

***Sagina maritima* Don (Caryophyllaceae) and other halophytes in London**

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ABSTRACT

Sagina maritima has been recorded at three sites by the River Thames near central London, much further from the open sea than elsewhere in Britain. Other halophytes occur nearby. Hydrological data and other records suggest that saline water carrying seeds or other propagules penetrated far upstream during periods of unusually low freshwater river flow. These are the first records of *S. maritima* in v.c. 17 (Surrey) and v.c. 21 (Middlesex); *Elytrigia atherica*, *Glaux maritima* and *Triglochin maritimum* are also new to Middlesex. The likely source populations of these halophytes are discussed.

KEYWORDS: Sea Pearlwort, estuarine flora, phytogeography.

INTRODUCTION

Centuries ago many marine and estuarine plants grew along the upper tidal reaches of the River Thames. This flora disappeared as a combination of drainage and embankment eliminated suitable habitats, narrowed the river and increased freshwater flow. Records for 1987–99 in the *New Atlas* (Preston *et al.* 2002) show that very few halophytes penetrate further upriver than hectad TQ57, more than 25 km downstream of London Bridge.

In March 2002 a pearlwort later determined as *Sagina maritima* Don was noticed on sloping river revetments along the Greenwich peninsula. Further stations were subsequently found at Rotherhithe and at Limehouse. Other saltmarsh plants have colonised a mudflat at East India Dock Basin, Blackwall. These stations are between 4–11 km below London Bridge where the river is normally only weakly brackish. This paper briefly reviews the phytogeography of *S. maritima* and describes its London sites. The estuarine flora at East India Dock Basin is described. The occurrence of coastal plants unusually far upstream, and similar changes in the distribution of estuarine algae and invertebrates, is related to increased salinity during periods of extremely low freshwater flow. If current trends in climate change and river use continue, more halophytes are likely to colonise London.

DISTRIBUTION OF *SAGINA MARITIMA*

S. maritima, an annual of open ground with little competition, is widely distributed around the eastern Atlantic and Mediterranean coasts from the Canary Islands north to the Lofoten-Vesterålen archipelago in Norway, and from the Azores to the Bosphorus. It favours upper saltmarshes, dune slacks and rock crevices washed by high spring tides or swept by blown spray. Inland it is native only where haline evaporites of the Keuper (Triassic) beds reach the surface; in Germany it formerly grew in such an area near Magdeburg in Saxony (Hegi 1909), and in England it occurs in the Cheshire plain near salt workings.

The distribution of *S. maritima* in northern Europe (Jalas & Suominen 1983) is strongly correlated with salinity. It is abundant on North Sea and Atlantic coasts (salinity 31–35‰), moderately common on the Baltic coasts of Denmark and south-western Sweden (salinity >10‰), occasional on the coasts of north Germany and east Sweden as far north as the Åland Islands (salinity 6–10‰) and extremely rare elsewhere in the Baltic, being classed as vulnerable in Finland and Estonia. In fact the limits of its distribution follow exactly the 6‰ iso-salinity contour (salinity data are from Rodhe 1998, expressed in gm NaCl per litre or parts per million, ‰).

There seem to be few ecological studies of *Sagina maritima*, perhaps because, unlike typical saltmarsh plants such as *Suaeda maritima* and *Salicornia* spp., it grows in a variety of habitats, dominating none of them, and has only a minor role in phyto-sociological communities (such as the NVC community SM27, “Ephemeral salt-marsh vegetation with *Sagina maritima*”, or the continental association *Saginetea*). Like *Suaeda maritima*, which has a very similar distribution and is also rare in the Baltic, it is absent from the brackish waters (salinity <5.5‰) of the Gulfs of Bothnia and Finland. Though these Gulfs are often frozen in winter months, many annuals that are, like *Suaeda maritima*, spring-germinating, are common round their shores. It seems to be low salinity, not ice cover, that excludes *Suaeda maritima*. According to Ellenberg (1988) *Suaeda maritima* has the highest possible indicator value of 3 for salinity and is an obligate halophyte, whereas the value for *Sagina maritima* is 2. Nevertheless its distribution suggests it behaves very much like *Suaeda maritima* and requires at least 6‰ salinity to maintain a stable population.

Apart from its Cheshire stations, confirmed records as a British or Irish native are from sites subject, at least occasionally, to inundation by sea water (or spray, as for example a Dorset record from Abbotsbury, 2 km inland from Chesil Beach). Rarely, *Sagina maritima* can penetrate some distance up tidal rivers. It was recorded in the 19th Century from salt marshes by the River Nene below Wisbech, Cambridgeshire (Perring *et al.* 1964; Crompton & Nelson 2000) near where A. C. Leslie found it again in 1983 (Crompton 2003); this is 10 km from the coast but the river is tidal as far as Wisbech. A recent spread to salted road verges was first noticed by Braithwaite (1997), who found it on roads up to 350 m altitude. However, Corner (2002) has convincingly argued that the solitary native record from an inland montane site (Ben Nevis) is erroneous.

THE NEW LONDON RECORDS

A pearlwort with deep green, fleshy, blunt leaves was noticed at Greenwich in early March 2002. Flowering plants gathered in May, from here and from further upstream at Rotherhithe, were determined as *Sagina maritima* Don by Nick Jardine. Flowering plants were also found at Limehouse, across the river from Rotherhithe, in June. Table 1 gives site details.

TABLE 1. LOCATION OF SITES

Locality	Grid reference	Distance below London Bridge in km
Greenwich (v.c.16, West Kent): Blackwall Reach between Alcatel Jetty and Amylum Works	TQ 391787 to TQ 390792	8.9–9.4
Rotherhithe (v.c.17, Surrey): Pageant Stairs	TQ 364805	4.3
Limehouse (v.c.21, Middlesex): Limehouse Hole Stairs	TQ 368805	4.7
East India Dock Basin (v.c.21, Middlesex)	TQ 390808	11.1

At Greenwich *Sagina maritima* was found growing with *Plantago coronopus*, *S. procumbens* and occasional *S. apetala* ssp. *apetala* in muddy cracks between stone and concrete slabs of a sloping revetment at several places along a 500 m stretch of river bank. Plants were on or below the strand line of the highest spring tides, and were matted with filamentous green algae, presumably *Blidingia* and/or *Rhizoclonium*. The plants at Rotherhithe and Limehouse were also close to the tide line, growing in compact colonies amongst green algae in the silty re-entrant angles of stone steps leading down into the river. At these sites *S. procumbens* was the only associated vascular plant. Colonies comprised many separate plants with intertwined root systems, suggesting a common origin from seed clusters. The Rotherhithe and Limehouse records are the first for Surrey and Middlesex respectively. The nearest *S. maritima* has previously come to London appears to be a 1903 record from Stone Marshes (TQ57) in West Kent, 36 km below London Bridge (Grinling *et al.* 1909); the closest modern record is near Gravesend (TQ67), 7 km further downstream. Two pre-1980 records from the Medway estuary (Philp 1982) have not been refound while in Essex, where *S. maritima* has always been rare, Shoeburyness, 75 km from London Bridge, is now perhaps its only station (see “Essex Rare Plants”, on the website of the Essex Field Club).

In May 2003 members of the London Natural History Society found *S. maritima* abundant at Greenwich, accompanied by *Plantago maritima* at its highest recorded Thameside site.

Their appearance so far upstream indicates a period of increased salinity in the upper Thames estuary. Support for this come from the discovery of a rich array of saltmarsh plants at East India Dock Basin, a disused tidal basin handed over in 1998 by the London Docklands Development Corporation (L.D.D.C.) to the Lee Valley Park Authority as a wildfowl reserve (Table 1). Infilling by the L.D.D.C. to provide reedbeds for nesting cover produced a small area of mudflats. Halophytes recorded variously by Park ranger David Miller in 2000, by the author in 2001 and by the London Natural History Society in 2002 include *Aster tripolium*, *Bolboschoenus maritimus*, *Cochlearia anglica*, *Elytrigia atherica*, *Glaux maritima*, *Schoenoplectus tabernaemontani*, *Spergularia marina* and *Triglochin maritimum* as well as *Atriplex* spp. (including plants determined as *A. longipes* by John Akeroyd, but possibly closer to *A. × gustafssoniana* (Brian Wurzell, *in litt.*, and Knapp & Spiers 2003)). The records for *Glaux maritima*, *Triglochin maritimum* and *Elytrigia atherica* are the first for Middlesex (though the latter occurs nearby on the Essex side of the River Lea) while *Cochlearia anglica* was last recorded, from near this site, in 1869, and *Schoenoplectus tabernaemontani*, which has now been lost from its only other Middlesex station, was also here (“in a pond of breach a little beyond Limehouse”) about 1700 (Kent 1975). Mr Wurzell has carried out a full survey of plants at the Basin.

The L.D.D.C. is thought to have introduced *Phragmites australis* deliberately, and the presence of abundant *Cotula coronopifolia* raises the possibility that other halophytes may have been introduced accidentally at the same time. But the swift development of a native flora and its persistence suggests that most arrived naturally (some perhaps brought by birds) and found a suitable habitat. Ellenberg recounts a similarly rapid colonisation of the Baltic island of Bock, formed by dredging in 1945 and “occupied by plants with an almost explosive rapidity presumably because of the masses of viable seeds floating in the sea and deposited on the new land shortly after its formation” (Ellenberg 1988: 363). A less extensive suite of saltmarsh plants, including five of the eight mentioned above, was recorded at Woolwich (v.c. 16) a further 6 km downstream, in 1962 (Lousley 1963) but that site has since been built over.

HYDROLOGY OF THE TIDAL THAMES

At 110 km, the Thames estuary is one of the longest in Britain. It is well-mixed vertically, so salinity varies very little between river bed, mid-stream, and banks; average salt levels vary from zero at Teddington to 2–3‰ at London Bridge and 3–4‰ at Greenwich, reaching open sea values of 32–34.5‰ at Southend. This average salinity profile is sensitive to the relative flows of tidal and fresh water and is by no means linear with distance downstream. Kinniburgh (1998) explains in some detail how low freshwater flows result in increased salinity at various points in the estuary. Fig. 1 shows monthly mean flows at Teddington between 1986 and 2002. The low flows of 1990–92, when a quarterly average salinity as high as 6.8‰ was measured at Greenwich, and the even lower flows of 1996–97 are striking features. The average flow for the whole of 1997 was 27% of the long-term yearly average, the lowest annual flow ever recorded. Monthly mean flows were above $10 \text{ m}^3 \text{ s}^{-1}$ in only four months between July 1996 and October 1997. At such times flow is dominated by daily tidal movements, river water taking on average three months to flow from Teddington to the sea. This long residence time sets the time-scale for changes in salinity; Kinniburgh’s data from a monitoring station at Greenwich show salinity in 1990 still rising after two months of low flow. During 1996–97 salinity must have reached or exceeded 5‰ at London Bridge and 7‰ at Greenwich for many months.

DISCUSSION

Changes in the distribution of lower plants and invertebrates in the Thames estuary have been well documented. Upriver migration of marine algae (*Fucus vesiculosus* and, to a lesser extent, *Ulva lactuca*) is described by Titley & John (1998) who postulate changes in salinity due to decreasing freshwater flow as a possible cause. A similar change, attributed unequivocally to lower freshwater

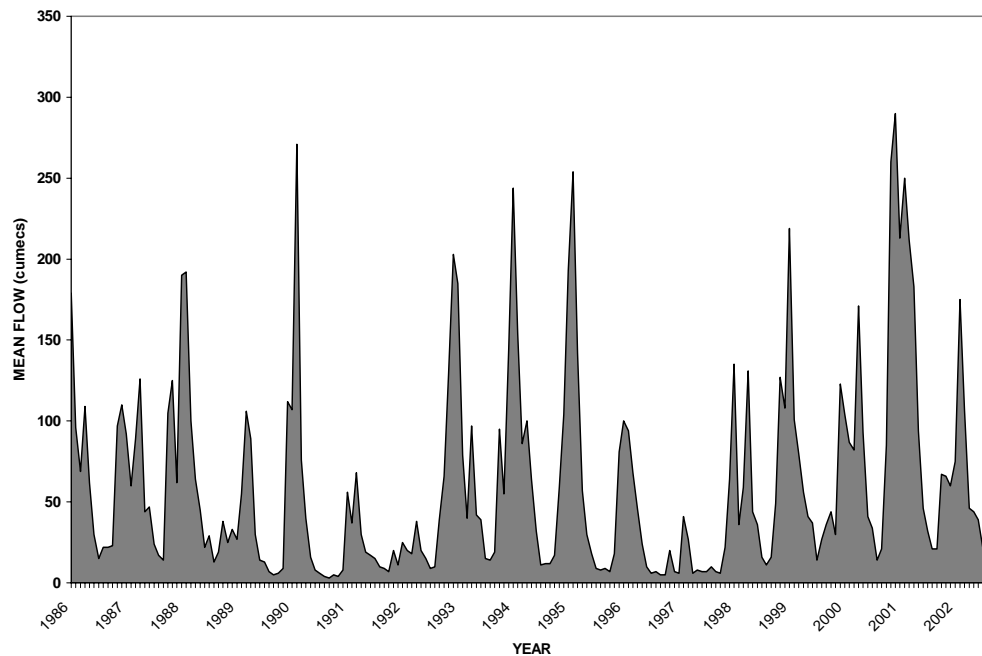


FIGURE 1. Monthly mean gauged flow of the River Thames at Kingston, 1986–2002. 1 cumec = $1 \text{ m}^3 \text{ s}^{-1}$. Data from *Hydrological data UK: Hydrometric Register and Statistics yearbooks*, Institute of Hydrology (1986–1995), and website of the National River Archive at the Centre for Ecology and Hydrology, www.nwl.ac.uk (1996–2002).

flows, was found amongst some *Mollusca* and *Annelida*, at the same time as some freshwater macroinvertebrates were being lost from their upper Thames sites which became too brackish for them (Attrill 1998). Attrill & Rundle (2002) interpret such effects in terms of a “two-ecocline” model in which mid-estuary fauna are at the edges of their range. A similar model may apply to plants, a possible example being a rapid population fluctuation seen in *Plantago maritima* in response to similar edaphic changes over quite short distances (Jerling 1985). An annual such as *Sagina maritima* should be at least as susceptible. During extended periods of very low flow the salinity far upstream rises to at least 6‰ and perhaps even 10‰, allowing *S. maritima* and other halophytes to colonise the upper Thames.

Of course, as in the case of the new island of Bock quoted by Ellenberg, seeds must be present. It is not obvious that *Sagina maritima* plants found at Rotherhithe and Limehouse developed from isolated seeds. Trials on the author’s table-top show that seeds of *S. maritima* do not float even in strong brine solution. This, and the presence of compact clusters with intertwined roots suggests that tidal currents deposited fragments of stems including whole capsules. Unger (1978) reports that this is an important dispersal mechanism for *Salicornia* spp., fragments of which float for up to three months.

The possible source of the seeds or other propagules has been investigated using *New Atlas* software. Strong counter-clockwise currents circulate in the North Sea, so most water entering the Thames estuary has flowed southwards down the East Anglian coast. The eight halophytes (excluding *Atriplex* spp.) recorded at East India Dock Basin are common along this shoreline. It is a simple exercise to map the hectads in which these eight occur as natives, together with *Sagina maritima*. Between 1987 and 1999, 54 British hectads had all nine. Fig. 2(a) shows the hectads in south-eastern England, including four on the coasts of Essex and Suffolk. This small number is due primarily to the sparse records for *S. maritima* itself, and *prima facie* it is doubtful whether there are sufficient sites to provide enough fruiting material.

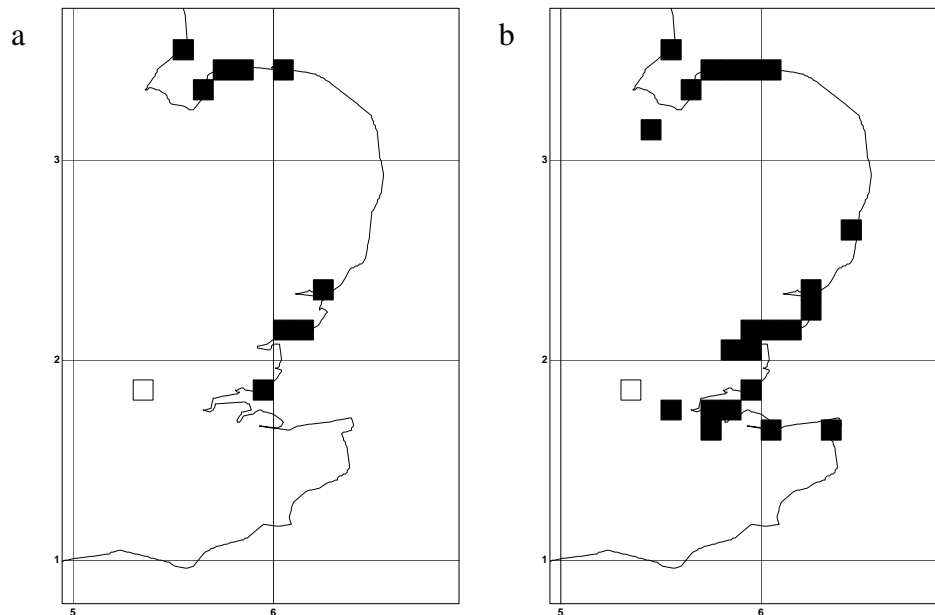


FIGURE 2. (a) Hectads in south-eastern England in which *Sagina maritima* and eight other halophytes (see text) were recorded as native between 1987 and 1999. The southernmost hectad contains the Shoeburyness site for *S. maritima*. (b) As (a) but including all historic records for *Sagina maritima*. The hectad south of the Wash contains the Cambridgeshire site mentioned in the text.

Hectad TQ38 containing the Rotherhithe and Limehouse stations for *S. maritima*, and East India Dock Basin, is shown as an open square on both maps.

Since *Sagina maritima* is an inconspicuous plant one might wonder whether there has been any recording bias. The *New Atlas* records “little significant change” since 1962 (change index = -0.08). However, if one considers records from 1987–99 as a proportion of all historic records, a different picture emerges. Only 62% of all British records of *S. maritima* were found or re-found in 1987–99, compared with 80% or more for most coastal species. This raises the possibility that *S. maritima* may still be present unrecognised (or, as Braithwaite (1997) warns, recorded as *S. apetala* subsp. *erecta*) in some of its former sites. *New Atlas* data were re-analysed as before, but now including all historic records of *S. maritima*. The number of British hectads with all nine rises to 74. As shown in Fig. 2(b), 22 of these are in south-eastern England with 14 clustered around the mouth of the Thames. If *S. maritima* lurks unrecorded in a few of these hectads, much more material is available to be swept up-river. Regular replenishment from such a source is needed if appearance of this annual species in the upper Thames is to be other than sporadic.

The trend to drier summers in southern Britain (Kundzewicz & Parry 2001) suggests that periods of exceptionally low freshwater flow will occur more frequently. The volume abstracted from the Thames for public water supplies continues to rise so that it is now sometimes greater than the natural flow (being compensated by release of treated sewage). It is likely that periods of high salinity will become more common. Given suitable habitats, other halophytes may follow *Sagina maritima* and surprise the London botanist.

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