The Distribution and Dispersal of *Beta vulgaris* L. ssp. *maritima* Germplasm in England, Wales, and Ireland[1]

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ABSTRACT

The collection and evaluation of wild germplasm has received increased attention in recent years due to the need for pest resistance genes and concern about loss of germplasm through gradual elimination of natural habitats. This is particularly true of *Beta vulgaris* L. ssp. *maritima* (L.) Thell. (sea beet). A joint exploration among USDA-ARS, International Board of Plant Genetic Resources (IBPGR), Kew Botanical Gardens, Centre for Genetic Resources The Netherlands (CGN), and the Department of Agriculture of the Republic of Ireland was conducted in 1987 to search for this taxon along the coasts of England, Ireland, and Wales. This exploration provided an opportunity to evaluate the distribution and dispersal of sea beet and to collect seed for preservation. The distribution of sea beet was similar to earlier observations. However, many small populations were in danger of elimination, or had disappeared. Plants were most prevalent on shingle (gravel) beaches in a narrow band between high tide and 10 to 20 m inland. Factors threatening or causing extinction of local populations included livestock grazing (particularly sheep), slippage of mud cliffs, industrialization, sea ports, and recreational activities. Agents dispersing

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sea beet germplasm were high tide, wind, animals, and man. Seed collections were made every 15 to 20 km, or wherever a known geographic barrier existed. Seed of the collections were deposited in the USDA NC-7 collection, Ames, Iowa; Kew Botanical Gardens, Wakehurst Place, England; Department of Agriculture, Ireland; and CGN, The Netherlands.

Additional Key Words: Sea beet, plant distribution, population elimination, plant geography.

The collection of exotic germplasm has received increased attention in recent years, largely due to concern about the destruction of natural habitats. This is particularly true of *Beta vulgaris* L. ssp. *maritima* (L.) Thell. (sea beet). This taxon occurs along the sea coast of all Mediterranean Sea countries, most of the Middle East countries, and along the Atlantic coast of northern Europe (including the British Isles). A *Beta* collection team in southern Italy in 1985 found a gradual elimination of sea beet as a result of extensive farming, the practice of cutting and burning roadsides and fence lines, and increased tourist activities (Doney, 1985). Previous site records of *B. vulgaris* L. ssp. *maritima* (L.) Thell. in the British Isles have been published (Botanical Society of the British Isles, 1962) (Figure 1). The sea coast habitat of sea beet has been altered both by the erection of barriers to preserve the sea coast and by the recreational use of beaches and estuaries. Preservation of *B. vulgaris* ssp. *maritima* has received increased interest recently due to the discovery of new sources of pest resistance within the limited collections of this taxon. Resistance to necrotic yellow vein virus (Rhizomania), *Erysiphe polygone* (powdery mildew), and tolerance to *Tetanops myopaeformis* (root maggot) have been identified recently (Doney and Whitney, 1990; Lewellen et al., 1987; Whitney, 1986; Whitney, 1988).

Our expedition in September and October of 1987 provided an opportunity to determine the current distribution of *B. vulgaris* ssp. *maritima*, as well as to collect seed for preservation.

METHODS

A systematic procedure based on previous site records (Figure 1) and ordinance survey maps was used to locate potential sites. The ordinance survey maps proved most beneficial in determining accessibility and land topography. In an effort to sample and preserve the genetic variation existing in the native sea beet populations, sites were selected about 15 to 20 km apart or whenever isolation existed due to a geographic barrier. Only mature seed were collected. In small populations, all plants were sampled; in large populations, a random sample of at least 50

plants was taken. Additional single-plant collections were made of variant plants and of plants showing unique characteristics such as male sterility, monogerm, etc.

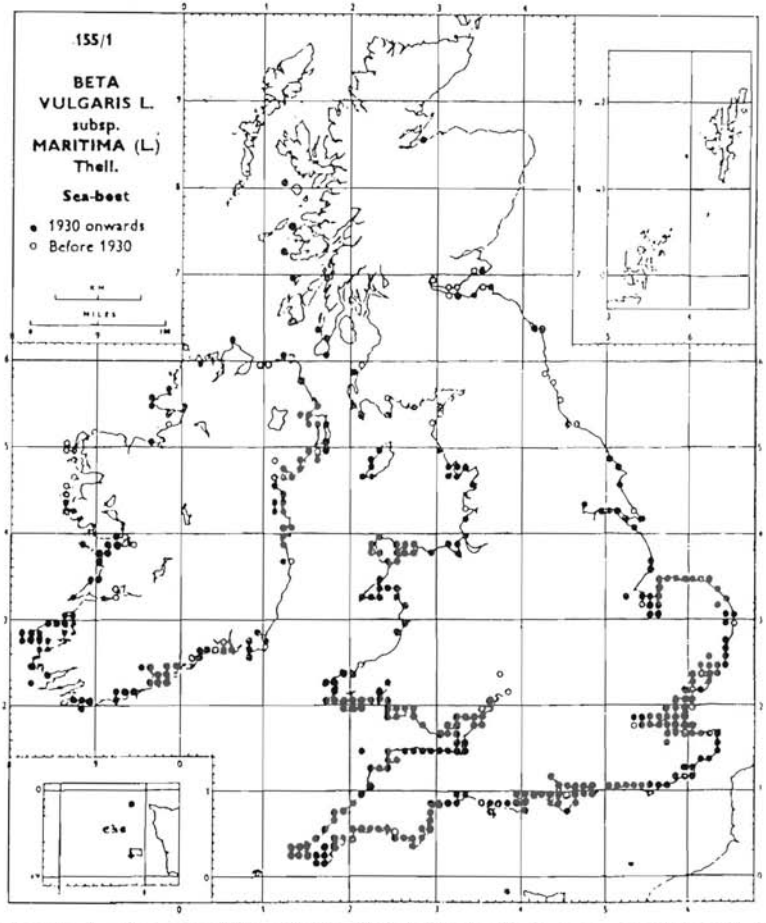

Figure 1. Recorded locations of *Beta vulgaris* L. ssp. *maritima* (L.) Thell. (sea beet) in the British Isles prior to 1962. Atlas of the British Isles, 1962. By permission of the Botanical Society of the British Isles.

For each collection, detailed notes were taken on site location, nearest geographic point or city, estimates of longitude and latitude, habitat, and selected plant characteristics. This information has been entered into the USDA- ARS Germplasm Resources Information Network (GRIN) (Perry and Mowder, 1986).

RESULTS

Distribution. We traveled approximately 12,800 km (8,000

miles), visited 296 sites, and sampled 143 populations. The areas most densely populated by sea beets were the eastern and southern coasts of England and Ireland. Plants ranged in maturity from very young vegetative types to plants with mature seed. Many populations appeared to be perennial in habit, *i.e.*, even though the current year's plants were bolting, older plants had at least one- and sometimes two-year-old seed stalks still present. In many cases, seed were collected from the previous year's seed stalks, since seed of the current year's seed stalks were still immature. Of the 143 collections, 81 were from England, 18 from Wales, 40 from Ireland, and 4 from Northern Ireland.

Wild beets appeared to survive in a very narrow niche along the sea coast. Most plants occurred in a narrow band between high tide and 10 to 20 m inland. They did not appear to survive in dense grass, trees, or sand. We did not find beets on sandy beaches or on sand dunes (Figure 2). Plants often would be found at the end of beaches, either in rocky cliffs or in shingle (rocky or gravel) areas (Figure 3). Areas of mud, clay, or shale cliffs where gradual slippage of the cliffs is occurring did not yield beets. The continual slippage of the cliffs either has destroyed any established beets or prevented their initial establishment.

Figure 2. Sandy beach, east coast of England, October 1987.

The most desirable habitat was shingle beaches within 10 m of high tide; very little other plant life survives here. Wild beets often were found in association with wild mustards (*Brassica* sp.), occupying the same environmental niche. Some very large wild beet populations were found further inland in vacant lots adjoining beaches, but wild beets were never observed in isolated

inland areas.

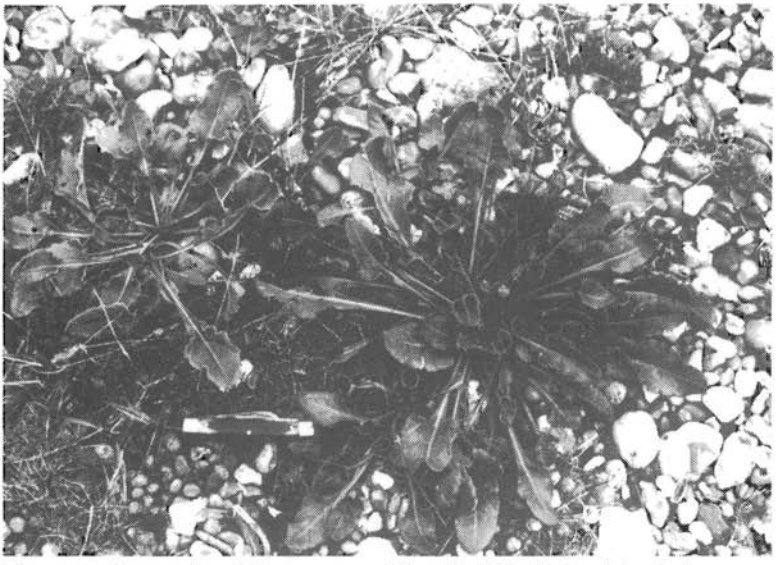

Figure 3. *Beta vulgaris* L. ssp. *maritima* (L.) Thell. in shingle (coarse gravel), southern England, September 1987.

Some populations were very uniform, suggesting a common ancestry. This uniformity was observed in populations that occurred in and around sea walls constructed prior to the 1950s. It appeared that these populations were established from seed washed in by high tide.

A great deal of variability was present in populations that appeared to be old and well established. These populations were most prevalent on relatively undisturbed shingle beaches and harbors. Larger differences in morphological characters were observed as distance and geographical barriers increased. Preliminary analysis of morphological characters suggested that the distance of 15 to 20 km between sites was a reasonable choice. The population at Pegwell Bay, Kent County, England, was morphologically different from the population at Dover (a distance of approximately 27 km south). A population sampled at Deal, Kent County, England, about midway between Pegwell Bay and Dover, exhibited traits from both populations. In this area, the distance of 27 km was sufficient to establish separate ecotypes.

A very large population exists on the eastern coast of Ireland and extends from the north near Ardglass in Down County south to Dublin. Our initial observation was that this was one continuous population extending over 100 km. However, 1988 field observations of plants from seed of this population, grown in Fargo, ND, revealed a gradual change in leaf morphological characteristics over this range. The distance between Ardglass and Dublin appeared to be sufficient to enhance isolation and the formation

of ecotypes.

Sea beets occupying the British Isles sea coast were distinct from those along the sea coasts of the Mediterranean. Mediterranean sea beets are largely annual, whereas the British Isles sea beets appeared to behave as perennials in their native habitat. Many of the latter appeared to have two- or three-year-old seed-bearing stalks. In many instances seed was still immature on the current year's seed stalks. Vegetative reversion also was a common observation, suggesting a narrow photo-thermal induction requirement. The Mediterranean sea beets have many leaf hairs compared to the British Isles sea beet, which has few leaf hairs and a very green, waxy appearance (heavy, waxy cuticle).

Elimination. In general, the distribution of sites for *B. vulgaris* ssp. *maritima* in 1987 was similar to that reported previously (compare Figures 1 and 4). The most densely populated areas were on the eastern and southern coasts of England and Ireland. Large populations were in no danger of extinction. However, elimination of small populations is possible, and in some cases already has occurred.

Sea beets previously had been observed at several sites north of Liverpool. A careful search of this area revealed only one small population of four plants (very susceptible to elimination) southwest of Lancaster and a large population in a protected area near Scarborough. These populations observed earlier must have been eliminated either due to industrialization and recreation activities (Liverpool north to Blackpool) or slippage of mud cliffs (Scarborough south). Many of the previously reported populations along southern Wales have been lost due to intensive industrialization.

The most damaging activity to the survival of sea beet in the British Isles is the grazing of livestock, particularly sheep. In no case did we find wild beets where sheep had grazed. Several populations have been reported on the peninsula west of Donegal, Ireland. This area had been extensively grazed by sheep. A careful survey of the area revealed only 10 surviving plants growing in the cliffs about 10 m below the cliff edge and about 20 m above the sea. Populations reported earlier must have been destroyed by grazing. The only surviving plants were inaccessible to sheep.

The other major factors eliminating sea beets in the British Isles were the many cement sea walls, ports, recreational parks, and human activities at the sea coast (Figure 5). Sea beets rarely were found in or around sea walls constructed since the 1950s. On an earlier expedition, a collection was obtained near Hastings, England, behind the sea wall. A thorough survey of this area in 1987 revealed only a few plants in the cliffs above the harbor.

Dispersal. Factors influencing the dispersal of *B. vulgaris* ssp. *maritima* appear to include wind, tide, animals, and man. During our expedition, a severe storm struck the southern and eastern coasts of England with winds in excess of 100 mph. Wild

beet plants in the path of this storm were stripped of seed and badly beaten. The strength of the storm undoubtedly carried the seed for significant distances. Storms of this magnitude can be major factors in the distribution of the species.

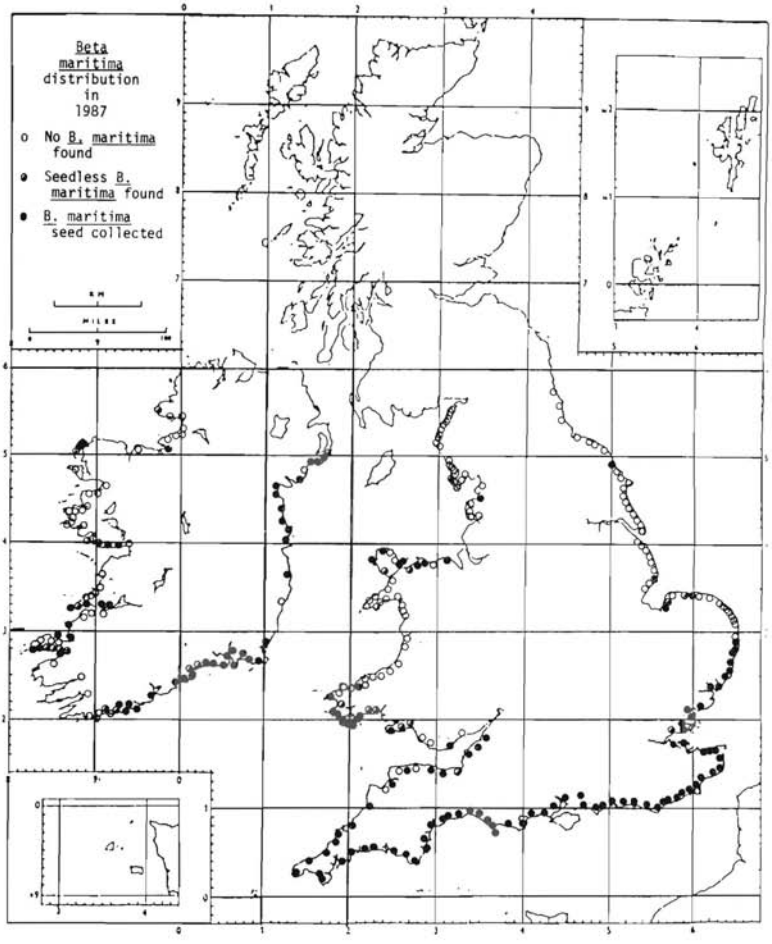

Figure 4. Observed locations of *Beta vulgaris* L. ssp. *maritima* (L.) Thell. and sites visited during 1987 collection expedition.

High tide appeared to be an effective dispersal agent. Several collections were made from plants growing in the cracks of man-made sea walls. One such collection (PI 518403) was found near Tarbort, Kerry County, Ireland. The only plants found within a 20-km radius were growing at or just above high tide, in the cracks of a stone sea wall constructed to protect the nearby power plant. The most plausible explanation for the establishment of this population is that seed was carried in by high tide.

Figure 5. Man-made sea wall and recreational park, southern England, September 1987.

Animals and man have been and still are important agents in the distribution of sea beet. At a collection site near Portsmouth, England, an elderly couple was found collecting beet leaves for food purposes. Upon questioning, we learned that they had collected seed of wild beets to grow in their garden. This practice probably was more prevalent in earlier times.

Seed of the collections were deposited in the USDA NC-7 collection, Ames, Iowa; Kew Botanical Gardens, Wakehurst Place, England; Department of Agriculture, Ireland; and Centre for Genetic Resources, The Netherlands. All collections maintained in the USDA-ARS NC-7 station will be increased under controlled isolation conditions. The resultant seed increases will be evaluated for priority descriptors and made available to the worldwide user community.

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