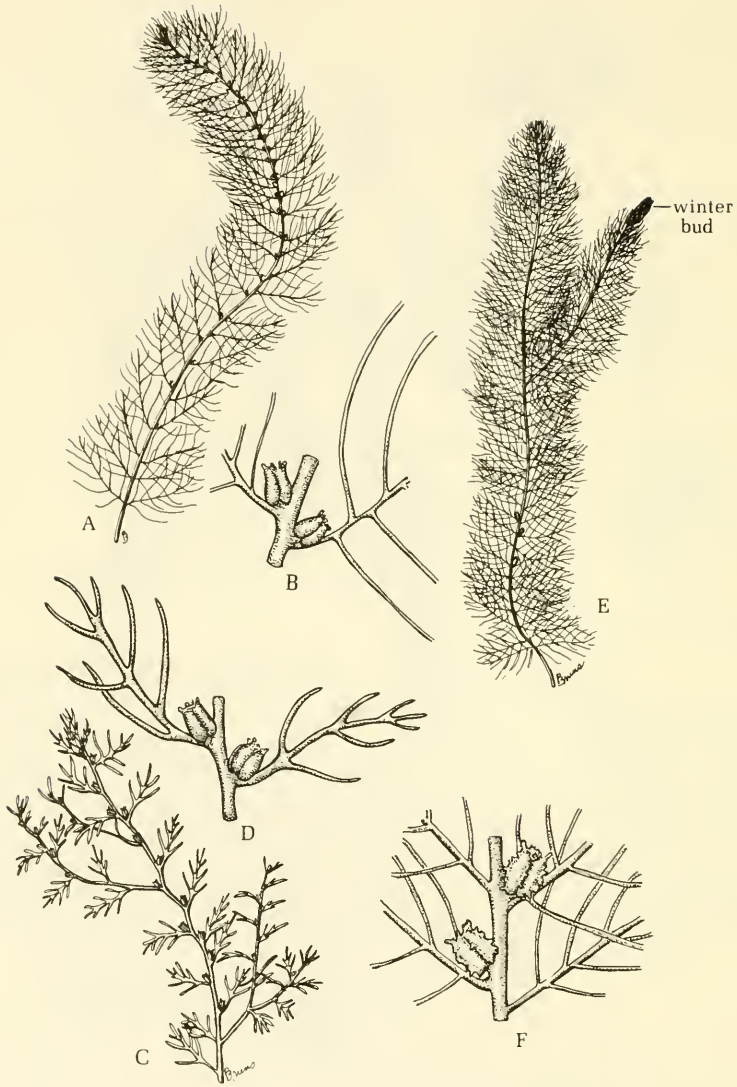
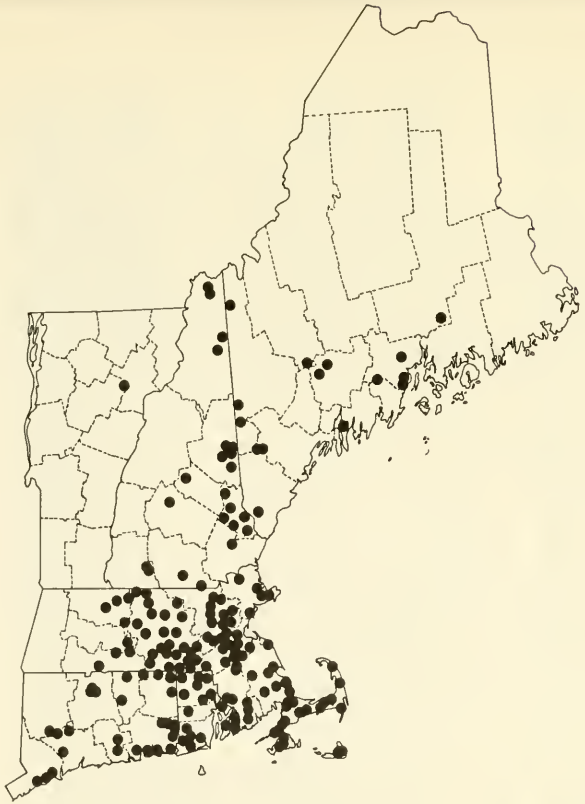
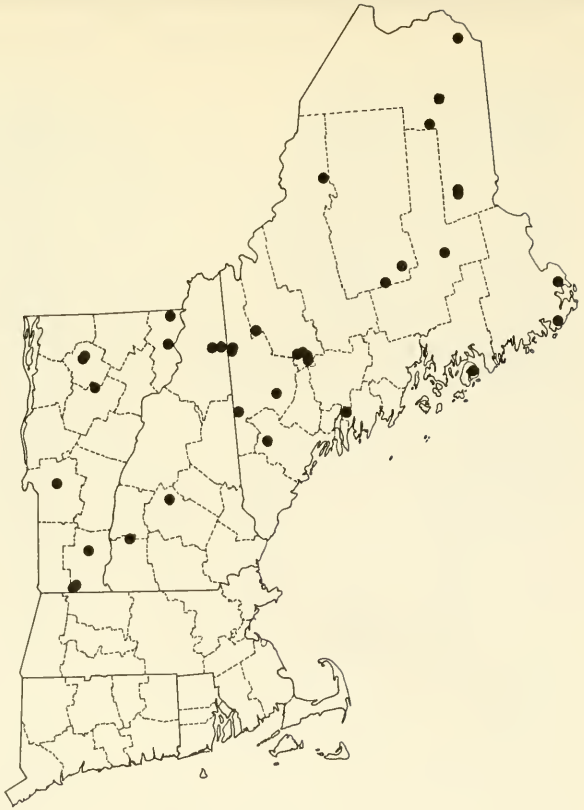


Figure 3.
Myriophyllum humile: **A. habit of submersed plant, × ½. B. fruits on submersed plant, × 5. C. habit of terrestrial growth form, × 1. D. fruits on terrestrial plant, × 5.** ***Myriophyllum farwellii:*** **E. habit of submersed plant, × ½. F. fruits, × 3.**



Map 3.
Myriophyllum humile



Map 4.
Myriophyllum farwellii

3. *Myriophyllum farwellii* Morong Fig. 3, Map 4

Uncommon in acid ponds and streams of northern New England. Sterile plants of *M. farwellii* can be easily confused with *M. humile* and *M. alterniflorum*. Positive identification requires fruit or presence of turions. The black-spiculate vegetative character used by Fernald (1950) to distinguish *M. farwellii* is sometimes observed in *M. humile*. In New England *M. farwellii* is restricted to northern states, while *M. humile* is chiefly distributed in southern New England. Range extends from Newfoundland and Nova Scotia west to northern Michigan and central Minnesota, south to Maine, New Hampshire, Vermont, and central New York; British Columbia.
Rare and endangered plant list: New Hampshire
alkalinity: mean 7.2; range 3.0-9.5 mg/l; (3)
pH: mean 6.6; range 6.1-7.1; (3)

4. *Myriophyllum alterniflorum* DC. Fig. 2, Map 5

Widely scattered in lakes and rivers of northern New England; uncommon to rare in southern New England. The leaf width varies considerably. Plants with short compact leaves have been separated as *M. alterniflorum* var. *americanum* Pugsley, but Aiken (1981) notes that this condition appears to develop in low nutrient environments and nomenclatural recognition is unwarranted. Range extends from Newfoundland to Alaska, south to Nova Scotia, New England, northern New York, northern Michigan, and northern Minnesota.
Rare and endangered plant lists: New Hampshire, Massachusetts, Connecticut
alkalinity: mean 21.9 mg/l; range 5.0-78.0 mg/l; (17)
pH: mean 7.2; range 6.5-8.0; (17)

5. *Myriophyllum pinnatum* (Walt.) BSP. Fig. 4, Map 6

Rare, on peaty and muddy shores of southeastern Massachusetts and Rhode Island. Last collected in 1951 in Falmouth, Massachusetts. This species is found close to the ocean with the exception of the Worcester County, Massachusetts population. Range extends from southern New England west to West Virginia, Kentucky, Illinois and Iowa, south to Florida, southwestern Oklahoma, and Texas.
Rare and endangered plant list: Massachusetts, New England

6. *Myriophyllum verticillatum* L. Fig. 5, Map 7

Uncommon, in quiet waters of lakes and streams throughout New England. This species was last collected in Connecticut in 1920 and in Massachusetts in 1943. It appears that it cannot compete with more vigorous species of *Myriophyllum,* but may also be sensitive to pollution. The best field characters for identification include bracts

that are always divided, or the production of the club-shaped winter buds which are formed along the stem during the late summer. Variety *pectinatum* Wallr. has long been applied to the New England plants, but Aiken (1979, 1981) documents great plasticity in this species and does not recognize this or any of the other varieties described for this species in North America. Range extends from Newfoundland west to Alaska, south to Nova Scotia, Connecticut, Delaware, Maryland, the Great Lakes States, northeastern Texas, Utah, and California.

alkalinity: mean 18.0 mg/l; range 5.0-39.0 mg/l; (11)
pH: mean 6.9; range 6.5-7.8; (11)

7. *Myriophylum heterophyllum* Michx. Fig. 5, Map 8

Locally abundant and aggressive in ponds, lakes, and streams in New England. Populations of this taxon have recently become established in northern New England in the Sebago Lake region of Maine region and Lake Winnipesaukee, New Hampshire. The greatest concentrations of this plant are in southern Worcester County, Massachusetts where it is well established in most waters. The populations are so dense that boating, fishing, and swimming are hindered in these waters. To the west of New England this species is typically found in alkaline waters while in New England it has been restricted to waters of low alkalinity. A small terrestrial form is often formed when stranded on shore as the water level drops. Care must be taken to avoid confusion of this form with *M. pinnatum* or terrestrial growth forms of *M. spicatum or M. verticillatum.* Range extends from southwestern Quebec, southern Maine, and central New Hampshire west to Ontario, Michigan, and South Dakota, south to Florida, Oklahoma, Texas, and New Mexico.

alkalinity: mean 12.5 mg/l; range 3.0-33.0 mg/l; (29)
pH: mean 6.5; range 6.2-8.9; (25)

8. *Myriophyllum spicatum* L. Fig. 6, Map 9

Locally abundant and aggressive in alkaline waters of western Vermont and Massachusetts, widely scattered elsewhere. This Eurasian species has long been aggressive south of New England. The earliest record in New England dates to 1965 in Lake Champlain and has become a problem in the Lake Champlain Valley of Vermont and the Housatonic River Valley of Massachusetts. Weed irradication programs have been instituted by many towns to rid lakes of this weed. Three eastern New England localities have recently been discovered: East Thompson, Connecticut, Framingham and Canton, Massachusetts. These localities of low alkalinity are noteworthy as they may indicate future problems with this species in the acidic eastern waters. Range extends from Quebec and New England west

to Ontario, Michigan, Wisconsin, and British Columbia, south to Florida, Oklahoma, Texas, Washington, and California; Mexico.

alkalinity: mean 60.0 mg/l; range 12.0-102.5 mg/l; (16)
pH: mean 7.8; range 6.7-10.2; (16)

9. *Myriophyllum exalbescens* Fern. Fig. 6, Map 10

Scattered in alkaline regions of New England with the largest populations in Aroostook County, Maine, western Vermont, and western Massachusetts. This taxon has long been included as a variety under *Myriophyllum spicatum* L. in the United States. While both species occur in New England, the native *M. exalbescens* appears to be on the decline in areas where non-native *M. spicatum* occurs. Aiken *et al.* (1979) indicate a good character to distinguish the two species is that the vegetative stem apices of *M. spicatum* appear tassel-like and are usually red, while those of *M. exalbescens* are knob-shaped and generally lack the reddish color, except during the time of winter bud formation. Range extends from Newfoundland and southeastern Labrador west to Alaska, south to Nova Scotia, New England, West Virginia, Michigan, and northwestern Kansas. Plants collected south of the 0°C isotherm are likely to be *M. spicatum* (Aiken, 1981), thus records from Texas, New Mexico, Arizona, and southern California need reexamination.

alkalinity: mean 57.4 mg/l; range 13.5-123.5 mg/l; (19)
pH: mean 7.8; range 6.8-9.8; (18)

Proserpinaca (Mermaid Weed)

Submersed in shallow waters or emergent along shores of ponds, lakes, and streams; growing from slender creeping roots; leaves alternate, pinnatifid to serrate; flowers sessile in leaf axils, solitary or 2-5; fruit 3-angled, 3-seeded, nut-like.

Key to Species

1. Leaves of emersed plants serrate or serrate to deeply pinnatifid to pectinate (fig. 7A,B); submersed leaves divided. (fig. 7A).
   ..... 1. *P. palustris*
1. Leaves of emersed plants all pectinate (to divided), never serrate (fig. 7D); submersed leaves divided (fig. 7E).
   ..... 2. *P. pectinata*

Figure 4.
Myriophyllum pinnatum: **A. habit of terrestrial form, × ½. B. fruit on terrestrial form, × 2. C. habit of submersed form with emergent inflorescence, × ½. D. fruits on submersed form, × 2.**

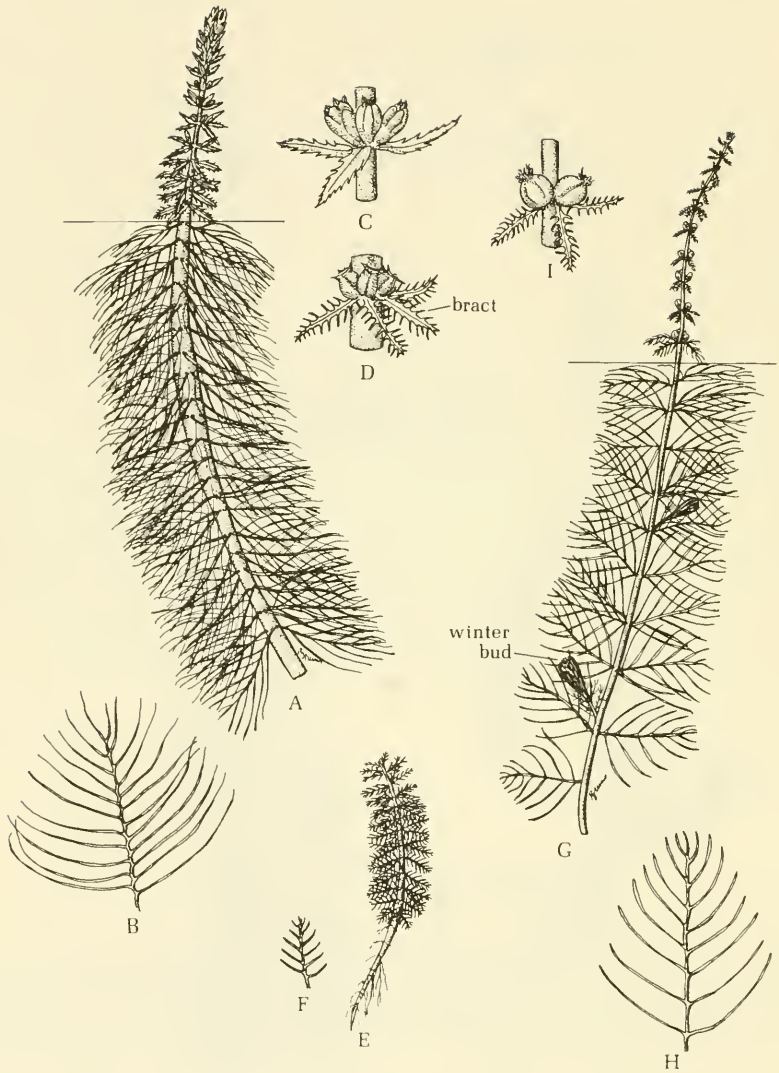


Figure 5.
Myriophyllum heterophyllum: **A. habit of submersed form with emergent inflorescence × ½. B. submersed leaf, × 1. C. flowers, × 1½. D. fruits, × 1½. E. habit of terrestrial form, × ½. F. leaf of terrestrial form, × 1.**
Myriophyllum verticillatum: **G. habit of submersed plant with emergent inflorescence, × ½. H. submersed leaf, × 1. I. fruits, × 1½.**

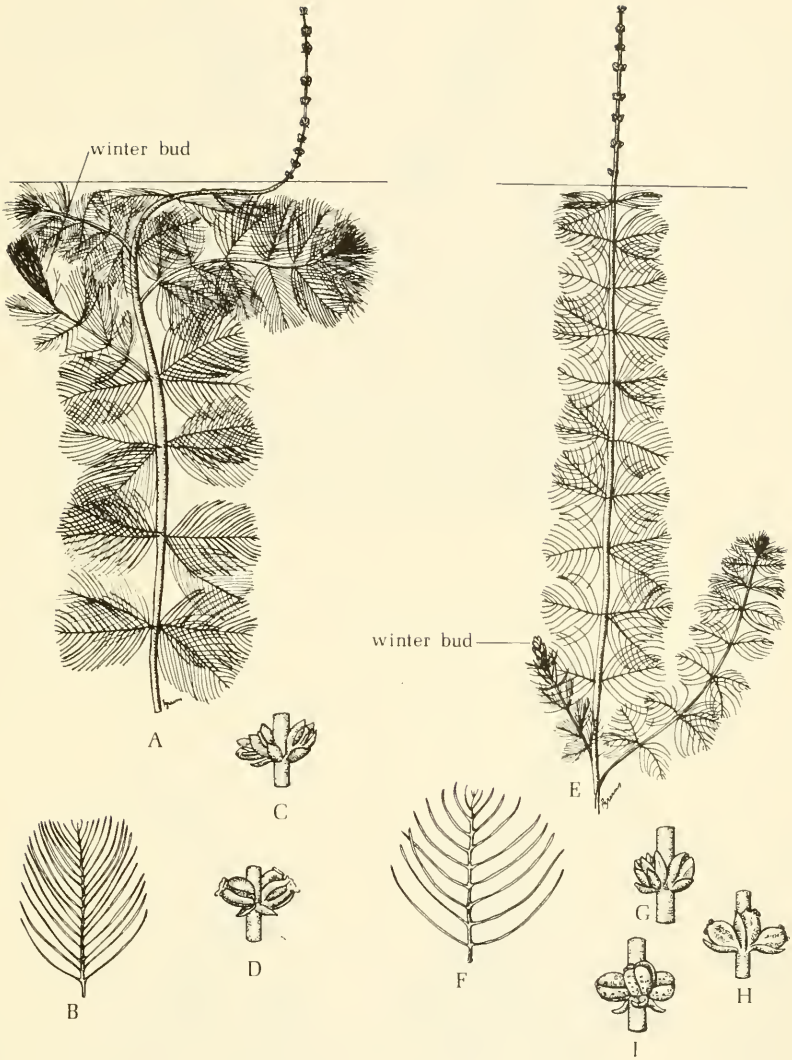
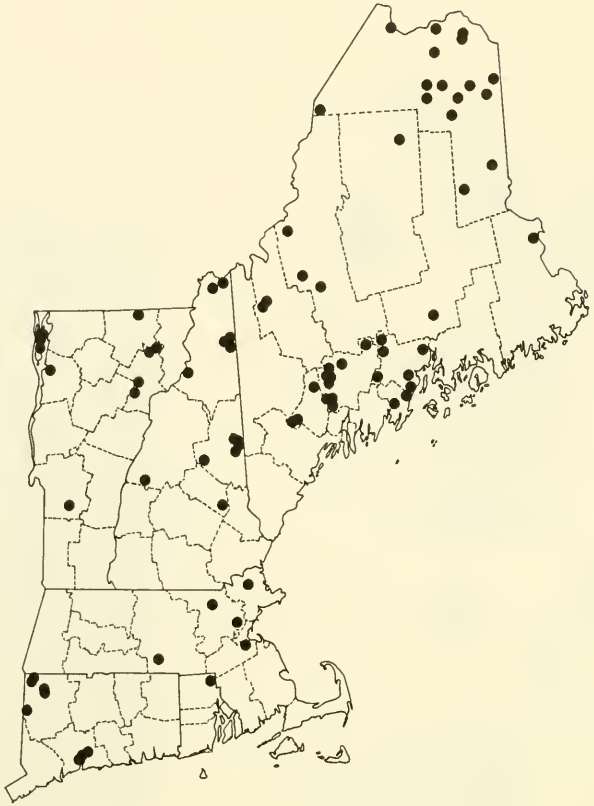
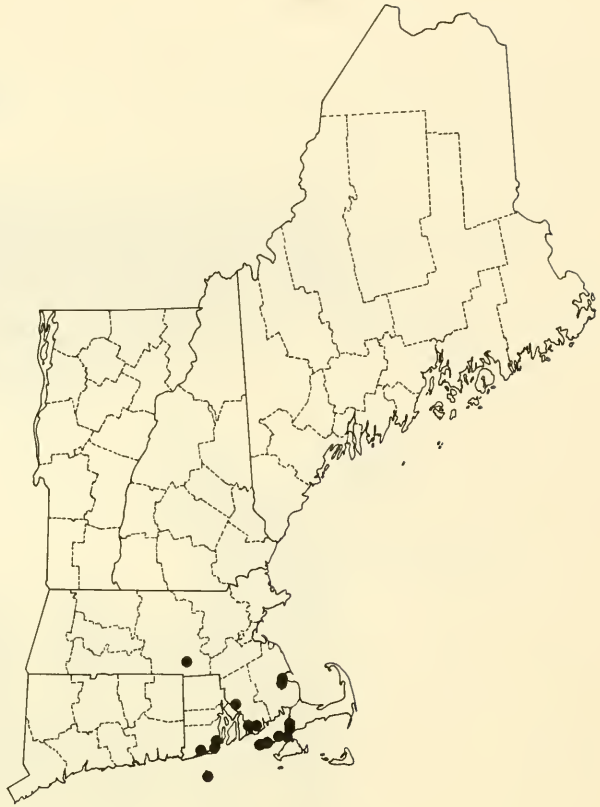


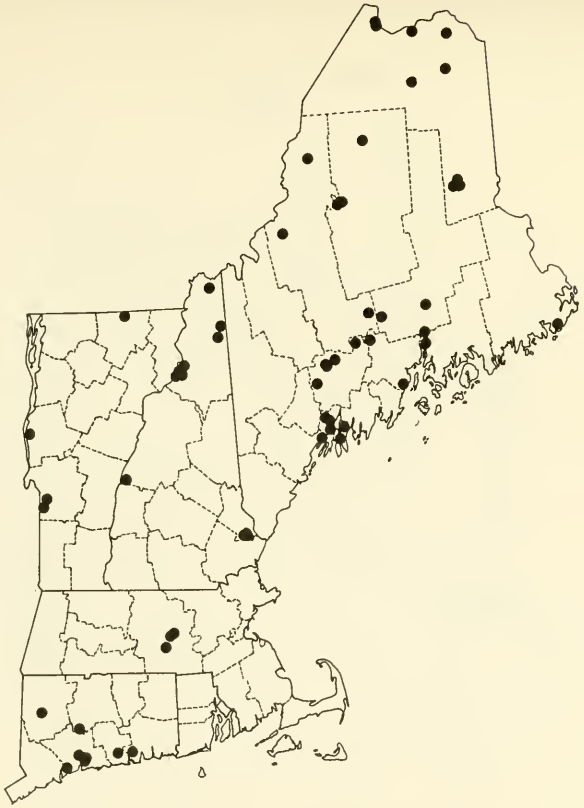
Figure 6.
Myriophyllum spicatum: **A. habit of submersed form with emergent inflorescence, × ½. B. leaf, × 1. C. flowers, × 2. D. fruits, × 2.**
Myriophyllum exalbescens: **E. habit of submersed form with emergent inflorescence, × ½. F. leaf, × 1. G. flowers, × 2. H. immature fruit, × 2. I. mature fruit, × 2.**



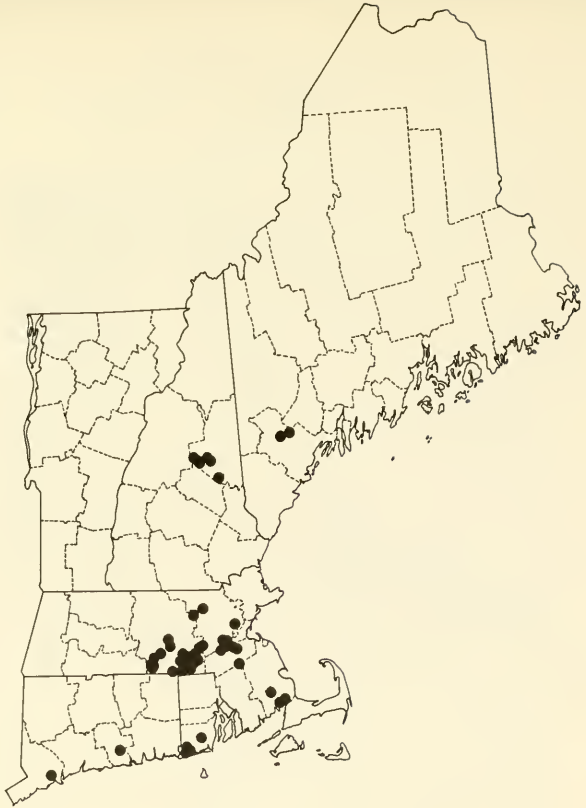
Map 5.
Myriophyllum alterniflorum



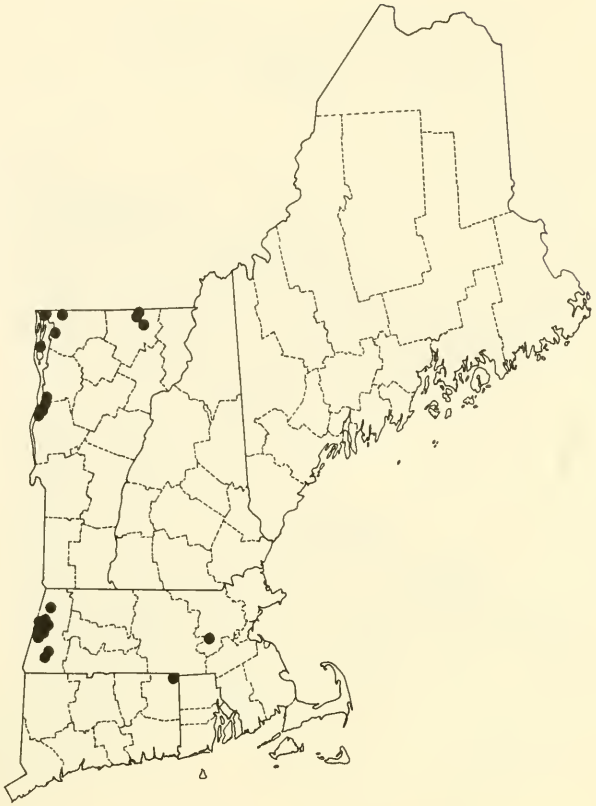
Map 6.
Myriophyllum pinnatum



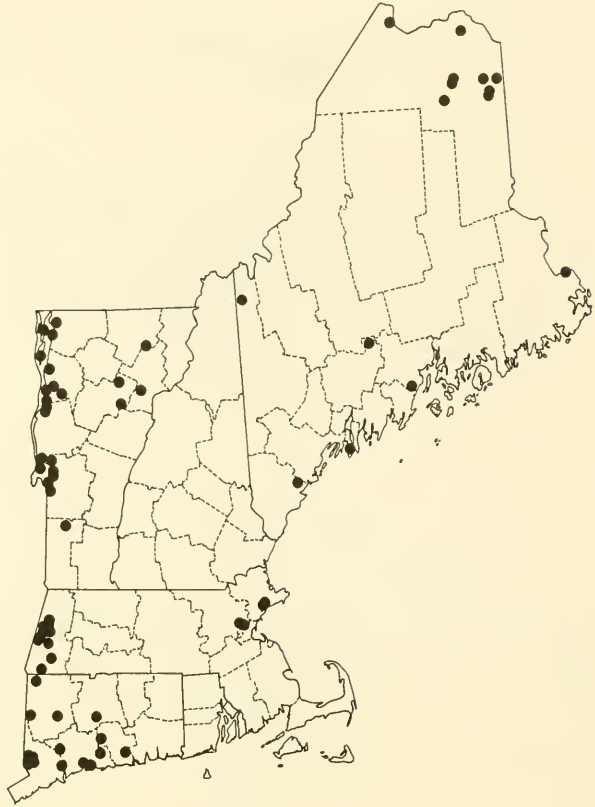
Map 7.
Myriophyllum verticillatum



Map 8.
Myriophyllum heterophyllum



Map 9.
Myriophyllum spicatum



Map 10.
Myriophyllum exalbescens

1. *Proserpinaca palustris* L. Fig. 7, Map 11

Common in the more acid waters of northern New England and throughout southern New England. This heterophyllous, amphibious species exhibits considerable variability in vegetative morphology. Submersed leaves are divided and tend to grade toward pectinate to pinnatifid to serrate as the water level drops. Serrate leaves (adult) are typically associated with flowering and fruiting. However, photoperiod appears to influence leaf morphology in emersed plants and a reversion to the juvenile leaf form (pectinate) is related to short-day photoperiodicity and suggests that plants which have been referred to *P. intermedia* fall within the range of variability of this species (Davis, 1967).Therefore, we are treating *P. intermedia* Mackenz. as a synonym under *P. palustris*. Fruit variability likewise lacks discontinuity. Thus, varieties are not recognized in this treatment. Range extends from Nova Scotia west to Minnesota, south to Florida, Louisiana, eastern Oklahoma, and eastern Texas.

alkalinity: mean 13.0 mg/l; range 2.5-100.0 mg/l; (14)
pH: mean 6.5; range 5.4-7.3; (12)

2. *Proserpinaca pectinata* Lam. Fig. 7, Map 12

Uncommon in sandy acid ponds of eastern New England. The leaves all remain finely dissected whether the plants are submersed or emersed. Range extends from Nova Scotia south mainly along the Coastal Plain to Florida, west to southeastern Texas.
Rare and endangered plant list: New Hampshire

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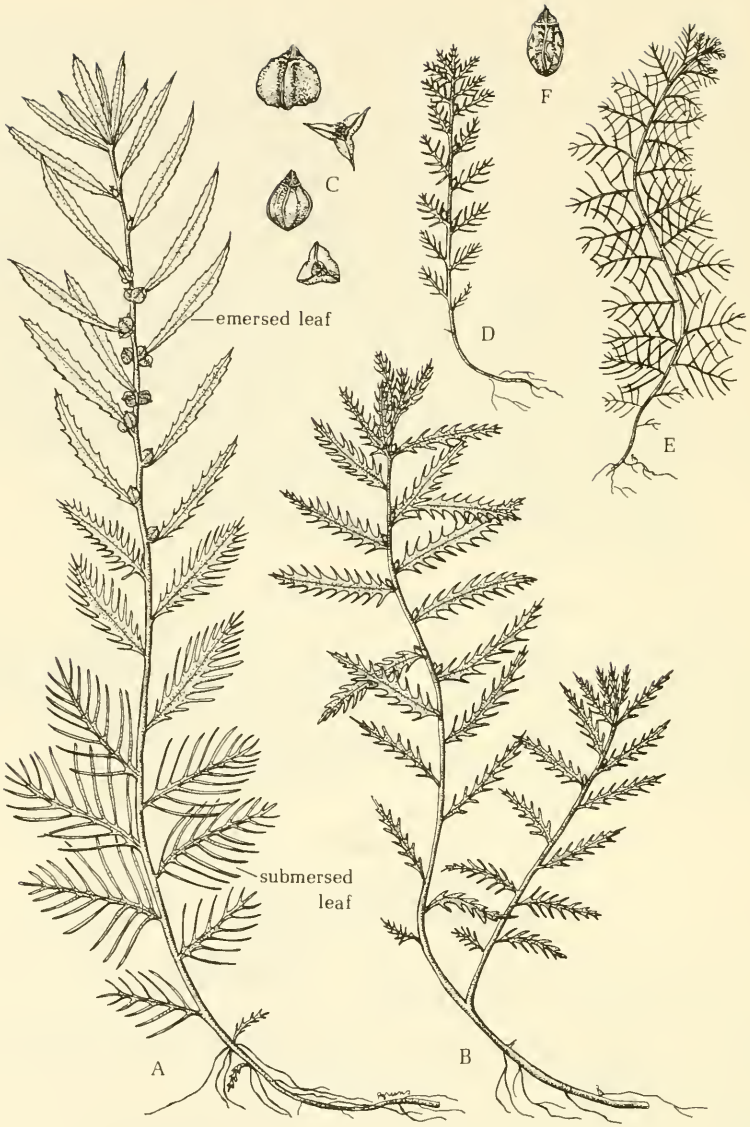
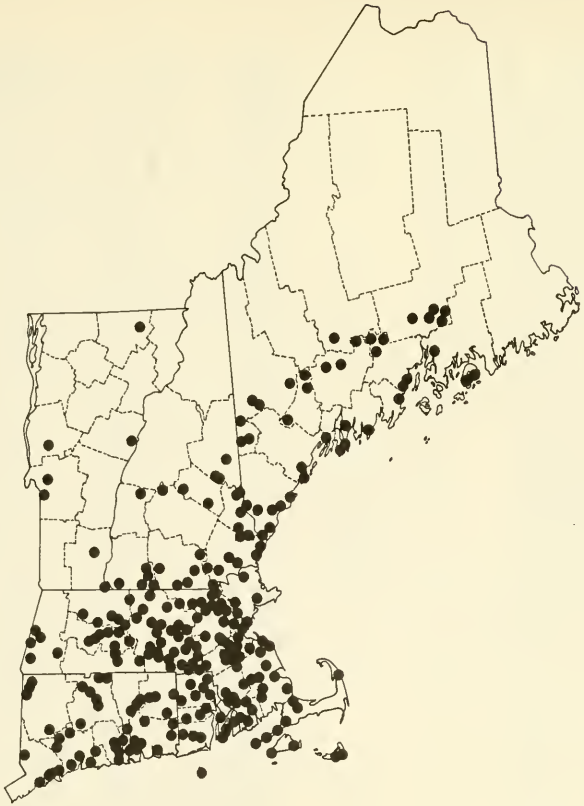
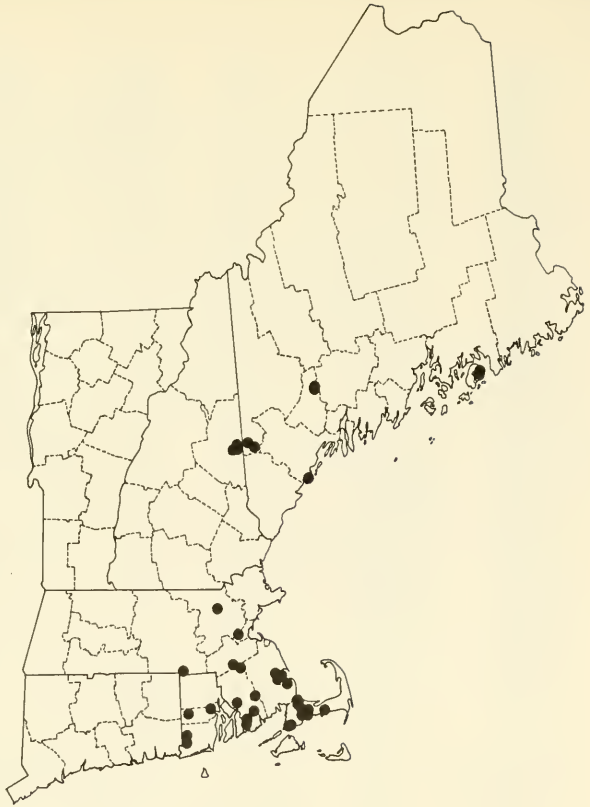


Figure 7.
Proserpinaca palustris: **A. habit of plant, upper portion with terrestrial growth form, × ½. B. habit of terrestrial form with pinnatifid leaves, × ½. C. side and top views of fruits, × 2.**
Proserpinaca pectinata: **D. habit of terrestrial growth form, × ½. E. habit of submersed plant, × ½. F. fruit, × 2.**



Map 11.
Proserpinaca palustris



Map 12.
Proserpinaca pectinata

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HIPPURIDACEAE

Hippuris (Mare's-tail)

Emersed or submersed perennial; growing from rhizomes; leaves whorled, entire, linear-attenuate; flowers sessile, perfect or polygamous, axillary in middle and upper leaves; fruit a small, ovoid nut.

1. *Hippuris vulgaris* L. Fig. 7, Map 13

Locally abundant along damp shores or in shallow waters of northern Maine, uncommon in New Hampshire and Vermont. Range extends from Greenland west to Alaska south to Newfoundland, Nova Scotia, northern New England, central New York, Indiana, northern Illinois, Minnesota, Nebraska, and New Mexico.

Rare and endangered plant list: Vermont

alkalinity: mean 24.6 mg/l; range 12.0-49.5 mg/l; (6)

pH: mean 7.0; range 6.5-7.3; (6)

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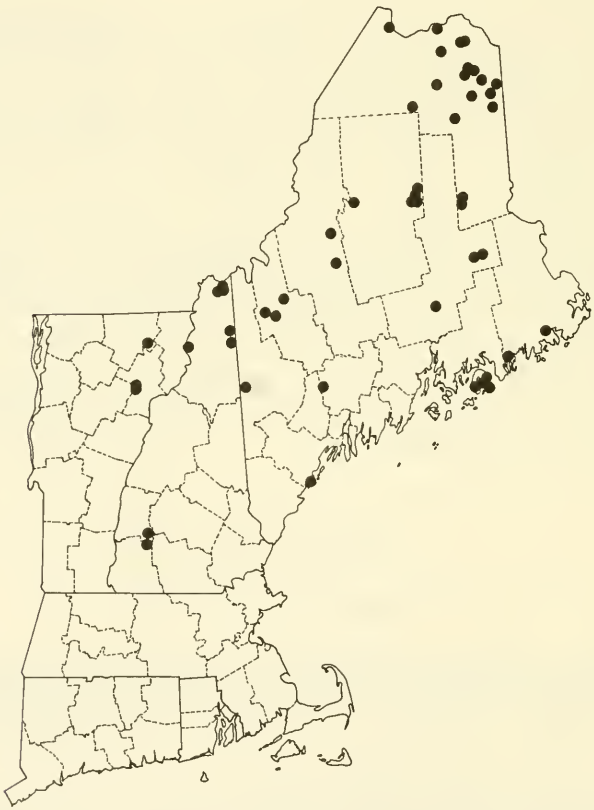

Map 13.
Hippuris vulgaris

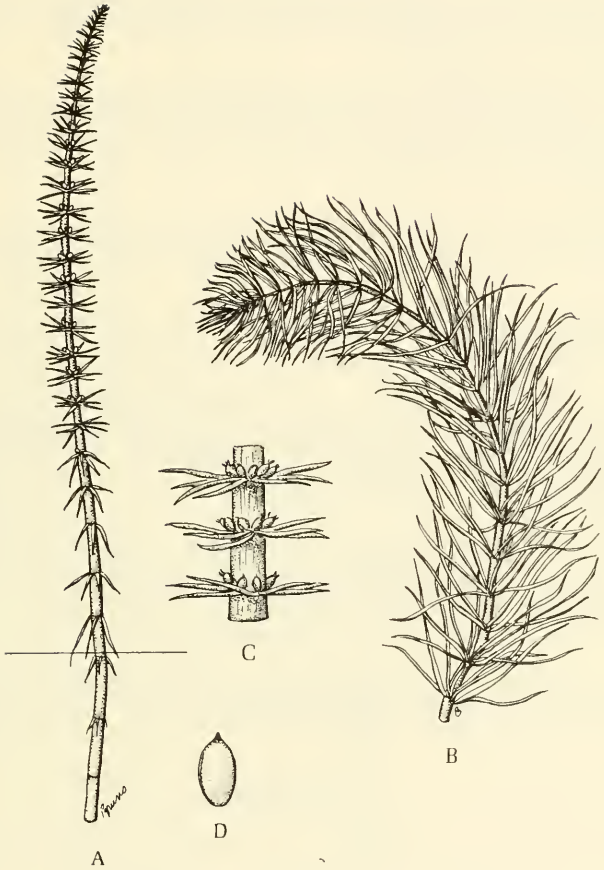

Figure 8.
Hippuris vulgaris: **A. habit of emergent portion of plant, × ½. B. submersed plant, × ½. C. section of aerial stem with fruits, × 1½. D. fruit, × 5.**

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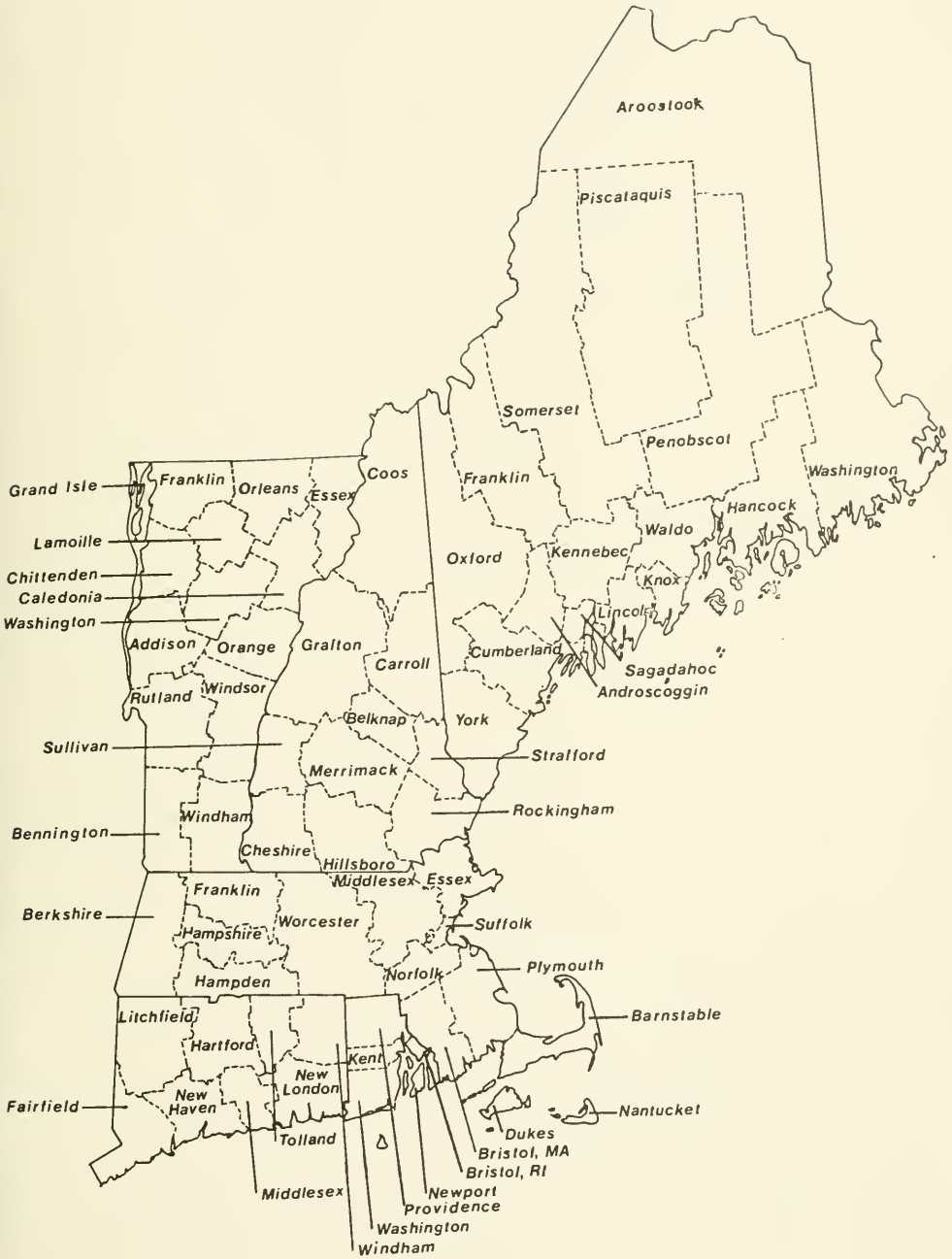
Aroostook
Piscataquis
Somerset
Penobscot
Washington
Hancock
Waldo
Kennebec
Knox
Lincoln
Sagadahoc
Androscoggin
Cumberland
York
Oxford
Franklin
Coos
Grand Isle
Franklin
Orleans
Essex
Lamoille
Chittenden
Caledonia
Washington
Addison
Orange
Grafton
Carroll
Rutland
Windsor
Belknap
Sullivan
Merrimack
Strafford
Rockingham
Windham
Bennington
Cheshire
Hillsboro
Middlesex
Essex
Franklin
Berkshire
Worcester
Hampshire
Suffolk
Hampden
Norfolk
Plymouth
Barnstable
Litchfield
Hartford
Kent
New London
New Haven
Fairfield
Tolland
Middlesex
Newport
Providence
Washington
Windham
Dukes
Bristol, MA
Bristol, RI
Nantucket