

The status of *Matthiola sinuata* (L.) R. Br. (Sea Stock) in South Wales

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INTRODUCTION

Matthiola sinuata is a nationally rare, native species of coastal sand dunes, cliffs and shingle (Rich, 1991). It is a UK Biodiversity Action Plan (BAP) species, a vulnerable Red Data Book species and is also included in the Schedule 42 list of vascular plants (Welsh Assembly Government, 2008); i.e. plants prioritised for biodiversity action in Wales. Surprisingly, it wasn't included in the Schedule 8 list of protected species in the Wildlife and Countryside Act 1981.

The *New Atlas of the British and Irish Flora* (Preston et al., 2002) records the occurrence of *M. sinuata* in 12 hectads, 6 of which are in Glamorgan (VC41). Elsewhere in Wales it was recorded new for Carmarthenshire (VC44) at Ginst Point, Laugharne in 2005 (see communication by R.D. Pryce in BSBI Welsh Bulletin, No. 77, p.31 (2006) and No. 80, p.18 (2007)) and 4 plants were noted on Pendine Sands in 2007 (R.D. Pryce and K. Pryce, pers.com.) There are also recent records of *M. sinuata* in Pembrokeshire (VC45) where plants have been noted on Penally/Tenby dune front (2004), Caldy Island (2008 – 2014) and Freshwater East dunes (2009 – 2013) (S.B. Evans pers.com. and see communication by S. B. Evans (2010) in BSBI Welsh Bulletin, No. 86, p. 37). Figure 1 is a summary of the current, known distribution of *M. sinuata* in South Wales.

Matthiola sinuata (Sea Stock)

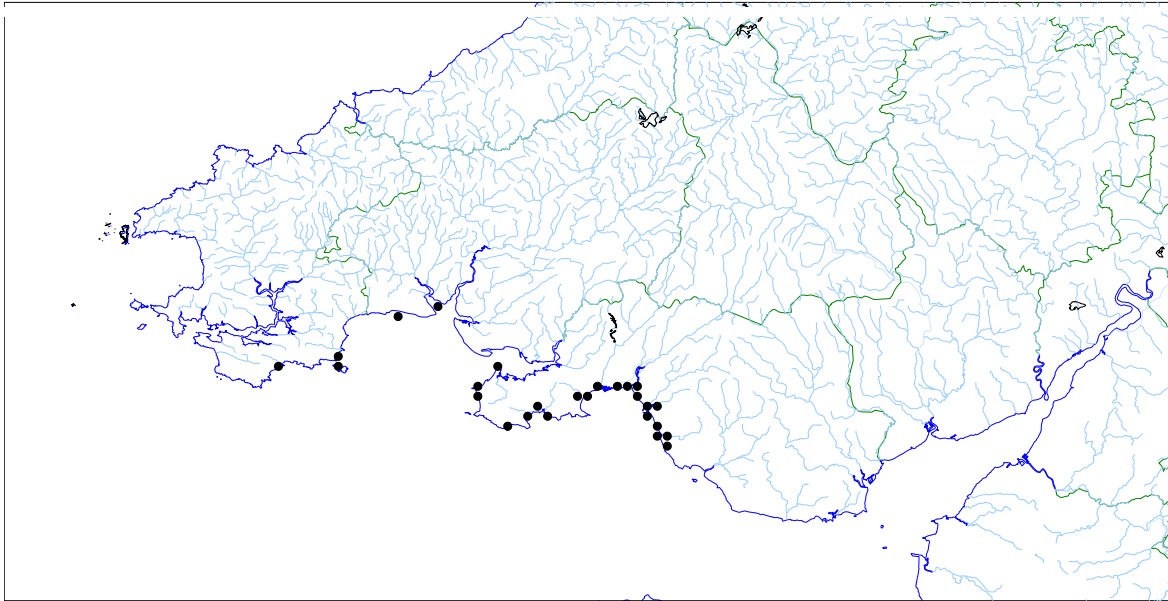


Figure 1: Current known distribution of *Matthiola sinuata* in South Wales

Outside Wales, extant populations of *M. sinuata* are known in Devon, Cornwall and the Channel Islands.

Matthiola sinuata has undergone a significant, southward contraction in its native distribution range in the last 100 years. Watson (1883) recorded its occurrence in north Devon (VC4), Glamorgan (VC41), Pembroke (VC45), Merioneth (VC48), Caernarvon (VC49), Flint (VC51) and Anglesey (VC52) and noted that it had also been recorded in Cornwall, Dorset and Sussex at remoter dates. The *New Atlas* reports pre-1970 occurrences in 13 GB hectads and 8 Irish hectads. It seems to have disappeared from Ireland.

Matthiola sinuata is a Mediterranean-Atlantic species which is endemic to the south and west coast of Europe (including islands). The survival of this species in South Wales is of considerable interest since its occurrence there represents the northern limit of its native, global distribution. Consequently, populations in South Wales are important not only in terms of national biodiversity but also because of their biogeographical and ecological significance.

HABITAT AND COMMUNITY RELATIONSHIPS

In South Wales, *M. sinuata* is exclusively a plant of coastal dunes where it grows in early successional mobile sand or strand line shingle communities. It is commonly associated with the Marram Grass mobile sand dune community (SD6) where it grows with species such as *Ammophila arenaria*, *Elytrigia juncea*, *Eryngium maritimum*, *Carex arenaria*, *Calystegia soldanella*, *Euphorbia paralias*, *Vulpia fasciculata*, *Phleum arenarium*, *Viola tricolor* ssp. *curtisii*, *Hypochaeris radicata*, *Oenothera cambrica*/ *X fallax* and *Senecio jacobaea*.

LIFE FORM AND REPRODUCTION

Although *M. sinuata* has often been described as biennial and semelparous (and will conform to this life form in cultivation), plants *in situ* often live for more than two years and are sometimes

iteroparous. After germination, which usually occurs between October and April, seedlings develop into rosettes which invest significant resources into forming deep root systems. This serves not only to improve absorption of water and minerals, but also the crucial role of anchoring plants in a very (sometimes violently) mobile substratum. High densities of seedlings are often found in the vicinity of parent plants (Figure 5), but few survive to produce productive rosettes; mature plants are not particularly gregarious. Normally a population consists of non-flowering rosettes (of different ages) and flowering/fruitlets plants. Populations may exhibit a large range in non-flowering rosette sizes (from <5cm to >50cm; Table 2). Some non-flowering rosettes continue to grow vegetatively for more than 1 year, but the precise dynamics of this life trait are not fully understood. Populations often contain a mixture of simple plants, with one rosette, and complex plants consisting of several rosettes arising from the rootstock. All rosettes can give rise to a single reproductive shoot which may produce flowers and fruits. Seed production is usually good and large floriferous plants may produce >300 seed pods with an average of 30-40 seeds per pod. Consequently, the reproductive output of some populations in South Wales can exceed 250,000 seeds per annum. Seeds are easy to germinate under laboratory or room temperature conditions, where 100% germination success is often achieved; seeds seem to exhibit little innate dormancy.

Some plants in a population die after one round of seed production while others continue to perennate, often as complex plants with several well-formed basal rosettes which flower and fruit again in the following year (Figure 3). Adventitious rosettes may also arise on reproductive shoots and these can also function as perennating structures as long as vascular contact with the parent rootstock is maintained; e.g. adventitious rosettes that occur near the base of the plant on the parent rootstock (Figure 4). Alternatively, adventitious rosettes may become established as independent ramets under favourable conditions. This may happen after shoots break off, or are bent over to the soil surface, enabling rosettes to root independently. Although the exact details of these strategies are not understood fully, they are similar to life history traits exhibited by other crucifers such as *Coincya monensis* (Hipkin and Facey, 2009).

Very little is known about reproductive strategies and genetic variation in *Matthiola sinuata* populations in South Wales. However, observations with isolated founders *in situ* and cultivated plants in garden experiments indicate that *M. sinuata* is self-compatible (Quentin Kay, unpublished observations; Charles Hipkin, unpublished observations). Information on the long-term viability of buried seed and soil seed bank dynamics is lacking, but desirable.

HISTORY OF SEA STOCK IN SOUTH WALES

George Bowles' record of *Matthiola sinuata* 'on the rocks' in Aberdovey, Merionethshire, in 1632 is probably the first record for Wales (Raven, 2010). It was also noted by John Ray near Abermenai, Anglesey, in 1662 and again by S. Brewer in 1727 (Roberts, 1982). Later, *M. sinuata* was recorded by John Lightfoot near Briton Ferry (probably on Baglan Burrows) in 1773, which is the first known record for Glamorgan and among the first for South Wales (Carter, 1952). Lightfoot's diary, which chronicled his 'Tour in Wales in 1773' also includes records of *M. sinuata* from Freshwater East, Pembrokeshire. Evidently, *M. sinuata* was widespread along the south and west coasts of Wales (and England) at that time, occurring in actively accreting sand dune systems which were larger, more abundant and more connected along the Welsh coast than today, and perhaps on sea cliffs. Dillwyn (1848) commented on the one-time abundance of *M. sinuata* in Swansea Bay but added that it had become rare there by 1840; plants were also known from Freshwater East and elsewhere in

Pembrokeshire between 1805 and 1863 (Turner and Dillwyn, 1805; Babington, 1897; Warren-Davis, 1970). Gutch (1844) described its occurrence in the vicinity of Swansea as: '*Present on the sand hills between Swansea and Mumbles, nearly opposite Singleton; and also on the sea side of Crymlyn Burrows, but now much less plentiful than formerly*'. Subsequently, Joseph Woods found some plants in Swansea Bay in 1850, but The Flora of Glamorgan (Wade *et al.*, 1994) draws attention to the absence of records for *M. sinuata* in Glamorgan between 1850 and 1964. Trow (1906) commented that there were no recent records for it in Glamorgan and Riddelsdell (1907) believed that it was extinct in the county by the beginning of the 20th century. Later, Webb (1929) included it in his *catalogue raisonné* of presumably extinct plants of West Glamorgan and Vachell (1936), in her list of Glamorgan flowering plants and ferns, also suggested that *M. sinuata* was extinct '*on the shore near Briton Ferry and Swansea Bay*'. However, the discovery of populations on Baglan Bay and Crymlyn Burrows in 1964 suggested that it may have survived throughout the first half of the 20th century in small or variable numbers in coastal areas that were rarely visited by field botanists (Kay, 1974). In contrast, sand dune systems along the Gower coast (e.g. Oxwich, Port Eynon, Horton, Llangennith, Whiteford) and mid Glamorgan (e.g. Kenfig, Merthyr Mawr) were visited regularly during the first half of the 20th century by very active local botanists such as Eleanor Vachell and John Arthur Webb, but they did not record *M. sinuata* in any of these places. By the 1970s, *M. sinuata* was well known on Crymlyn Burrows (and to a lesser extent on Baglan Burrows) where hundreds of plants were seen by numerous recorders. By the 1980s, *M. sinuata* was established on Kenfig Dunes, and was recorded in Swansea Bay (Swansea Sands), in the vicinity of Swansea University, and in several dune systems along the south Gower coast. The extent to which seeds collected from the Crymlyn Burrows population were introduced to areas outside Crymlyn Burrows and Baglan Dunes (i.e. Swansea Sands, Kenfig and Gower) in the 1970s and 1980s is a matter of conjecture. Gillham (1982) comments on the recovery of *M. sinuata* at Aberdovey in the 1960s but the species was not included by Benoit and Richards (1963) in their preliminary flora of Merioneth nor was it recorded as extant in Merioneth by Ellis (1983) in his compendium of Welsh flowering plants.

POPULATION SIZES AND RECENT TRENDS IN GLAMORGAN

The current distribution of *Matthiola sinuata* in Glamorgan is shown in Figure 2. Each dot on the map represents an occurrence in a monad (1km square) and a record (or records) in the MapMate database.

Sites where *M. sinuata* has been recorded in the last 10 years include: (*in Neath Port Talbot*) Baglan Dunes, Crymlyn Burrows, Little Warren (Aberavon), Margam Sands, Port Talbot Docks; (*in Swansea/Gower*) Llangennith/Broughton, Oxwich/Nicholston, Port Eynon/Horton, Tor Bay, Whiteford; (*in Bridgend*) Kenfig Burrows. There have been occasional records for Aberthaw but these records are not included currently in the local Mapmate database and are not indicated on the map in Figure 2. It was recorded on Whiteford Dunes by Inigo Jones in 1975 and more recently (2015) by Veronica Shenston who noted a single flowering plant there. I am not aware of any current records for Three Cliffs Bay or Pennard which nevertheless provide suitable habitat for it.

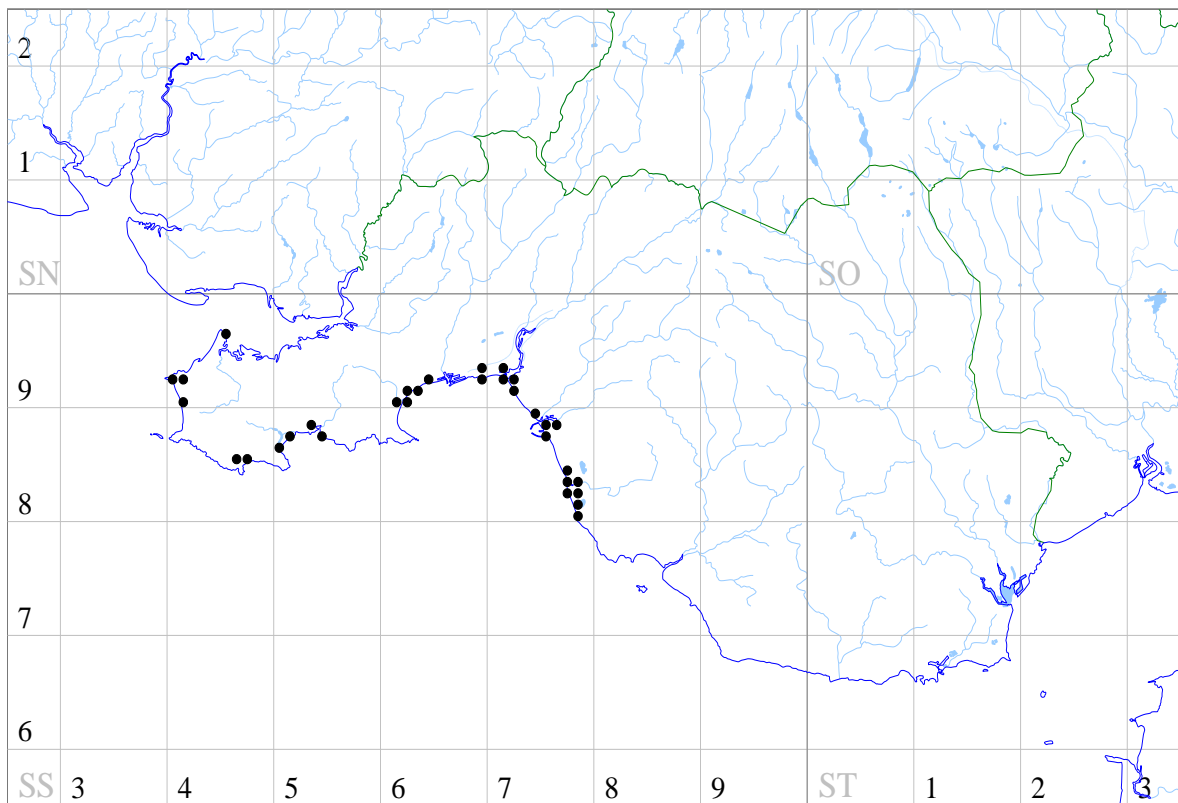


Figure 2 : The distribution of *Matthiola sinuata* in Glamorgan (records from MapMate Database). (NB Plants seen in Aberthaw are not recorded in this database).

Casual estimates of population sizes on Crymlyn Burrows in the 1970s and 1980s suggested that hundreds of plants were distributed across the site from the semi-fixed dunes and shingle near to Swansea Docks in the west to the mobile sand and strandline of dunes in the east near the River Neath. In the 1990s the population became concentrated more in the eastern part of the dune system. In 1993, 100 non-flowering rosettes and 120 flowering plants were counted in the fore dunes near the river mouth by Charles Hipkin (CRH) and Hilary Hipkin (HH); in 1995 the numbers there were 150 non-flowering rosettes and 70 flowering plants. The population decreased significantly after 2000. A count of 6 flowering plants and 28 non-flowering rosettes was made by CRH and HH in 2003. By 2008, the entire Crymlyn Burrows population (a few individuals) was confined to a small area in the eastern part of the site near the mouth of the River Neath. An extensive survey of Crymlyn Burrows by CRH, HH, Megan Woodhouse (MW) and Rebecca Mead (RM) in 2011 failed to record any plants (Mead, 2011; Woodhouse, 2011). However, in 2014 a single plant was located in dunes near the river mouth (Julian Woodman, pers.com).

The extensive surveys carried out in 2011 by CRH, HH, MW and RM in Swansea/Gower, Neath Port Talbot and Bridgend, provide a more detailed picture of the status of *Matthiola sinuata* in South Wales. A summary of the data is given below (Table 1). A recent record of *M. sinuata* plant at Aberthaw, which was photographed (Julian Woodman, pers. com.), is significant and represents the current, southern extension of the species in Glamorgan.

In 2011, 5705 plants were counted in Glamorgan; 38% of the Glamorgan population was on Kenfig Dunes in Bridgend County, 40% was in Swansea County and 22% was in Neath Port Talbot. The

number of non-flowering individuals accounts for more than 80% of all populations during the flowering period and in most populations flowering plants account for <10% of all individuals. This suggests that most individuals live for more than 2 years and this is supported by the unequal numerical proportions of non-flowering rosette classes at each site. (Table 2).

Based on data obtained between 2011 and 2014, the size of the South Wales population is estimated to be approximately 6,000 plants. The entire UK populations is probably <8,000 plants.

POSSIBLE IMPACTS ON SOUTH WALES POPULATIONS

Populations of species at the edges of their natural biogeographic ranges are susceptible to significant fluctuations in their local distribution and abundance, which appears to be true for *M. sinuata* in South Wales. There may be multiple reasons for the population decreases that occurred in Swansea Bay (and elsewhere) in the 100 years after 1850 and the current, spectacular decrease in the Crymlyn Burrows population which has occurred more recently. The following is tentative and offered for discussion purposes only:

1. The long term maintenance of viable populations of *M. sinuata* is dependent ultimately on adequate seed production, germination and seedling survival. Reproductive output by most plants is high and seed production by large populations is impressive. It is unlikely that low seed production *per se* has been the primary factor that has driven historic and current population variations. Seed germination occurs frequently during late winter periods and may be prolific under mild, wet conditions. In mild winters, large cohorts of seedlings can appear in February and March in the vicinity of mother plants. Under these conditions seedlings are prone to high mortalities during periods of severe frost which may occur in early spring.
2. Rosettes are often buried by translocated sand after violent autumn and winter storms, which have occurred frequently in the past and in recent years. *M. sinuata* has no obvious strategy for dealing with this. Severe storms may also remove large amounts of dune structure and any plants established there.
3. Young rosettes are eaten by rabbits (also suggested by McClintock, 1955) and recent decreases in the Crymlyn Burrows population seem to correspond with significant increases in the rabbit population there. Rabbit populations on sites where *M. sinuata* is doing well currently (e.g. Kenfig Dunes) appear to be much smaller. During the 1970s, when *M. sinuata* was abundant on Crymlyn Burrows, local rabbit populations had decreased markedly as a result of myxomatosis.
4. Climate warming may be expected to result in a range expansion of *M. sinuata* in Wales. The extent to which this may be limited by the current broken connectivity in coastal systems is an interesting question. The recent appearance of plants in Carmarthenshire and Pembrokeshire suggest that dispersal over relatively long distances (perhaps in sea water) is possible.
5. Broken connectivity and habitat loss, resulting from coastal development, pose significant threats to the long term survival of *M. sinuata* (and other species of mobile sand dune systems) in Wales. Losses of mobile sand habitats by sand dune fixation and/or erosion, which are occurring along the South Wales coast, are also relevant here. The long term

viability of *M. sinuata* seed in coastal soil reservoirs is unknown. However, the reappearance of plants after long absence in Glamorgan during the 1960s, and more recently in Pembrokeshire, may have resulted from the germination of long-lived, buried (dormant) seeds.

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Table 1: Distribution of flowering plants and non-flowering rosettes in Glamorgan populations in 2011

SITE	NON-FLOWERING ROSETTES	FLOWERING PLANTS	TOTAL
NEATH PORT TALBOT			
Baglan Dunes	118	17	135
Crymlyn Burrows	0	0	0
Little Warren (Aberavon)	487	27	514
Margam Sands	553	31	584
Port Talbot Docks	ND	ND	ND
SWANSEA/GOWER			
Llangennith	872	23	895
Oxwich/Nicholston	612	63	675
Port Eynon/Horton	383	44	427
Swansea Bay	269	15	284
Tor Bay	23	6	29
BRIDGEND			
Kenfig Burrows	2132	30	2162
TOTAL	5449	256	5705

Table 2: Distribution of rosette size categories (diameters in cm) in 8 sub populations on Kenfig Dunes (calculated from data in Mead, 2011).

POPULATION	Rosette Diameter Class					
	1-10cm	11-20cm	21-30	31-40cm	41-50cm	51-65cm
1	54	5	1	0	0	0
2	6	11	1	0	0	0
3	2	0	0	0	0	0
4	62	132	66	15	2	0
5	35	37	16	4	0	2
6	8	16	0	0	0	0
7	257	355	143	58	5	2
8	273	265	182	90	22	5



Figure 3: A 'complex' plant with 5 basal rosettes, Baglan Dunes. This plant has flowered and set seed but each remaining adventitious rosette may produce a reproductive shoot again in the following year.



Figure 4 (A and B): Adventitious rosettes on stems of plants that flowered in the previous year, Baglan Dunes.



Figure 5: Seedlings of *Matthiola sinuata*, Little Warren.