

Exhibit 3

The History, Spread And Present Distribution Of Some Immigrant Aquatic Weeds In New England

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INTRODUCTION

Many of the most aggressive and undesirable species of aquatic weeds in the United States are not indigenous to North America. *Eichornia crassipes* (Water Hyacinth), a native of South America, has become a serious pest in North America, Africa, India, Australia, Malaya and Borneo. A similar story could be told of many other species of aquatic weeds. In a few cases the mode of introduction of a species into a new territory is known and its rate of spread is well documented; in most cases, however, many of the details are lacking. I have selected for discussion here four species of exotic aquatic plants which are currently spreading or have recently expanded their ranges in the New England States. I have described each species briefly and commented on the possible way(s) by which it may have invaded New England. In cases where control measures have been undertaken I have indicated the methods used and the degree of success attained.

TRAPA NATANS

Trapa natans L., the Water Chestnut (family Hydrocharitaceae), is a native of Europe and Asia. It was introduced in Middlesex County, Massachusetts circa 1875. It occurs there now in the Sudbury and Concord Rivers and was formerly found in ponds in Cambridge, Arlington and Belmont. In the mid-1940's *Trapa* "exploded" in the Sudbury River and became a nuisance. At that time efforts were undertaken by the Massachusetts Department of Conservation to eradicate the species by mechanical and chemical means. R. J. Eaton has shown that the population increase of *Trapa* in the Sudbury River was probably associated with increased pH and nutrient levels of the water (1). Since the 1900's the Concord and Sudbury Rivers have been increasingly polluted with domestic sewage. The sewage, in addition to adding large amounts of nitrogen, presumably raised the pH of the water to the basic or slightly alkaline levels usually required by *Trapa natans* and *Lemna minor* (duckweed). As early as 1936 vast quantities of duckweed suddenly appeared in the Sudbury River and covered the water surface over extensive areas. *Nymphaea odorata* (fragrant water lily), once abundant there, declined rapidly in numbers as the pollution increased. *Nymphaea* usually grows in neutral to slightly acid waters.

A marked reduction in the numbers of *Trapa* plants in the Sudbury and Concord Rivers in recent years seems unrelated to the eradication efforts made earlier by the Massachusetts Department of Conservation. Perhaps this decline is due in some small measure to improved water quality in the river-system resulting from waste treatment facilities in the watershed. Today *Trapa* is present in the Concord and Sudbury Rivers but it is not objectionable; duckweed remains a nuisance, however, and fragrant water lily has nearly disappeared.

In the early 1940's *Trapa* was discovered in the narrow southern end of Lake Champlain where it occurred in shallow bays on both the Vermont and New York shores. In Vermont the species is found in the Towns of West Haven and Benson (Rutland County). It is generally assumed that the species reached Lake Champlain from the Mohawk or Hudson River in New York where a large population of *Trapa* has been established for many years. The Hudson River and Lake Champlain are connected by a barge canal and it has been suggested that the *Trapa* fruits may have "hitchhiked" on boats traveling in this waterway. *Trapa* fruits have four prominent spines each of which possesses numerous recurved barbs permitting the fruits to cling readily to ropes, nets, etc.

Efforts to control *Trapa* in Lake Champlain have been conducted jointly by the New York State Conservation Department and the Vermont Fish and Game Department. Herbicides have been applied but these were used mostly on an experimental basis. The major control effort has been hand-pulling of the plants by a two-man crew working from a small boat. The success of this operation has been phenomenal. Today the *Trapa* population in Lake Champlain is so small that plants can be found only after considerable searching. The data shown in the following chart indicate the magnitude and achievement of the operation.

Estimated total amounts of *Trapa natans* hand-pulled in Lake Champlain (data are for selected years only)

	1960	1963	1967
Bushels	752	48	8
Pounds	26320	1505	280
Tons (approx.)	13	0.8	0.1

Today the *Trapa* problem in Lake Champlain is largely one of surveillance. Each summer, beginning in early July, a two-man crew spends approximately three weeks searching for the few remaining Water Chestnut plants. All plants found are handpulled and destroyed by placing on dry land where they rot readily. Attempts are made to complete the hand-pulling operations before the fruits mature in order to minimize reinfestation.

NYMPHOIDES PELTATA

Nymphoides peltata (Gmel.) Ktze. (family Gentianaceae), is a native of Europe and Asia. It is an attractive aquatic plant with circular or oval floating leaves approximately 5 to 10 cm in diameter and fringed yellow flowers 2 to 3 cm broad. The fruit of *Nymphoides peltata* is a beaked capsule approximately 2 cm long containing numerous seeds. The seeds are flatish, ovate, and are approximately 3.5 mm long with ciliated edges. The cilia serve to float the seed (2). Seeds are produced abundantly during the summer and fall and germinate readily the

following spring. It has been observed that the seeds may become attached to the plumage of birds by means of their ciliated fringes. It is possible that the plant may occasionally spread in this way (3).

Nymphoides peltata has long been in cultivation having been offered for sale in the United States as early as 1891 (4). Its showy flowers have made it a popular ornamental for water garden culture. It is generally sold under the name "Yellow Floating Heart." It has escaped from cultivation and become naturalized in a number of localities in New York and Missouri and is reported also from Washington, Arkansas, Oklahoma, and New Jersey. At the present time it is known from a single station in New England at West Haven (Rutland County), Vermont. It was first collected there in 1963 but was known to occur there at an earlier date (5). The Vermont station is located at the southern end of Lake Champlain south of the Narrows of Dresden. *Nymphoides peltata* also occurs in the same general area on the western side of Lake Champlain in the Town of Putnam (Washington County), New York. The Lake in this area is narrow and shallow, except for a dredged channel, and the water is very turbid. It commonly grows there at depths of approximately 1 m but is occasionally established on the muddy shores of the lake where it has become stranded due to changing water levels. In both habitats it thrives, flowering and fruiting freely. Its long, creeping, and freely branching stems form a tangled mass in the water making it difficult to put a boat through an area in which it grows. Fishing or swimming in waters infested with *Nymphoides* is nearly impossible.

In Lake Champlain *Nymphoides* frequently grows with *Trapa natans* and, like *Trapa*, is assumed to have reached the Lake from the Hudson River via the barge canal. There are several colonies of *Nymphoides peltata* in the upper and middle regions of the Hudson River (6, 7).

Some success in the control of *Nymphoides* in Lake Champlain has been achieved by the Vermont Fish and Game Department using applications of 2,4-D in various formulations.

BUTOMUS UMBELLATUS

Butomus umbellatus L., the Flowering Rush (family Butomaceae), is a native of Europe and Asia. It is an attractive species bearing showy pink flowers in an umbel atop an erect scape which often reaches a height of 1 m. The leaves are narrow and erect, arising from a fleshy rhizome which bears numerous small corms or "bulbils." *Butomus* most frequently grows emersed in shallow water but occasionally occurs on land near the water's edge. A sterile submersed form with limp leaves occurs in deep water. *Butomus* is frequently found growing with *Zizania aquatica* (wild rice) and doubtless competes with that valuable species for space and nutrients. The occurrence of *Butomus* in this country is too recent to properly evaluate its possible usefulness to wildlife. Martin and Uhler report a single occurrence of its use by waterfowl (8). They found *Butomus* corms in the stomach of a green-winged teal collected in late October 1935 at the southern end of Lake Champlain; the tubers constituted approximately one-half of the bird's stomach contents. In a more recent study, Hewitt reports that the leaf bases of *Butomus* formed an important part of the diet of muskrats in an Ontario marsh during July and July (9).

In the New World, *Butomus* was presumably first discovered circa 1897 when it was found growing along

the mud flats of the St. Lawrence River near Montreal. It is assumed to have arrived as seeds or corms in packing and ballast from ships which had recently visited European ports. The first report of *Butomus* from the United States was August, 1929. It was discovered almost simultaneously by Knowlton and Muenscher growing abundantly in the southern end of Lake Champlain near Whitehall, New York (10, 11). I have recently noted an herbarium specimen of *Butomus* collected by D. L. Dutton which antedates by one year the discoveries of Knowlton and Muenscher and appears to be the earliest record of *Butomus* in the United States. Dutton's specimen was collected from the shores of Lake Champlain at Orwell (Addison County), Vermont on 13 August 1928 and is deposited in the Pringle Herbarium at the University of Vermont, Burlington. *Butomus* has now been found in 19 of the 23 Vermont Towns which border on Lake Champlain.

In 1943 J. J. Neale collected *Butomus* in a ditch near the airport at New Haven, Connecticut. Apparently the plants at this station have died out for *Butomus* has never again been reported or collected from Connecticut.

Outside of New England *Butomus* has spread rapidly. It is found in most of the Great Lakes States as well as Idaho (12). In Canada it has spread as far west as Manitoba (13).

In 1915 *Butomus* was first offered for sale in the United States, thirteen years before it was found in the wild (14). It seems reasonable to assume that its occurrence in this country may have come about as the result of an escape from cultivation. Elsie M. Kittredge is reported to have stated that *Butomus* became established in Lake Champlain from ballast dumped at Whitehall, New York by ships coming from Montreal (15). The ballast purportedly consisted of sand dug from the St. Lawrence River banks near Montreal. As *Butomus* had been established at Montreal for many years, it is easy to imagine that the sand used for ballast might contain seeds or corms which could readily propagate the species when transported to a new location.

EGERIA DENSA

Egeria densa Planch. (family Hydrocharitaceae), is a submersed rooted aquatic plant with slender stems bearing dense whorls of ribless leaves. Its tendency to dominate its environment by vigorous growth, often producing nearly pure strands, has earned it the right to be called an aquatic weed.

Egeria is closely related to *Elodea* sp., which it greatly resembles, and until recently it has been placed in the latter genus by most botanists. The following chart will serve to distinguish *Egeria* from the two species of *Elodea* found in eastern North America (*E. canadensis* Rich in Michx. and *E. Nuttallii* [Planch.] St. John):

	Average size of upper leaves (in millimeters)		Usual number of leaves in upper leaf whorls
	Length	Width	
<i>Egeria densa</i>	25	4.0	4-5
<i>Elodea canadensis</i>	12	2.0	3
<i>Elodea Nuttallii</i>	9	1.3	3

The flowers of egeria possess conspicuous white petals approximately 10 millimeters long; they are held above the water surface by a slender peduncle, contain nectaries, and presumably are pollinated by insects. In contrast, the flowers of elodea are small and inconspicuous, petals are up to 5.0 mm long or may be lacking; the flowers are not insect pollinated.

Egeria is a native of South America (Brasil, Uruguay and Argentina) where it is found growing in lagoons, in the quiet waters of lakes and ponds, and in slow-moving streams and rivers. It is known in cultivation in Austrilia, Mexico and in the Hawaiian Islands and is naturalized in Europe and North America. In the United States it has been found in California, Oregon, Arizona, Colorado, Nebraska, Texas, Arkansas, Louisiana and in nearly all of the Southeastern States. Its present wide distribution is doubtless accounted for by its escape from cultivation. It has long been known in the trade as "Anacharis canadensis var. gigantea" or simple as "Giant Elodea." It has been recommended for use in aquaria, fish bowls and garden pools. It is readily available from dealers in tropical fish and aquarium supplies and usually can be found in the pet departments of "five and ten cent" stores. Egeria was offered for sale in the United States as early as 1915 when one dealer described it as, "A rapid grower and one of the best oxygenators" (16).

Only staminate plants of egeria are known in the United States. Pistillate plants are apparently rare even in the native range of the species. St. John has stated, "The absence of pistillate specimens among the numerous ones cultivated in the northern hemisphere may well be explained by their establishment from a single or from a few importations (17)." Vegetative propagation by fragmentation appears to be the usual way in which this species reproduces. The stems are somewhat brittle and broken fragments quickly form adventitious roots at the nodes. St. John notes, "Plants washed loose or branches broken off may drift to colonize other bodies of water. Dispersal within a single drainage system needs no special explanation. Dispersal from one river system to another may well be caused by migrating water fowl. One short stem fragment with nodes is all that is needed to transplant the species to a new river system (18)."

Egeria has been reported in New England from two localities: Abington (Plymouth County) and Quincy (Norfolk County), Massachusetts.

The Plymouth County station was discovered by Clarence H. Knowlton who found the species abundant in 1939 in a pond by the Memorial Park in Abington (19). It was later learned that the plant had been established there for several years. The growth became so rampant that the Park Department drained the pond in the fall of 1939 in an attempt to eradicate the species. In spite of exposure to dessication and low temperatures the egeria persisted and was found again by Knowlton in the fall of 1940. Curious to know of the present status of the colony, I traveled to Abington on 19 November 1968 to see if I could find plants still present in the Memorial Park Pond. When I arrived I found the pond drained; earth moving machinery was being used to excavate the rich soil and make the pond deeper. I talked with a Park official and learned that the pond had become so overgrown about a year previously that it had been decided to drain it and dig it deeper hoping that the aquatic weed problem would not return when the pond was refilled with water. I

looked in the narrow channels of water which were flowing through the old bed of the pond but I was unable to discover any egeria plants.

The Quincy egeria record was reported by Frank C. Seymour in 1939; he found the species growing in a brook in Furnace Brook Parkway. The present status of this population is not known.

A third record of egeria in New England has been cited by Seymour (20). The specimen which forms the basis of this record is from Townshend (Windham County), Vermont. The label bears only the notation, "Kindness of Mrs. H. E. Willard" and is dated 25 January 1913. It would probably have been necessary to chop through a considerable thickness of ice to collect a submersed aquatic plant on that date in Vermont. It seems unlikely that the specimen was collected from the wild; I suspect it more probably came from Mrs. Willard's goldfish bowl.

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