

A short history of the introduction and spread of *Elodea* Michx in the British Isles

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ABSTRACT

In the British Isles during the 1970s, there was a sudden and rapid increase of plants having the general characteristics of *Elodea* Michx, but with longer and narrower leaves than had previously been observed. A recent investigation has shown that three species are present, *Elodea canadensis* Michx, *E. ernstiae* St John and *E. nuttallii* (Planch.) St John. The study has also confirmed the identity of *Hydrilla verticillata* (L.f.) Royle in western Ireland. The history of the three *Elodea* species is reviewed. *E. canadensis* was first recorded in 1836 and then rapidly increased, becoming widespread and often reaching pest proportions. Its introduction presented a number of problems to 19th century botanists, particularly regarding its origins and identity. From the 1880s it showed a general decline and, although still widespread throughout the British Isles, it rarely occurs in large numbers. *E. ernstiae* was first seen in 1948, but has not shown any rapid increase or spread, being confined to southern England and one locality in Wales. It has often been confused with *E. nuttallii*. *E. nuttallii* was first recorded in 1966. It has since increased and spread rapidly, particularly in north-western and south-eastern England but is rare in Wales and Ireland and absent from Scotland. It shows a wide range of morphological variation which has caused many problems of identification. *E. nuttallii* has replaced *E. canadensis* at a number of sites where the latter was well-established. It frequently forms large and extensive beds but it has rarely become a pest.

The genus *Elodea* is a member of the family Hydrocharitaceae and comprises 17 species (St John 1962, 1963, 1964, 1965). The genera most closely related are *Egeria* Planch. (once considered to be congeneric with *Elodea*), *Lagarosiphon* Harv. and *Hydrilla* L.C.M. Richard. *Elodea* is native only in the New World and of the 17 species, nine are endemic to North America and eight to South America. There are no native species between northern Mexico and southern Panama or in the West Indies. A few species are adventive in the Old World, particularly Europe and Australasia, the most widespread and well-known of these being *Elodea canadensis* Michx. Following its introduction into a new area, *E. canadensis* frequently attains pest proportions, after which there is a steady decline in its numbers.

After a long period of neglect by British systematists there was renewed interest in the genus during the 1970s. This was due to the sudden and rapid increase in the British Isles of plants which had the characteristic features of the genus, including lowermost leaves in decussate pairs, median and upper leaves in whorls, flowers minute on long thread-like hypanthia and with three bifid stigmas. However, these plants had narrower and often longer leaves than had previously been observed. They were also notable for their wide range of morphological variation, which often appeared to be more or less discontinuous and which suggested the possibility of two or even three new taxa being present. The taxonomic status of *Elodea* was clearly in a state of confusion and, furthermore, the narrow-leaved plants gave every indication of being invasive, with the same potential for colonisation and spread as that shown by *E. canadensis* during the 19th century.

An investigation was therefore carried out which aimed to discover the species present and the most reliable means of their identification, to examine morphological variation and the factors influencing it and to provide information on the ecology and distribution of the taxa. This work has concluded that three species are present: *E. canadensis*, *E. ernstiae* St John and *E. nuttallii* (Planch.) St John. It has also confirmed Scannell & Webb's (1976) identification of *Hydrilla verticillata* (L.f.)

Royle, which is now known from only one locality (Rusheenduff Lough, Renvyle, W. Galway, v.c. H16) and which has in the past been confused with *E. nuttallii*. The results of this investigation will be presented in later papers but, by way of introduction, this paper briefly reviews the history and associated taxonomic problems of the three *Elodea* species in the British Isles.

ANALYSIS

Elodea canadensis is native to North America, being distributed throughout most of the U.S.A. particularly in the northern and eastern states. It is also frequent in south-eastern Canada. The first authenticated station in the British Isles was Waringstown, Co. Down, v.c. H38, where the plant was found in 1836 by a Mr J. New (Moore & More 1866). However, a number of authors have suggested that the plant was seen before this date. Kirk (1851) noted that the lock-keepers on the Market Harborough Canal at Foxton, Leics., v.c. 55, claimed to have had problems with the plant since 1828, whilst Douglas (1880) maintained that Professor D. Oliver believed it to have been first seen in 1817. Furthermore, Lees (1888) wrote "In Aveling's History of Roche Abbey (S.W. Yorks., v.c. 63), there occurs a curious statement 'we noticed it in several places growing with great freedom about half a century ago then it disappeared as mysteriously as it came'. This could hardly have been penned later than 1865 or 1866, which would carry the first observance back to the time of Waterloo". These earlier reports remain questionable without substantive evidence, and New's 1836 locality is still accepted as the first for the British Isles, and indeed for Europe.

The locality usually cited as the first for Great Britain is Duns Castle, Berwicks., v.c. 81. It was discovered there in August 1842 by Dr G. Johnston in a small lake near to the River Whiteadder, a tributary of the Tweed (Marshall 1852). Walker (1912), however, suggested an earlier record from Watford Locks in 1841, and Johnston later indicated that the Duns Castle plants had been introduced from England (Marshall 1852). Therefore it is conceivable that the Duns Castle plants had been taken from Watford Locks, which would suggest that the latter is more likely to be the first British station. Unfortunately there is again no substantive evidence to confirm this, so Duns Castle must remain as the first definite locality.

Johnston observed that *E. canadensis* had disappeared from Duns in 1843 (Douglas 1880) and no further observations were made until the autumn of 1847, when it was seen by Miss M. Kirby in a reservoir next to the canal at Foxton, Leics., v.c. 55. Similar plants were also noted at Leigh Park, S. Hants., v.c. 11, in the same year. There is good evidence to suggest that the arrival of the plant at Foxton was recent, because it appears that the reservoirs had been cleaned and drained two years before its discovery. This contradicted the view of the Foxton lock-keepers that the plant had been present for a number of years. In 1848 *E. canadensis* was known to be present in the Grand Union Canal at Watford Locks, the River Trent at Burton-upon-Trent, Staffs., v.c. 39, and at Chesterfield, Derbys., v.c. 57. By 1849 it had appeared in the River Leen near Nottingham, v.c. 56, and had spread rapidly in the River Trent where a year later it almost blocked the river. In 1850 it reached Rugby, Warks., v.c. 38, where it was observed in the Oxford Canal. Meanwhile the plant had reappeared in Berwicks. and Johnston noted that it had reached the River Whiteadder, where by 1850 "it had colonised almost every part of the river where the water ran sluggishly, almost to choking" (Douglas 1880).

Between 1850 and 1880 *E. canadensis* spread vigorously and some of the most seriously affected areas were the Fen districts of S. Lincs., v.c. 53, and Cambs., v.c. 29. There is good documentary evidence to account for its origin here, given by Marshall (1852). In 1847, specimens were taken from Foxton to the Cambridge Botanic Garden, where they were planted in a tub. In 1848 the curator, W. H. Murray, placed some in a conduit stream running past the garden. From here it spread into the River Cam, via a waste outlet and a small tributary stream, where by 1852 it had become well established, impeding navigation and drainage. It then spread along the Cam and into the River Ouse so that by 1855 it was blocking drains, sluices and most navigable sections of the river. Marshall also gave a vivid description of its effects upon water-borne activities in the Cambridge area: "I am told that the river at the backs of the colleges has been so blocked that extra horses have to be yoked on before barges could be got up to Fosters Mills. Sluice-keepers complain that masses of it get into the pen . . . and the operation of getting boats through is greatly impeded . . . rowers find it interferes with their amusements, and swimmers remark that it clings to them . . . if they are

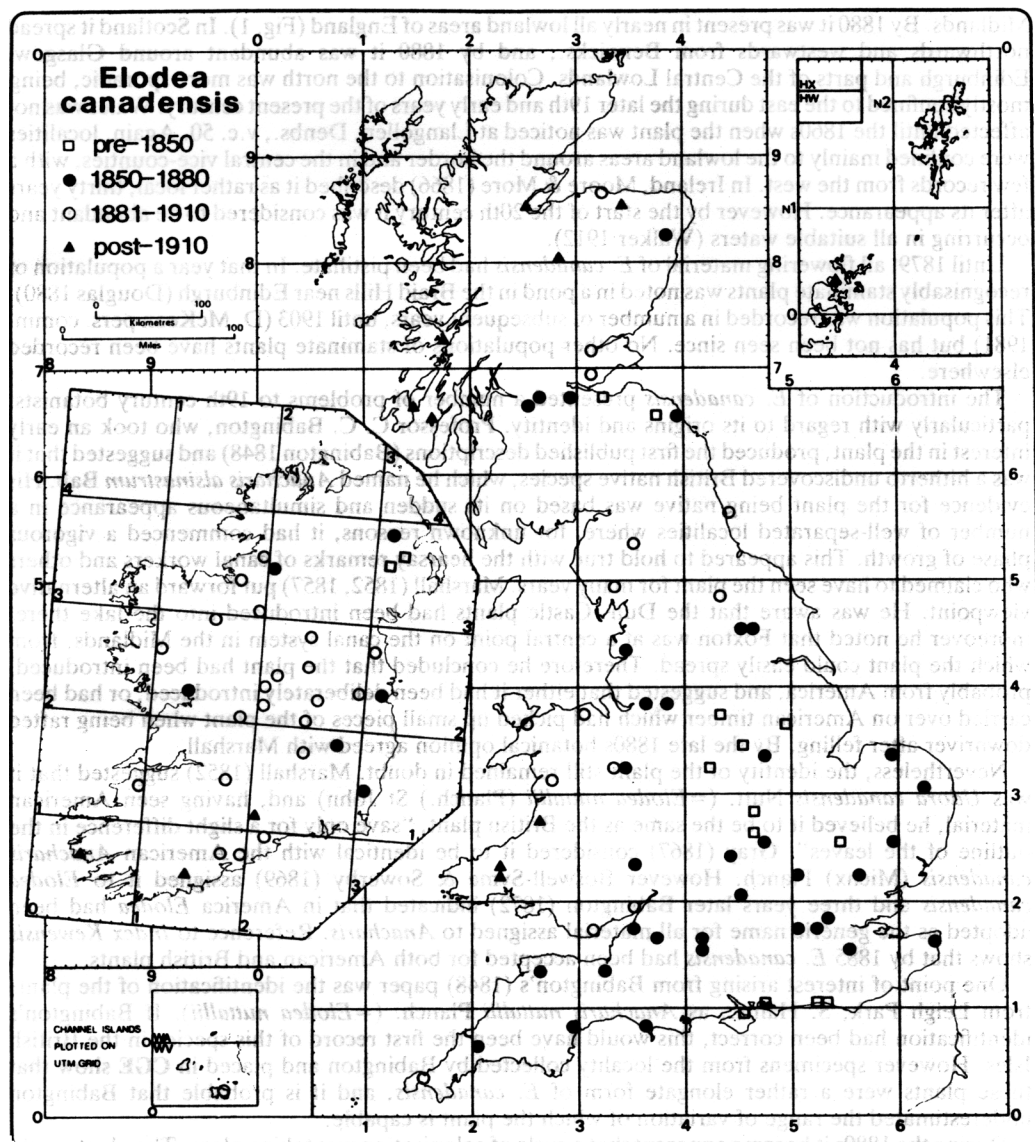


FIGURE 1. Spread of *Elodea canadensis* in the British Isles. Symbols refer to 10 km squares containing the earliest vice-county record in the vice-counties where such records are known. Details of records are held at LANC.

overtaken by a lump of it they are likely to be entangled and dragged by it into deeper water. Lastly drainage is impeded . . . and the average depth of the water in the river below Cambridge has been a foot higher than in ordinary seasons". In 1852, a Mr Rawlinson was sent to the Fens by the Government, to investigate methods of controlling or eliminating the plant. His recommendation, which necessitated dredging the plant, proved ineffective and by 1857 it had colonised ditches and streams throughout S. Lincs. and Cambs.

Meanwhile, the spread continued unabated elsewhere in the British Isles. Marshall (1857) observed that ten years after its appearance at Foxton it was showing no signs of a decline. By 1860 it had reached most of the southern vice-counties of England and was well distributed throughout the

Midlands. By 1880 it was present in nearly all lowland areas of England (Fig. 1). In Scotland it spread northwards and westwards from Berwicks., and by 1880 it was abundant around Glasgow, Edinburgh and parts of the Central Lowlands. Colonisation to the north was more sporadic, being mostly confined to the east during the later 19th and early years of the present century. Wales was not affected until the 1860s when the plant was noticed at Llangollen, Denbs., v.c. 50. Again, localities were confined mainly to the lowland areas around the border and in the central vice-counties, with a few records from the west. In Ireland, Moore & More (1866) described it as rather local, thirty years after its appearance. However by the start of the 20th century it was considered to be abundant and occurring in all suitable waters (Walker 1912).

Until 1879, all flowering material of *E. canadensis* had been pistillate. In that year a population of recognisably staminate plants was noted in a pond in the Braid Hills near Edinburgh (Douglas 1880). This population was recorded in a number of subsequent years, until 1903 (D. McKean pers. comm. 1981) but has not been seen since. No other populations of staminate plants have been recorded elsewhere.

The introduction of *E. canadensis* presented a number of problems to 19th century botanists, particularly with regard to its origins and identity. Professor C. C. Babington, who took an early interest in the plant, produced the first published descriptions (Babington 1848) and suggested that it was a hitherto undiscovered British native species, which he named *Anacharis alsinastrum* Bab. His evidence for the plant being native was based on its sudden and simultaneous appearance in a number of well-separated localities where, for unknown reasons, it had commenced a vigorous phase of growth. This appeared to hold true with the hearsay remarks of canal workers and others who claimed to have seen the plant for many years. Marshall (1852, 1857) put forward an alternative viewpoint. He was aware that the Duns Castle plants had been introduced into the lake there; moreover he noted that Foxton was at a central point on the canal system in the Midlands, from which the plant could easily spread. Therefore he concluded that the plant had been introduced, probably from America, and suggested that either it had been deliberately introduced, or had been carried over on American timber which had picked up small pieces of the plant when being rafted downriver after felling. By the late 1880s botanical opinion agreed with Marshall.

Nevertheless, the identity of the plant still remained in doubt. Marshall (1852) suggested that it was *Udora canadensis* Nutt. (= *Elodea nuttallii* (Planch.) St John) and, having seen American material, he believed it to be the same as the British plant, "save only for a slight difference in the outline of the leaves". Gray (1867) considered it to be identical with the American *Anacharis canadensis* (Michx) Planch. However Boswell-Syme & Sowerby (1869) assigned it to *Elodea canadensis* and three years later Babington (1872) indicated that in America *Elodea* had been adopted as the generic name for all material assigned to *Anacharis*. Reference to *Index Kewensis* shows that by 1885 *E. canadensis* had been accepted for both American and British plants.

One point of interest arising from Babington's (1848) paper was the identification of the plants from Leigh Park, S. Hants., as *Anacharis nuttallii* Planch. (= *Elodea nuttallii*). If Babington's identification had been correct, this would have been the first record of this species in the British Isles. However specimens from the locality collected by Babington and placed in CGE show that these plants were a rather elongate form of *E. canadensis*, and it is probable that Babington underestimated the range of variation of which the plant is capable.

During the 1880s it became apparent that a cycle of colonisation was taking place. The plant would become established at a locality and over a period of three to four years it would rapidly increase, eventually reaching pest proportions and excluding most, if not all, other macrophytes. Maximum numbers would be maintained for a further three to ten years followed by a gradual decline over a seven to 15 year period. A much smaller, relict population would sometimes remain, or the plant would disappear altogether, possibly returning some years later. This pattern was noted by Siddall (1885) who indicated that "in 1867 the large fishpond in front of Eaton Hall (Cheshire, v.c. 58) was so choked with it as to prevent waterfowl from swimming across" but by 1884 "it was still frequent but far less abundant than formerly". Lees (1888) noted that there was a consensus of opinion that the plant had begun to die out and Murray (1896) suggested that the plant was somewhat less abundant than in recent years. Walker (1912) produced a county-by-county assessment of the status of *E. canadensis* in 1909. This indicated that the plant had declined in the original areas of colonisation, whilst continuing to expand into suitable habitats which had not been previously affected. Therefore the situation between the mid-1880s and the early years of the present century was one of decline in

TABLE 1. LIST OF VICE-COUNTIES IN GREAT BRITAIN AND IRELAND FROM WHICH *ELODEA MICHX* SPECIES HAVE BEEN RECORDED

<i>E. canadensis</i>	<i>E. nuttallii</i>		<i>E. ernstiae</i>
Recorded from all except:	Recorded from:		Recorded from:
74. Wigtowns.	4. N. Devon	30. Beds.	6. N. Somerset
97. Westernness	5. S. Somerset	31. Hunts.	8. S. Wilts.
104. N. Ebudes	6. N. Somerset	32. Northants.	12. N. Hants.
105. W. Ross	7. N. Wilts.	33. E. Gloucs.	13. W. Sussex
107. E. Sutherland	11. S. Hants.	35. Mons.	17. Surrey
108. W. Sutherland	12. N. Hants.	38. Warks.	20. Herts.
109. Caithness	13. W. Sussex	40. Salop	21. Middlesex
110. Outer Hebrides	14. E. Sussex	42. Brecks.	34. W. Gloucs.
112. Shetland	15. E. Kent	51. Flints.	42. Brecks.
	16. W. Kent	53. S. Lincs.	
	17. Surrey	56. Notts.	
	18. S. Essex	57. Derbys.	
	19. N. Essex	58. Cheshire	
	20. Herts.	59. S. Lancs.	
	21. Middlesex	60. W. Lancs.	
	22. Berks.	63. S.W. Yorks.	
	23. Oxon	64. Mid-W. Yorks.	
	25. E. Suffolk	66. Co. Durham	
	28. W. Norfolk	69. Westmorland	
	29. Cambs.	70. Cumberland	
	H21. Co. Dublin		

central and south-eastern England, together with a continued extension of range in north-eastern Scotland, northern and south-western England, central Wales and central Ireland.

During the present century, dramatic increases of the plant became rare events. These rare events usually occurred when the plant became established in the increasing number of man-made water-bodies such as drainage-channels and gravel-pits. Grose (1957) noted that the plant invaded these habitats within a few months of their being filled by water; it then increased for one or two years and then declined. Messenger (1971) saw a similar cycle occurring in the Eye Brook Reservoir, Leics., v.c. 55, where *E. canadensis* spread over a wide area shortly after flooding, but soon receded again. The colonisation cycle therefore appeared to be shorter than in the 19th century. By the middle of the present century *E. canadensis* had reached the maximum extent of its distribution, being present in 103 vice-counties in Great Britain and every vice-county in Ireland (Table 1). This was aptly summarised by Tutin (1952) who described it as widespread but seldom abundant.

ELODEA ERNSTIAE ST JOHN

Elodea ernstiae is native to South America, and is present in southern Uruguay and northern Argentina. The first plants in the British Isles were found in the River Colne, near Harefield, Herts., v.c. 20, in 1948 (BM), and in the Longford river at Stanwell, Middlesex, v.c. 21 (BM), two years later. Grigg (1951) thought that both populations had originated as discarded aquarium material and suggested that they were likely to spread rapidly, starting another *Elodea* 'invasion'. However since 1948, only 19 populations in nine vice-counties have been recorded, 18 of which are in southern England, and one in Wales (Fig. 2, Table 1). Of these only two were still extant at the end of 1982. Therefore the rate of spread of these plants has not warranted the term 'invasion'.

The plant was first assigned, by Grigg, to *E. callitrichoides* (Rich.) Casp., but it was subsequently re-determined as *E. ernstiae* by St John during the 1960s. By the late 1970s there was a lot of confusion between *E. ernstiae* and *E. nuttallii* because of their vegetative similarity. However it is now clear that they are distinct species.

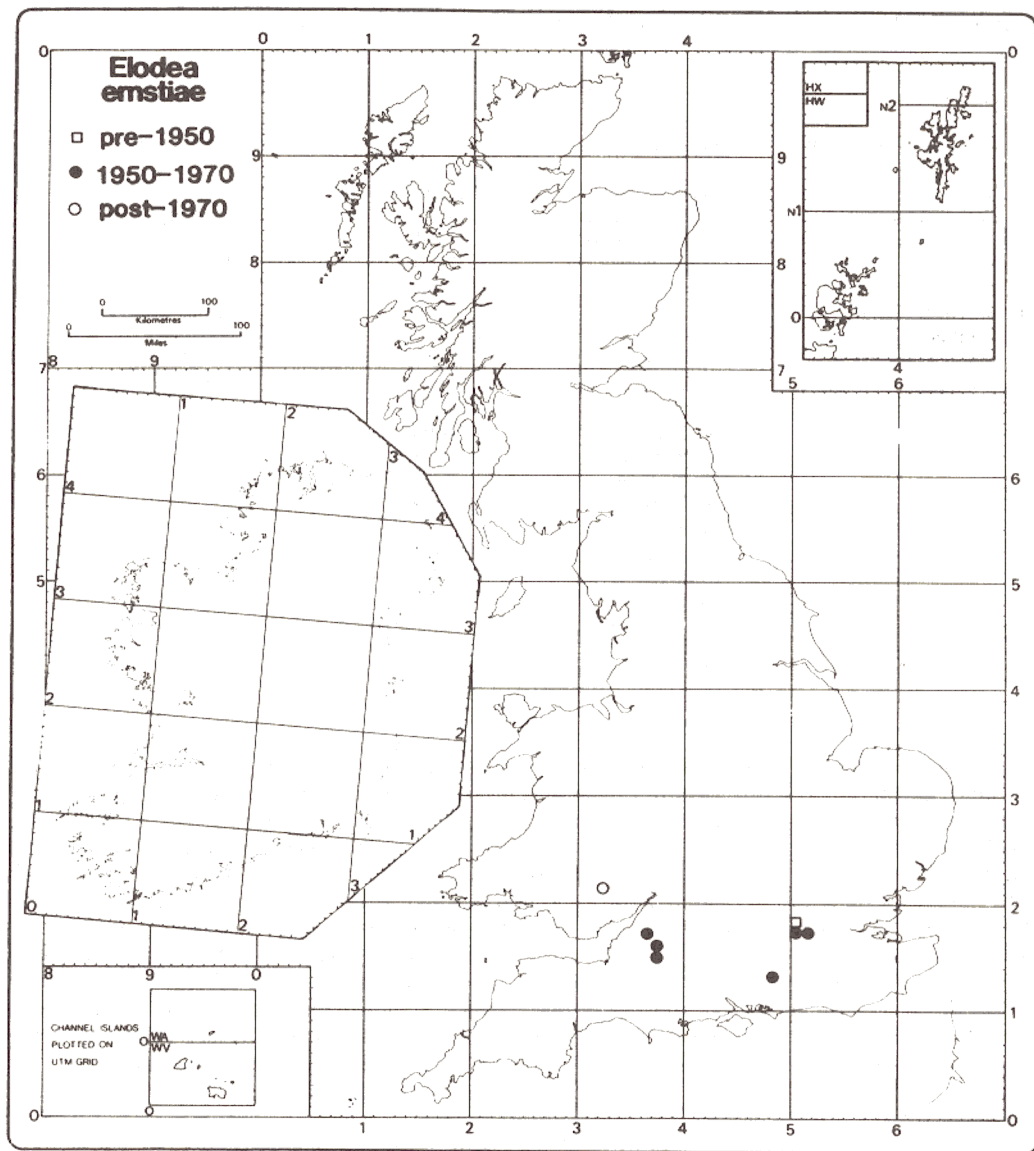


FIGURE 2. Spread of *Elodea ernstiae* in the British Isles. Symbols refer to 10 km squares containing the earliest vice-county record in the vice-counties where such records are known. Details of records are held at LANC.

ELODEA NUTTALLII (PLANCH.) ST JOHN

Elodea nuttallii is native to North America, particularly mid- and north-eastern U.S.A. and Canada, where it has a similar distribution pattern to *E. canadensis*. It is adventive in Europe where it has been known since 1939 (Wolff 1980). The plant was first recorded in the British Isles at Stanton Harcourt near Oxford, v.c. 23, by R. C. Palmer in 1966 (OXF). Three years later, further populations were found at localities in the vicinity of Oxford and, in 1970, the plant was noted in a flooded gravel-pit at Twyford, Berks., v.c. 22. During 1972 and 1973, the Oxford populations were re-discovered and in 1974 further specimens were reported from various localities in Herts., v.c. 20.

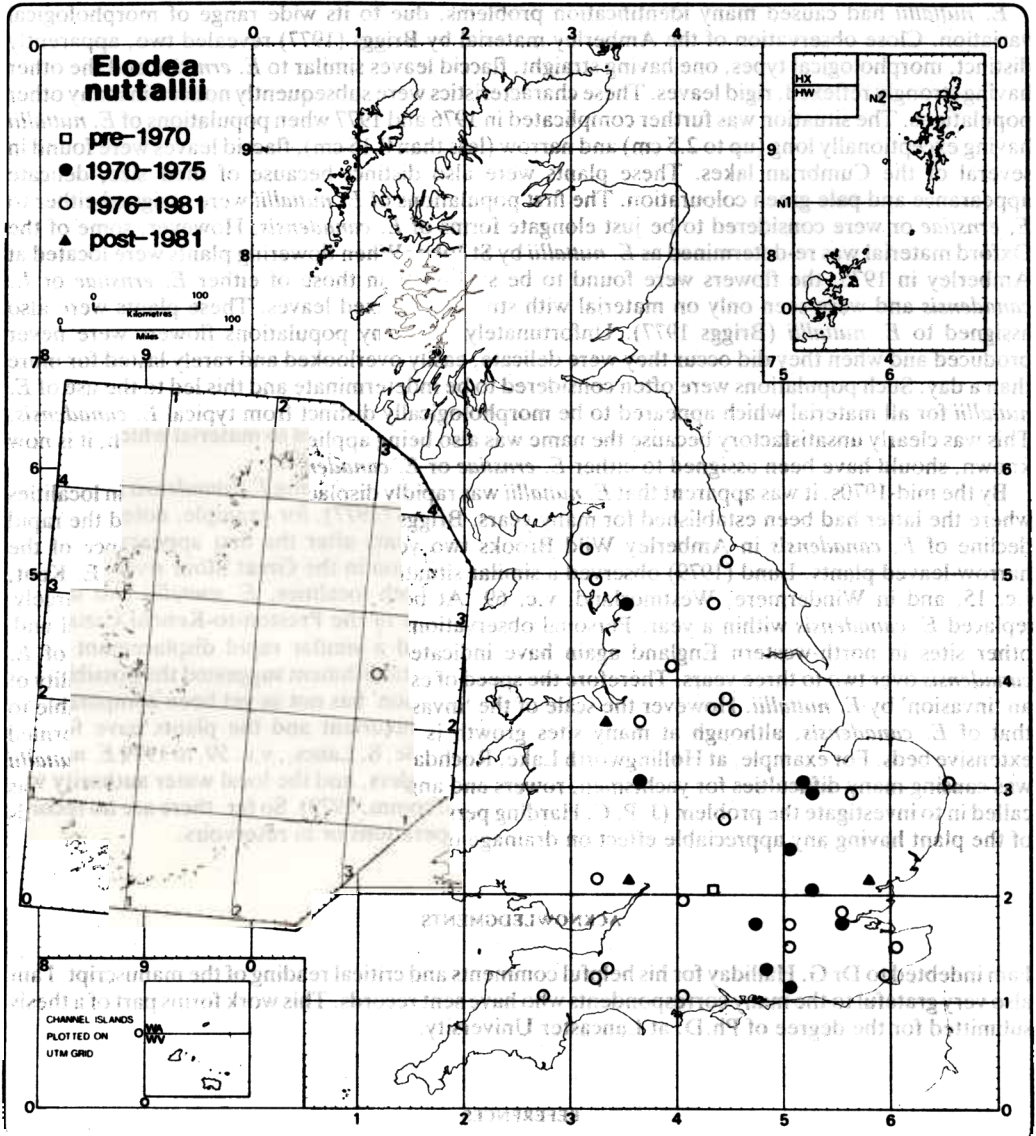


FIGURE 3. Spread of *Elodea nuttallii* in the British Isles. Symbols refer to 10 km squares containing the earliest vice-county record in the vice-counties where such records are known. Details of records are held at LANC.

Cambs., v.c. 29, Hunts., v.c. 31 and S. Lincs., v.c. 53. The plant was also seen at Amberley Wild Brooks, W. Sussex, v.c. 13, in the same year. By 1975, *E. nuttallii* had been reported from a total of ten vice-counties. This number had increased to 35 by 1978, and by 1982 to 41 with many localities (Fig. 3). The spread appears to have been most vigorous in north-western and south-eastern England, although this may reflect more active recording in these areas. There are a number of areas where populations have remained more or less isolated. This is particularly evident in East Anglia, the Midlands and north-eastern England. By the end of 1982, there appeared to be no decline in the number of stations, but only three of these were in Wales, and none were known in Scotland. There is one population known in Ireland.

E. nuttallii had caused many identification problems, due to its wide range of morphological variation. Close observation of the Amberley material by Briggs (1977) revealed two, apparently distinct, morphological types, one having straight, flaccid leaves similar to *E. ernstiae* and the other having strongly reflexed, rigid leaves. These characteristics were subsequently noticed in many other populations. The situation was further complicated in 1976 and 1977 when populations of *E. nuttallii* having exceptionally long (up to 2.5 cm) and narrow (less than 0.15 cm), flaccid leaves were found in several of the Cumbrian lakes. These plants were also distinct because of their size, delicate appearance and pale green colouration. The first populations of *E. nuttallii* were assigned either to *E. ernstiae* or were considered to be just elongate forms of *E. canadensis*. However, some of the Oxford material was re-determined as *E. nuttallii* by St John. When flowering plants were located at Amberley in 1975, the flowers were found to be smaller than those of either *E. ernstiae* or *E. canadensis* and were seen only on material with strongly-reflexed leaves. These plants were also assigned to *E. nuttallii* (Briggs 1977). Unfortunately, in many populations flowers were never produced and when they did occur they were delicate, easily overlooked and rarely lasted for more than a day. Such populations were often considered to be indeterminate and this led to the use of *E. nuttallii* for all material which appeared to be morphologically distinct from typical *E. canadensis*. This was clearly unsatisfactory because the name was also being applied to material which, it is now known, should have been assigned to either *E. ernstiae* or *E. canadensis*.

By the mid-1970s, it was apparent that *E. nuttallii* was rapidly displacing *E. canadensis* in localities where the latter had been established for many years. Briggs (1977), for example, noted the rapid decline of *E. canadensis* in Amberley Wild Brooks two years after the first appearance of the narrow-leaved plants. Lund (1979) observed a similar situation in the Great Stour river, E. Kent, v.c. 15, and in Windermere, Westmorland, v.c. 69. At both localities, *E. nuttallii* had largely replaced *E. canadensis* within a year. Personal observations of the Preston-to-Kendal Canal and other sites in north-western England again have indicated a similar rapid displacement of *E. canadensis* over two to three years. Therefore the speed of establishment suggested the possibility of an 'invasion' by *E. nuttallii*. However the scale of the 'invasion' has not as yet been comparable to that of *E. canadensis*, although at many sites growth is luxuriant and the plants have formed extensive beds. For example, at Hollingworth Lake, Rochdale, S. Lancs., v.c. 59, in 1979 *E. nuttallii* was causing many difficulties for yachtsmen, rowers and anglers, and the local water authority was called in to investigate the problem (J. P. C. Harding pers. comm. 1979). So far, there are no records of the plant having any appreciable effect on drainage operations or in reservoirs.

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