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First records of *Sophora tomentosa* (Fabaceae) seeds recorded as beach drift in Northwest Europe

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Abstract
Five seeds of *Sophora tomentosa* L. were found as drift on Irish and British Atlantic exposed shores during 1987 to 2010. This species is unknown in the wild in northwest Europe as its native range is within sub-tropical to tropical environments. In the Americas it extends southwards from southern Florida. These seeds were most probably carried with oceanic and wind currents across the Atlantic Ocean. Parent plants are evergreen shrubs that have a maritime distribution. In this account the seeds were compared with material collected from Florida and those previously lodged in the seed collection of **DBN**.

Key words: Oceanic drift; long distance dispersal; hydrochory; seed drift

Introduction

There are about 60 *Sophora* L. species occurring in tropical to temperate environments. Seeds of this genus have been widely dispersed over time. In the Southern Ocean there are 19 species with some of these confined to small island groups (Hurr *et al.,* 1999). The circum-Antarctic distribution of this genus is likely to have resulted from hydrochory. Such is this distribution that the genus would appear to have evolved in New Zealand where eight species presently exist (Heenan *et al.,* 2001).

Sophora tomentosa L. has a worldwide sub-tropical to tropical distribution occurring both coastally and inland on five continents (Lonard *et al.,* 2015). In its Atlantic range, *S. tomentosa* extends from the south of Florida (Gilman, 1999; Perry & Dennis, 2010) to southern Brazil, and in Africa extends from Senegal to Nigeria (POWO, 2025). It is locally known in Florida as silver-bush due to its leaf colour. This plant has distinctive yellow flowers forming an elongated raceme of up to 40 cm (Lonard *et al.,* 2015) that produces a seed pod that extends to 10 to 13 cm containing up to ten seeds. It is also referred to as the necklace pod bush due to the pods having prominent bulges about each of the seeds, due to compression of the pod in-between each seed.

Its widespread occurrence on remote islands and atolls is due to its seeds floating in seawater and being transported by ocean currents (Sykes & Godley, 1968). In an early study undertaken by Guppy (1906) its seeds were found to be capable of floating for more than a year. Seeds of *S. tomentosa* have also been found as drift by Partonihardjo *et al.* (1993) and Muir (1933) including environments outside of its parent range (Gregory 2006; Shepherd & Heenan, 2017a). This long-distance dispersal (LDD) explains its pan sub-tropical and tropical distribution worldwide (POWO, 2025) and to areas outside of its normal parental range. Seed production within its tropical range can take place throughout the year (Lonard & Judd, 1989). This increases the possibility of storm events (Pringle, 1982) causing seeds to enter coastal waters. Coastal plants may shed seeds directly onto shores to be borne away with wind and sea currents. On some shores, seeds and seedlings have been found in the drift materials deposited on the high shore (Nakanishi, 1988; Smith, 1990). In this account the presence of *S. tomentosa* seeds from two exposed Atlantic shores in Ireland, and three from southwest Britain, represent the first accounts of this species appearing in northwest Europe.

Methods

All *S. tomentosa* seeds were collected from the high shores of separate exposed Atlantic beaches. Several such beaches were infrequently examined from 1974. Beaches that were productive for the stranding of drift seeds, neustonic species and drift plastics were examined in most years since 1984; but not in every season. Collections were retained in vials along with other stranded disseminules.

Comparative material was procured from the high shore of Dania Beach, Fort Lauderdale, USA, during April 2023. Photographs of the Ballydonegan Beach specimen was confirmed as being *S. tomentosa* by Ed Perry. Additional material lodged in the herbarium of Dublin Botanic Gardens **DBN**, sourced from Australia and Fiji beaches, and presented by JBM Smith, were also examined.

Irish seeds were measured for maximum height, width and depth down to the nearest 0.1 mm using a Mitutoyo steel Vernier caliper. Seeds were weighed using a Diamond professional digital pocket scale, series A03, and read to 1 mg.

Results

The collected seeds were from:

1. Ballydonegan Beach, Co. Kerry (51. 63222, -10.05833) VCH3.

A light-orange brown seed was collected from the high shore during April 1987. The seed measured 6.4 mm maximum height and width of 5.8 mm and had a smooth testa.

2. Trawgor Beach, Streedagh, Co. Sligo (54.43888, -8.46972) VCH28.

This was collected by the late Don Cotton on 19 August 1993. This light brown seed measured 7.2 mm in height and 5.8 mm in width and 4.9 mm in depth weighing 102 mg and had a dull testa.

3. Constantine Bay, N. Cornwall, (50.53459, -5.02259) VC1. This was collected by Jane Darke (JD) and Nick Darke (ND) on 12 November 2000. The seed was 6.0 mm in height x 4.0 mm in width.

4. Treyarnon Bay, N. Cornwall, (50.52557, -5.02342) VC1. This was collected by JD and ND on 26 November 2000. The seed was 6.0 mm in height x 4.0 mm in width

5. Treyarnon Bay, N. Cornwall, (50.525578, -5.023429) VC1. This was collected by JD on 17 November 2010. The seed was 5.0 mm in height x 4.0 mm in width. Two representative seeds from Florida of *S. tomentosa* and the two stranded Irish specimens appear in Fig. 1.

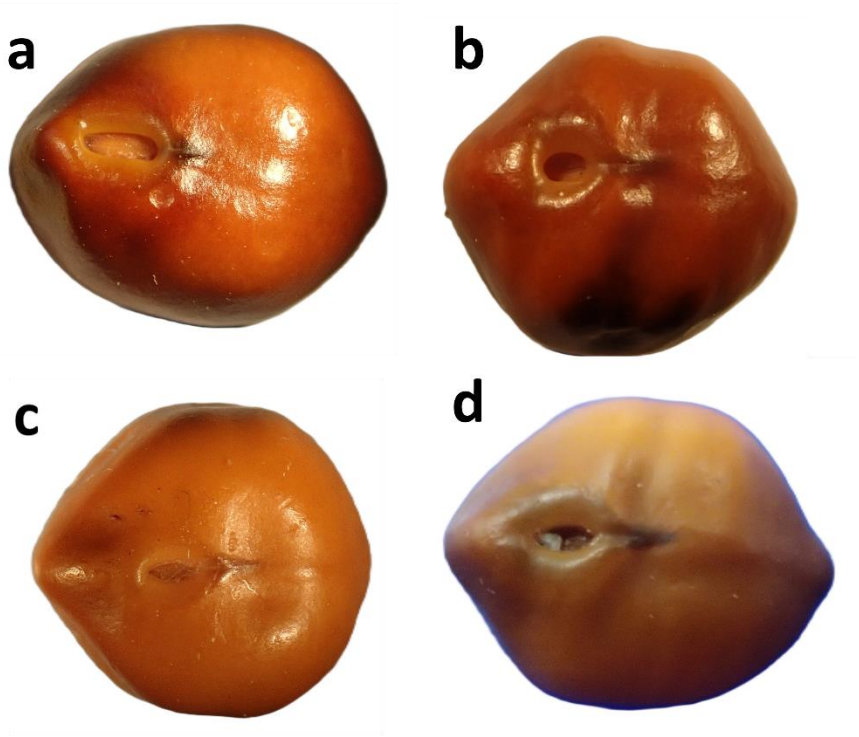

Figure 1. Seeds of *S. tomentosa* collected from southern Florida (a,b) and from two Irish beaches (c,d).

Seeds have a long to oval sunken hilum with a distinctive flaring triangular lens with darker localised colouration. Seeds are generally red-brown to light brown and rounded to oval in outline with a basal bulge.

Discussion

These records of occurrences of *S. tomentosa* seeds arriving within northwest Europe are the only known accounts apart from that recorded by French (2020). This species was not previously recorded by Colgan (1919) who undertook reviews of disseminule beach strandings in Ireland or by Nelson (1998, 2000) for northwest Europe. Seeds of

S. tomentosa are comparatively small, and similar in size to those of some Convolvulaceae genera regularly stranded in Ireland and southwest Britain. The records from over a twenty-three-year period from widely spaced beaches would indicate that while rarely found, these findings probably underestimate their actual presence, as only selected sites have been examined for such drift. It is likely that further findings will appear in the future. The same beaches have also yielded subtropical and tropical disseminules from within the native range of S. tomentosa throughout the year. Although the duration of oceanic transport remains unknown, their arrival is most plausibly explained by marine dispersal, with transit times varying according to oceanographic conditions (Minchin & Quigley, 2023).

There is little doubt that many *Sophora* species have the ability to float with potential for long-distance dispersal (LDD). Nakanishi (1988) undertook floating experiments in seawater with >85% of *S. tomentosa* surviving ninety days, Hnatiuk (1979) found them capable of floating for over a hundred days and Guppy (1906) followed their ability to float for over a year. The ability to float being due to spaces between the cotyledon folds (Nakanishi, 1988). While it is uncertain if transmissions of the *S. tomentosa* seeds resulted solely from oceanic and wind currents alone, there is the possibility that part of the transmission might involve other vectors. Anthropogenic activities can be responsible in the case of many larger disseminules, having commercial or ritual purposes, being released to become carried from distant coastal regions, or perhaps following a local festival (Hnatiuk (1979) or an event while at sea (Cadée & Berg, 1988). Seeds of *S. tomentosa*, are of a small size and are of little commercial significance and being a coastal plant is less likely to have any anthropogenic involvement.

However, birds have been implicated by surface water feeding that could account for part of a seeds journey. Within the Pacific Ocean Carlquist (1966) provided circumstantial evidence that bird crop transmissions were responsible for some of the of the Hawai'ian and Polynesian floras, although he claimed as a transmission mode bird transport was unlikely to be efficient over '…very great…' distances. There is a case of a *Sophora* seed found on the shore of a sub-Antarctic freshwater lake, well beyond the range of adult plants, where the wandering giant petrel *Macronectes giganteus* nests (Smith, 2012). Similar sized seeds of a bindweed *Ipomoea* L. sp. have also been recorded from this same island (Taylor, 1955) and Vian *et al.* (2016) found long dispersal by birds with small seeds being carried within their crops. Furthermore, Tennyson (1995, in Shepherd & Heenan, 2017b) found *Sophora* species in the crop of petrels. While we have some evidence of bird transport, the frequency of such events is unknown and the propagule pressure may be low. In any case for successful colonization seeds would need to arrive at a suitable locality to germinate. Bird nesting sites may not be suitable. In past times the large trans-oceanic procellariform bird migrations may have held a more important role (Schofield, 2009).

Seeds of several species were found associated with bird carcasses in the Pacific (Wagner, 2002). There are several surface feeding birds that may ingest floating seeds, perhaps feeding on the biota that may be attached. These birds include fulmars, petrels and albatross species. Fulmars are known to ingest larger seeds sizes of up to *c.*20 mm

in diameter that include the grey hard-coated nikarnut *Guilandina bonduc* L. (in Nelson, 2000).

The five stranded seeds fall within the size range of the reference material (Table 1). Nakanishi (1988) refers to seeds stranded in southern Japan with a mean dried weight of 128 mg. The heavier Florida seeds collected in this study may have recently been released from a pod, their high glossy appearance would suggest this was the case. The duller Irish specimens will have been exposed to sunlight and agitation that could account for the testa appearance. Their size and lower weight correspond more closely with those collected on Pacific Ocean shores (Table 1).

Table 1. Collections of *S. tomentosa* in the DBN herbarium deposited by J.M.B. Smith.

Region	Florida, USA	Florida, USA	Australia	Australia	Fiji	Fiji	Fiji
Locality	Dania Beach, Fort Lauderdale	Dania Beach, Fort Lauderdale	Sawtell, New South Wales	Sawtell, New South Wales	Nananu-i-Ra Island	Nananu-i-Ra Island	Nananu-i-Ra Island
Date	April 2023	April 2023					
DBN Collection			910	910	1912	1912	1912
Length	7.3 mm	5.3 mm	6.5 mm	7.2 mm	6.4 mm	6.9 mm	6.5 mm
Width			6.5 mm	6.7 mm	7.3 mm	7.8 mm	7.1 mm
Depth			6.4 mm	7.0 mm	6.1 mm	6.6 mm	6.2 mm
Weight	555 mg	230 mg	128 mg	145 mg	148 mg	181 mg	139 mg

The times involved for such a transmission to Ireland from Florida, or from further south, are unknown. However, transmissions from the higher latitudes of North America, that regularly result in strandings of the sea pea *Lathyrus japonicus* var. *maritimus* (L.) P.W.Ball may take months rather than years to arrive (Minchin, 2021).

On account of the small size of *S. tomentosa* seeds, they are likely to be overlooked when stranded on the shore and so have gone unrecorded. The finding of five *S. tomentosa* seeds found over a 38-year period, would indicate they are seldom present in the oceanic drift in northwest Europe.

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