

Chapter 2

Range of Distribution

Abstract Sea beet is the most widespread taxon within genus *Beta*, and can be found quite easily along the seashores of Mediterranean Sea and the European Atlantic Ocean. On these coasts, countless localizations have been reported in the literature beginning in the early 1700s. The frequency of sea beet populations decreases as one goes inland, where the origin of the populations is more likely due to hybridization between sea beet and cultivated beet crops. Although rare, the presence of sea beet has been reported on the shores of the Middle East North Sea, India, China, Japan, and California. In North America, wild populations of *Beta maritima*, *Beta macrocarpa*, and respective hybrids (with cultivated beet) likely originated from contaminated seed imported from Europe during colonization of California by the Europeans.

Keywords Sea beet distribution • Sea beet habitat • Coastal distribution • Mediterranean distribution • Geographic distribution • North Atlantic populations

Identification of plants in wild habitats is often difficult because the specific distinctive traits may not be displayed at the time of observation. The best period for sea beet identification and classification is at early to late flowering when the seed stalks, flowers, and seed can be differentiated more easily from the surrounding wild vegetation. Confusion between section *Beta* species (*Beta vulgaris* subsp. *vulgaris* and *Beta vulgaris* subsp. *maritima* [sea beet]) and species belonging to other *Beta* taxonomic sections usually does not occur owing to the differences in morphological traits and the difficulty of interspecific crossing. Mistakes of identification among the species and subspecies of the section *Beta* also occur only rarely due to the limited range of *Beta macrocarpa*, *Beta patula*, etc. The major sources of error of identification are the hybridizations between *Beta maritima* and the domesticated *B. vulgaris* complex.¹

¹ Species complex is a cluster of closely related species, subspecies, cultivated, wild, and feral forms, which are able to exchange genetic material in natural conditions (Coyne 1989; Driessen 2003; Fénart et al. 2008; Pernès 1984).



Fig. 2.1 World map showing the distribution of *Beta maritima* along the seashores (red frequent, blue sparse, green rare). For the sea currents, see the text. A Azores, C Canary Islands, CV Cape Verde Islands

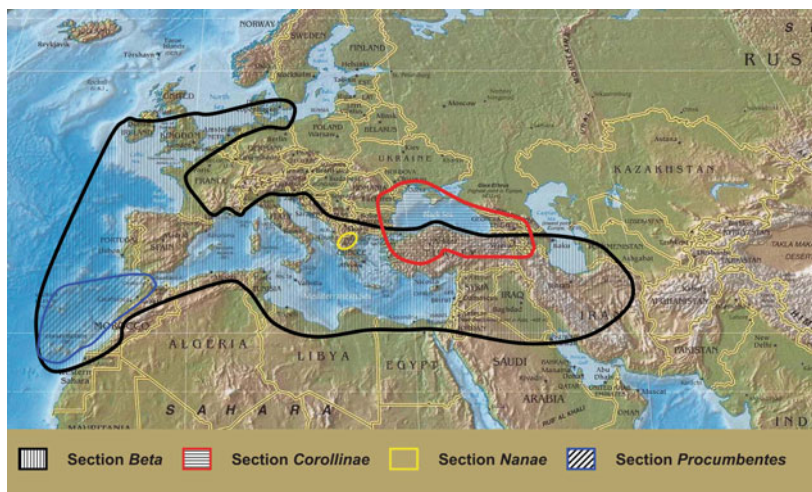


Fig. 2.2 Map shows distribution of the sections of *Beta*, similar to the map of Becker-Dillingen (1928) taken from Krasochkin

Accurate classification always is important, but it is particularly so when sea beet is utilized in breeding programs or there is concern of gene flow. Sometimes, the accessions stored in *Beta* germplasm collections bear an incorrect taxonomic name because species and subspecies are confused when determined by traditional, morphologic methods. It is also possible that the accession, unbeknownst to the collector, includes hybrids from within the *Beta* complex. Molecular techniques can reduce greatly classification mistakes. According to El-Samad et al. (2009), seven markers were enough to differentiate the wild species of genus *Beta*. Only two markers were needed to distinguish cultivated from wild beets. The reliability of the molecular analyses has been confirmed by Hansen et al. (1999).

The countless locations of sea beet populations referred to in the literature are summarized in Fig. 2.1. Most sites, as can be seen, coincide with the areas (Fig 1.5)

bounded by maritime environments within the ranges described by Becker-Dillingen (1928) and Ulbrich (1934). According to Doney (1992) and Fievet et al. (2007), the sites near the sea (up to 10 m above sea level) are where sea beet is the most prevalent. Also *B. maritima* is very common and numerous on seashores and along estuaries (Viard et al. 2004); however, it disappears almost completely as one moves inland, thus demonstrating the environmental preferences of the species (Biancardi 1999).

According to currently prevailing schools of thought, it is likely that some inland populations classified as sea beet are in reality feral beets or some other species or subspecies of the section *Beta* (*macrocarpa*, *patula*, etc.), or hybrids among them. The inland populations are more frequent in the southernmost localities, where the species is found (Villain 2007) and, if classified as sea beet, are in reality crosses among the *B. vulgaris* complex. Van Dijk (1998) asserts that only a few true sea beet populations exist in inland regions. Hohenacker (1838) identified sea beet plants at an altitude of 1,300 m in the Talysh Mountains, on the western coast of Caspian Sea. According to Frese (2010), the altitude of collection sites, corresponding to 798 accessions currently stored in the gene banks and entered into the International Data Base for *Beta*, ranges from 280 m below sea level around the Dead Sea (Post 1869) to 1,300 m on the Talysh mountains. Letschert and Frese (1993) identified populations of *B. maritima* living along the Sicilian coasts and inland up to 1,150 m above sea level. In this case, the overall difference between the coastal and inland populations was small, likely indicating a recent shift of the latter. Sea beet also displays a wide latitudinal range, which on the east Atlantic coasts varies from about 15° North (Cape Verde Islands) to about 58° North (southern Norway and southern Sweden).

Information concerning the localization of *B. maritima* is fairly rare and generic up until the end of the Middle Ages. Bauhin (1622) reported the presence of sea beet near Basel (Switzerland). Parkinson (1655), in an edition of the de Lobel's "*Stirpium illustrationes*," wrote that *B. maritima syl(vestris) minor* and *B. maritima syl(vestris) spontanea* are spread along the Atlantic coast of France, UK, and Scotland. Linnè (1797) confirmed that "*Beta maritima habitat Angliae, Belgii littoribus maris*" (sea beet grows in English and Belgian seashores).

Beginning with the early sixteenth century, the ease of shipping and traveling favored long-range exploration organized by botanical societies, which had become numerous by then in all European countries. The scientific curiosity of botanists was expensive, especially travel to the unexplored territories of the New World, East Asia, and Australia. This spirit of research was supported by governments not only out of scientific curiosity, but also for political and commercial purposes. John Ray (1738), in collaboration with other local botanists, wrote, "Travels through the low-countries, Germany, Italy, and France," and catalogued the plants encountered during long journeys in Spain, Sicily, Germany, and so on. Among the botanists cited by Ray, Antonio Donati (1826) did not detect the presence of *B. maritima* in the Lagoon of Venice, and no populations of *Beta cretica* were reported in the Greek islands. Different types of wild beets were located in Lusitania (Portugal) and named as *Beta alba maxima*, *Beta radice rubra*, and *Beta marina semine aculeato*. The latter was found, together with *Beta marina semine aculeato minor* (sea beet minor with thorny seed), on the island and the promontory of Pachino and Pozzallo (Sicily, Italy). Sea beet was located in several parts of the Italian Peninsula and included in

botanical gardens there (Micheli 1748; Tenore 1851), as well as in other parts of Europe (Desfontaines 1829).

Hooker (1835) wrote, “*Beta maritima* Linn. is in sea shores, especially in muddy soil, England; and in the south, principally of Scotland.” Bunge cited by von Proskowetz (1895) listed the localities, where the species of genus *Beta* are widespread. He highlighted that 9 species out of 14 belonging to genus *Beta* were identified on the Canary Islands. Boissier (1879) listed the shores of the following locations: *Zacynthus*, *Attica*, *Pontus Exinius* (Black Sea), *Maris Caspii*, *Cyprus*, *Syriae littorals* (Syrian seashores), and *Egypti Alexandria, interioribus umidis Babyloniae* (wet sites around Babylon). In addition to areas of the North Sea listed by other authors, Reichenbach and Reichenbach (1909) asserted that sea beet also grew at Eppendorf and on the shores of Aerø Island, Denmark. Darwin (1899), cited by von Lippmann (1925), observed that an indigenous wild *Beta* in India developed better than other European varieties. This wild variety, named “*palung*” and “*mitha*,” could have been a locally adapted sea beet (Watt 1899). Von Proskowetz (1896) summarized a number of observations and locations made by his contemporaries (Hehn, Willkomm, Bunge, Freyn, Engler and Prantl, de Candolle). The *Beta* species were named according to de Tournefort (1700).

De Vries (1905) wrote, “Beets are even now found in large quantity along the shores of Italy. They prefer the vicinity of the sea, as do so many other members of the beet family, and are not limited to Italy, but are found growing elsewhere on the littoral of the Mediterranean, in the Canary Island, and through Persia and Babylon to India. In most of their native localities they occur in great abundance.” Ascherson and Graebner (1919) limited the range of sea beet to Denmark, the British Islands, France, Italy (and its islands), Spain, Albania, Greece (and its islands), Bulgaria, Central and southern Russia, the Near East up to Western India, North Africa, and Canary Islands. Becker-Dillingen (1928) listed the areas into which *B. maritima* had spread and stated, “the species is clearly halophytic. It is widespread not only along the seacoasts, but also in soils more or less recently submerged by salty water.” The northern limit seems to be the isotherm at 14°C in July (Villain 2007). Grogan (2009) asserted that Ireland seems to be at the limit of the sea beet habitat, since populations were located only on the southern and central part of the island, i.e., near the sea warmed by the Gulf Stream and sunny sites. But other authors have localized sea beet along the northern shores of Northern Ireland as well (Anon. <http://habitas.org.uk>).

Von Lippmann (1925) summarized the locations of sea beet populations reported in literature at the time, which were divided among the three continents facing the Mediterranean Sea.

Asia: Along coasts of the Caspian Sea, Talysh, Caucasus, Dagestan, Transcaucasia, the Black Sea, Armenia, Asia Minor, Syria, Mesopotamia, Red Sea, Persia, India, Turkestan.

Africa: In Egypt, Atlantic Isles (Canary, Madeira, Cape Verde).

Europe: In Norway, Lapland, Finland, Karelia, Sweden, southern coasts of the North Sea, Schleswig (Germany), Holland, England, Ireland, France, Portugal, Spain, Italy, Balkan countries, Malta, Cyprus.

After mentioning the different synonyms for *B. maritima* used by various authors at the time, Ulbrich (1934) sketched the area of dispersal, confirming much of the range described by Becker-Dillingen (1928), excluding only the most northern parts of Europe cited by von Lippmann (1925). According to Ulbrich (1934), the range extended from the shores of the Mediterranean, the Canary Islands, and Iberian Peninsula to the Middle East and Western India. The species is widespread on the Atlantic coasts of France, England, Holland, Denmark, Germany, and on the southern coasts of Sweden and other Nordic countries bordering the Gulf Stream. As observed by Strobl, cited by Ulbrich (1934), the sea beet grows on the slopes of the volcano Etna (Italy) up to 850 m in altitude.

According to de Candolle (1884), the plant was common in sandy places near the seas of Mediterranean Europe, Africa, Asia Minor, and in the Azores and Canary Islands. It was also present in Algeria, Egypt, Persia, India, and Eastern Europe. Moquin-Tandon, cited by de Candolle (1884), extended the localization of the species to the Caspian Sea and eastern India. The dispersal, according to (USDA-ARS GRIN), includes also Azerbaijan, Belgium, Ireland, Morocco, and the Azores, Madeira, and Cape Verde Islands. Trotter, quoted by Munerati et al. (1913), detected the presence of *B. maritima* near Aquiloni, Italy, at 350 m in altitude and about 60 km far from the sea. Krasochkin and Ouzunow (1931) limited the range of the species belonging to genus *Beta*.

Zossimovitch, cited by Coons (1954), reported the presence of *B. maritima* in the Russian steppes, especially in depressions characterized by salty and alkaline soils. Hermann (1937) located sea beet on the East coasts of England, also observing a different flowering behavior and an elevated diversity among the populations. The same (polymorphism in habit, pigmentation, number of flowers/cluster, and incidence of male sterility) was observed by Jassem (1985) along the French and British shores of the English Channel. These populations were widely studied beginning in 1990 (Cuguen et al. 1992). An accurate description of the environments preferred by sea beet was made by Doney and McFarlane (1985) after a survey along the coasts of Southern Italy: “The best collections were near ancient ruins and undisturbed beaches. Near Capo Colonna, Sicily, the wind creates a constant sea water spray on the *Beta maritima* growing in the rocky cliffs along the shore.² The intensive farming along with the increased tourism appeared to have driven much of the native flora to fence lines and roadsides.”

The first written mention of the presence of sea beet on the Baltic seashores was at the end of the seventeenth century at Marstal, Denmark (Christensen 1996). Hehn and Hück, cited by von Lippmann (1925), reported German localizations. Further locations noted were on Samsø Island, Denmark, and in the southern coasts of Sweden and Norway (Batwik 2000; Engan 1994; Often and Svalheim 2001; Pedersen 2009). Since 1967, several new populations also have been located on German shores (Driessen 2003); although the presences of sea beet in this area was considered doubtful by Karsten (1880), the presence of sea

² On some sea beet samples belonging to the *Herbarium siccum* of Aldrovandi (Baldacci et al. 1907), salt crystals are still evident on the leaves (fig 1. 19).

beet here has been established dating back to prehistoric times (Kubiak-Martens 1999). According to Griesebach, Schübeler, Müller, Kempe, Hehn [cited by von Proskowetz (1895) and by von Lippmann (1925)], different species of genus *Beta*, including sea beet, were present in Lapland, Finland, Karelia, Central Australia, etc. These locations were not confirmed by later authors. Makino (1901) reported that *B. maritima* was at Musashii and Hiranuma on Yokohama Island, Japan, but only as very rare. In China, some populations of sea beet were mentioned by Doney and Whitney (1990).

Carsner (1928, 1938) reported the presence of wild beets along the Pacific coasts of California (Santa Clara, Ventura, San Bernardino, and Los Angeles) and in the Imperial Valley near the Mexican border. In the first case, he speculated that these beets were either *B. maritima* or natural crosses between this species and the cultivated varieties. In the latter case, the wild populations were classified as more or less composite crosses with *B. macrocarpa* and sugar beet varieties (Bartsch and Ellstrand 1999; Bartsch et al. 2003; McFarlane 1975).

Confirming the countless locations related in the literature, *B. maritima* is widespread on almost all Mediterranean and Black Sea coasts, if the site fits the needs of the species. Those needs are the presence of stones, limited periods of drought, limited presence of weeds, full sunlight, and a location close to saltwater (Biancardi, unpublished). In Fig. 2.1, note the absence of colonization not only in the east coasts of the Americas, but also in the southern hemisphere. Absence from the African shores below Morocco and the Cape Verde Islands could be explained by the prevailing direction of the Canary ocean current that flows westward toward the Caribbean Islands. The abundant floating seeds of *Beta* species released from the Canary Islands and the Atlantic North African coast would lose germination viability, become saturated, and sink before reaching the American shores.

Letschert (1993) confirmed the occurrence of *B. maritima* at the sites mentioned above, except for China, Japan, Lapland, Karelia, Finland, and Australia. A few isolated populations were discovered both in China and Japan and the seed is stored in the respective national banks of germplasm (Frese 2010) (Sect. 8.1). Recent surveys did not report the presence of sea beet in China (Shun et al. 2000), the Czech Republic (Stehno et al. 2000), Latvia (Rashal and Kazachenko 2000), Belarus (Svirshchetskaya 2000), Georgia, and Iran (Aleksidze et al. 2009). The presence was confirmed in Azerbaijan (Akperov 2000) and Armenia (Ghandilyan and Melikyan 2000). *B. maritima* is fairly widespread on the western coasts of Caspian Sea, Slovenia, Romania, and Crimea (Ukraine), but is very rare in Bulgaria (IPGRI 2004).

Sea beet currently appears to be expanding its range on the German coast of Baltic Sea perhaps due to global warming (Driessen 2003). On the West-Adriatic coast, a reduction in size of populations has been observed caused both by the decreasing amount of summer rain and increasing tourist activities along the seashores (Pignone 1989; Stevanato, personal communication 2011). At this location, the number of plants within undisturbed populations seems to be correlated with the distribution and amount of rainfall from the previous year. In long-lasting drought periods, the number of plants decreases dramatically (Bartsch and Schmidt 1997). If this occurs, the older plants, i.e., those with more developed and deeper

root systems, are greatly favored in survival because of the very low water holding capacity of the sandy soils along the seashores (Biancardi, unpublished). Doney et al. (1990) wrote, "The current (1990) distribution of sea beet (in Ireland) was similar to earlier observation in 1962. However, many small populations were in danger of elimination, or had disappeared. Factors threatening or causing extinction of local populations included livestock grazing (particularly sheep), slippage of mud cliffs, industrialization of sea ports, and recreational activities."

In conclusion, sea beet is common in many places along the Mediterranean coasts and islands, where the location is fit for the plant. Likewise, it inhabits the North Atlantic shores, from Morocco to southern Norway, including the Brittan, Macaronesian, and Cape Verde Islands. The Cape Verde Islands, which cross the Cancer Tropic (around 23° latitude), seem to be the southern limit of the species, whereas the northernmost populations have been found on the South-Norwegian coasts, around 59° latitude. Minor spread is reported in the Middle East, Caspian Sea, Iran, and West India.

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