

ART. XLIII.—*The Difference between Sea and Continental Climate with regard to Vegetation*; by Mr. BUYSMAN, of Flushing (Vlissingen), Holland.

THE difference between the vegetation of the sea and continental climates is, no doubt, best observed in the growth of the plants that are generally cultivated for different purposes in the temperate zone; as every climate has its own region or flora.

Whether the climate of a country is favorable to those plants or not is shown, in the first place, by their extension northward; and we shall first, therefore, endeavor to trace the northern limits of the most important plants, either cultivated in one country and growing wild in another, or cultivated everywhere.

To the first class most trees belong; to the second, annual or perennial plants. We begin with trees.

Pinus sylvestris L. Scotch Pine. Scotland, 59°. Norway, 70° 20'. Kola, 69°. Petschora region, 67° 15'. Obi river, 66°. Turuchansk, 65°. The Werchojansk mountains, east of the Lena river (64°), are the eastern limits of this tree.¹

¹ Middendorff, *Sibirische Reise*, Bd. IV, Th. I, p. 556.

Betula odorata Bechst. (*alba* L. var.) Birch. Greenland, 61°, shrub. Iceland, 65°, shrub to 10 feet high. Britain, 59°. Norway, 70° 50'. Peninsula Kola, 69° 30'.² Peninsula Kanin 67°, to the Obi river 66°, and from the river Kolyma 68°, to the Peroshina Gulf 63°, and Kamtschatka; on this peninsula it is a large tree.

Quercus pedunculata Ehrh. (*Q. robur* L. var.), Common Oak. England, 58°. Norway, wild, to 62° 55': cult. 65° 54'. Finland, coast, 61° 30' (Björneborg). St. Petersburg, Taroslav, Perm, 58°.³

Larix Europæa DeC. (including *L. Sibirica* Ledeb and *L. Dahurica* Turcz.), Common Larch. Norway, *Europæa* DeC. 66° 5'; *Dahurica* Turcz. 59° 55'; both cultivated. Onega river, White Sea, S. W. shore of Onega Lake, Mesen (Peninsula Kanin), 67°. Petschora river, 67° 30'. Ural mountains, 67° 15'. Kora river, 68°, northern limit in Europe. Yenisei river, 70°. Boganida river, 71° 15'. Chatanga river, 72° 30', most northern limit of trees on the globe. Anabar, 71°. Olenok and Lena, 72°. Yana, 71°. Yndigirha, 70° 45'. Kolyma, 69°. Anadyr, 65°. Between Ochotsk and Gishiga, 61°. Peninsula Sachalin, 49°. To Yeddo and the island Kunaschir, 43° 45'. On the shores of Kamtschatka the larch is nowhere to be found; in the valleys of this peninsula, however, protected from sea-winds, it is a very large tree.⁴

Pyrus Malus L., Apple. Shetland Isles, cult. Britain, 57°. Norway, cult., 65° 28'; wild, 63° 40'. Gulf of Bothnia, 63° 45', cult. Finland, 63°, cult.; 60° wild. Northern shore of Onega Lake, cult. Narva, 59° 30', wild. Twer, 56° 45', wild. Nishny Novgorod, 56°, wild. Kasan, 56°, wild. Southwest of Orenburg, 50°. Kopal, Asia, 45°.

Fagus sylvatica L., Common Beech. Britain, 58°. Norway 59°, cult. 67° 56'. Sweden, 57°. Königsberg. Poland. S. W. Russia. Krim. Caucasus. Persia.

Castanea vesca Gærtn., Chestnut. South Britain. Germany (to the island of Rüyen). Austria. Caucasus.

Populus alba L., Abele Tree. Britain, 56°, wild and cult. Norway, cult., 67° 56'. Germany, wild and cult. Austria. Russia: Volhynia. Kiev. Charhow. Tambow. Kasan. Ufa. Altai Mountains.

Populus tremula L., Aspen. Britain, 59°. Norway, 70° 37'. Russia. Peninsula Kola, 69° 30'. Eastern shores of the White Sea, 66°. Yenisei, 66°. Kolyma river, 67° 30'.⁵ Amur river.

Alnus incana W., Hoary-leaved Alder. Canada. Norway,

² Ibid., p. 567.

³ Ibid., p. 575.

⁴ Middendorff, Sibirische Reise, Bd. IV, Th. I, p. 536.

⁵ Middendorff, p. 573.

70° 30'. Kola, 69° 30'. Yenisei, 67°. Amur region. Petropaulovsk, on Kamtschatka.

Ulmus campestris L., Common Elm. Britain, 57°. Norway, cult., 63° 26'. Russia: Ilmen Lake. South of Moscow. Riazan. South of Kasan and Ufa to the Ural mountains.

Tilia Europæa L. (inclusive of *parvifolia*, *grandiflora* and *intermedia*). Lime Tree. Britain, 57° (*parvifolia*). Norway, wild, 62° 9'; cult., 67° 56'. Petersburg. Kargopol. Ust Süssolsk, about 62°. Solikamsk. Ural mountains, about 58° 50'. Werchoturje.

Vitis vinifera L., Common Grape. Bretagne, 47° 30'. Liège, 50° 45'. Thuringia to Silesia, 51° 55'. South Galicia. South Russia, between about 48° and 49°. Astrachan. Bucharra in Turkestan, 40°; here the vine is cultivated in the open fields.⁶ Chiwa, 42°. China, 40°. California.

This plant cannot stand the extreme cold of the Asiatic continental winter climate, and requires a very warm or a very long summer (California); it cannot, therefore, be cultivated generally in Britain. The fact of its being cultivated with success in California is no doubt owing to the continual clear sky and then to the *direct solar warmth*; the *mean temperature* is here in summer *much lower* than in Europe in the same latitude.

Triticum vulgare Vill. var. *æstivum*, Summer Wheat. Britain. Norway, in the fields, 64° 40'; in gardens, 69° 28'. Finland, 65°.⁷ Dwina river, 63°. Yakutsk. Western shores of North America, 55°. Fort Liard, 60° 5' (N. W. territory of Canada).⁸ Peace river, 56° 6'. Ontario. East Canada.

Hordeum vulgare L. (including *hexastichon*), Barley. Faröe Isles, 62° 15', seldom ripe grains. Norway, 70°. Western shores of the White Sea, 67°. Ob river, 61°. Yakutsk, 62°. Udsuvi Ostrog, near the Ochotsk Sea, 54° 30'. Kamtschatka (inland), 53° to 54°. N. W. American shore south of Sitka, 57°. Fort Norman, Mackenzie river, 65°.⁹ East of Winnipeg, 50°. St. Lawrence Bay, 50°.

Avena sativa L., Oat. Scotland. Norway, 69° 28'. Finland, 69°. Asia: the same latitude as *Hordeum vulgare*. Yenisei, 61°. Yakutsk, 62°. Kamtschatka (inland). North America: the same latitude as *Hordeum vulgare*.

Secale cereale L., Common Rye. Britain. Norway, 69° 30'. Finland, 67°. Mesen river, 65° 45'. Petschora region, 65° 45'. Ural mountains, 57°. Obi river, 60°. Yenisei, 59° 30'. Yakutsk, 62°. Kamtschatka (inland). N. America, a little south of the latitude of the barley; eastern shores, 50°.

⁶ Grisebach die Vegetation der Erde, vol. i, p. 407.

⁷ Middendorff, p. 709.

⁸ Richardson, Searching Expedition through Rupert's Land, vol. ii, p. 267. Fort Liard is between 400 and 500 feet above the sea-level.

⁹ Richardson, p. 269.

Solanum tuberosum L., Potato. Britain. Norway, 71° 7'. Russia, Pinega river, 65°. Turuchansk, 65°. Yakutsk. Shores of the Ochotsk Sea. Kamtschatka. Kadjak Island. Sitka Island. Mackenzie river, 65°. Canada. Labrador, 58° 45'.¹⁰ Greenland.

Zea Mays L., Indian Corn.—This plant requires also a very warm summer to ripen. In England it can be cultivated only as a green vegetable; on the western shores of Europe the cultivation is profitable only to the 46th degree N. L., while in the valley of the Rhine it reaches to 49°. In Northern Germany the grain usually does not ripen. In North America, however, it is cultivated with profitable returns up to 51° N. L.¹¹ The period of vegetation varies there between seven and three months. Cultivation of the varieties maturing in a shorter period has been tried in Europe but without success; they were transformed after a few generations into the common corn. There must exist peculiar relations between the American climate and the vegetation of this plant.

Thus we see that of the plants just named, the Larch, the Pine, the Birch and the Aspen go into Siberia, with its excessive continental climate, farthest to the north; yet many of the cultivated plants mentioned above, and almost all those of the temperate zone, are either cultivated or grow wild in the sea climate of Norway to very high latitudes.

On the northwest shores of America the Pine attains considerable size (Sitka) in a climate with continual precipitation, but the same size is to some extent observed on the Rocky Mountains (eastern slope), where the climate is wholly different.

In British Columbia the climate is continental and very cold in winter, yet the same gigantic trees are here to be found as on the coast; precipitation takes place in spring, but the amount is very great.

In California, with the largest coniferous trees of the world, (*Wellingtonia gigantea*), rain falls chiefly in winter (November to April); the other months are dry. The cause is known: the polar stream coming from the northwest reaches the Californian coast under about 45° N.; the water being in summer much colder than the land and the winds in this season mostly northwest, no precipitation can take place. This is the cause also of there being very little difference in temperature between summer and winter;¹² but climatical causes will not alone explain the gigantic vegetation of the west and northwest shores of North America. In Norway or Ireland, both having very wet

¹⁰ Petermann, Geogr. Mittheilungen, 1859, p. 124.

¹¹ Richardson, vol. ii, p. 267.

¹² San Francisco, winter 46°, summer 53°, year 51°.

climates, such enormous trees are nowhere to be found. It is a peculiarity of the Pacific coast vegetation, the cause of which is unknown.

In the southern parts of the Amur region in Asia, there is in summer a luxuriant vegetation; the annual precipitation amounts to 27.56 inches (about the same amount as in Germany), and the plants much resemble those of Central Europe,¹³ and this notwithstanding a winter temperature much lower than is observed in the most northern parts of Lapland; but the summer is here much warmer than in Europe under the same latitude, and *precipitation takes place only in summer*.

In the interior of Siberia the vegetation consists chiefly of coniferous trees; thus the luxurious growth in the region just named must be caused by the influence of the sea climate, as Middendorff suggests,¹⁴ though there is a mountain chain on the east coast.

The extensive forests of Russia and Siberia prove that an extreme continental climate is resisted by some coniferous and other trees; but it is evident that in general a sea climate with mild winters, and thus a long period of vegetation, suits them best.¹⁵

As we have seen, the northern limit of the cultivation of corn reaches to a much higher latitude over the continent than near the seashore. On the northwest coast of North America the Island of Sitka (57° N. L.) and Radjah are on the extreme limit. On the Faroe Islands barley is cultivated, but corn seldom ripens;¹⁶ the cause is absence of sunlight on account of the continual cloudy sky, storms and precipitation causing low temperature in summer (mean temperature at Thorshaven in July, 55°); for corn wants a sunny climate and the direct influence of the sun's rays. This explains why it can be cultivated within the polar circle (Norway) where the sun in the summer season remains constantly above the horizon.

In North America, on the shores of Hudson's Bay, the tree limit goes down to 59°, the corn limit to 50° (Ontario). On the shores of the Ochotsk Sea corn cannot be cultivated at all, even on the south coast under 50°. In Greenland also the cultivation of corn is impossible. The causes are the same as stated above—the sea winds, wet climate and fog in summer; that is, want of sunlight.

Of all cultivated vegetables *Raphanus sativus* L. et var. (Radish), *Brassica Rapa* L. et var. (Turnip) and *Brassica Napus*

¹³ Kittlitz, Vierundzwanzig Vegetationsansichten von Küstenländern und Inseln des Stillen Ozeans, p. 53.

¹⁴ Middendorff, p. 763.

¹⁵ The stems of all the Siberian trees are slender compared with those of Europe, even when they are centuries old. Middendorff, p. 632.

¹⁶ Martins, Sur la vegetation de l'Archipel des Féroé.

L. et var. (Rape) grow as far north as there are settlements. In Norway beyond 70° N. L.; in Siberia to the Polar Circle; on the N.W. coast of America to $64^{\circ} 45'$ (Nulato) and Redout St. Michael ($63^{\circ} 30'$); in the interior to 67° (Fort Good Hope).¹⁷ In Greenland, Rapes, Turnips, Cabbage and Salad are cultivated under 70° L. (Island Disko).

The potato follows the above named plants in their distribution to the north and belongs also to sea climate species. On its northern limit, however, in Siberia as well as in N. America, it reaches only the size of a walnut.¹⁸ In Greenland, only the most careful treatment can produce eatable potatoes. The plant never blossoms there.¹⁹

Comparing the vegetation of the extreme continental climate with that of the extreme sea-climate on the globe, the continental has the advantage. The South Shetland Islands under 60° – 63° S., are the most southern limit of phanerogamous plants (only a grass—*Aira antarctica* Forst—is found there); and on Cockburn Island, 64° S., the last trace of vegetation is found (cryptogamous plants). In this latitude north there is in Siberia a forest of very high coniferous trees. In the antarctic regions there are several causes why vegetation ceases at so low a latitude, but these are all consequences of the chief cause, viz: the fact that the whole southern hemisphere, with the exception of relatively small spaces, is covered with water; a continual very low barometer and severe storms,²⁰ combined with a very low summer temperature,²¹ banish all vegetation.

The extreme continental climate has also its disadvantages, but chiefly with relation to the cultivation of corn. In the first place, corn is very often destroyed by night frosts, which make the harvest uncertain.

The constantly frozen ground is the chief cause why corn cannot be cultivated in Siberia beyond 62° (Yakutsk). The temperature of the soil in which the roots vegetate varies between 36° and 41° . Thus, notwithstanding the mean temperature of June at Yakutsk is 55° , and that of July 62° ,²² the vegetation is relatively slow,²³ though its period (10 to 12 weeks) is the same as observed in Central Europe. The same period is observed in North America, under 63° (Fort Simpson)²⁴ of the barley. (Wheat does not come to maturity there.) But

¹⁷ Richardson, vol. i, p. 214.

¹⁸ Middendorff, p. 700.

¹⁹ Etzel, Grönland geogr. und statistisch beschrieben. Stuttgart. 1860. p. 282.

²⁰ Lowest reading of the barometer by the United States Exploring Expedition under Wilkes on lat. $65^{\circ} 15'$, 27.50 . See Narrative of the Expedition, London, 1852, vol. ii, p. 281.

²¹ Under lat. $64^{\circ} 5'$ mean temp. of January, 1843. 31° ; under 62° – 66° , in February, 31° . See Ross, Voyage in the Southern and Antarctic Regions, vol. ii, p. 352–360.

²² Middendorff, p. 772.

²³ Middendorff, p. 718.

²⁴ Richardson, vol. i, p. 165.

a harvest of thirty to forty times the quantity that was sown alternates in this climate with years of no harvest at all.²⁵

As is well known, the native plants withstand the lowest temperatures of the Siberian winter.

Returning to Europe we have seen that even the climate of the northern parts of the British Isles is not suited for many vegetables and other cultivated plants.

It is Germany which has a climate adapted to almost all the plants of the temperate zone and to those commonly cultivated. We see the vine in this country ascend farthest to the north, while corn and all vegetables ripen their seeds perfectly. The climate is clearly that best suited for the vegetation of this latitude.

Now, if we compare the mean temperature of July in Germany with the mean for the latitude (for 50° N.— 62°) calculated by Dove, we find that even in this country the summer temperature is, in general, *only a few degrees above the calculated*. Germany is crossed in July by the isotherm of 68° , and Britain by that of 59° ; but the difference in vegetation is not caused by a difference in mean temperature of nine degrees, but by the difference in the *days of sunshine*.

Thus we come to the conclusion that a mixed climate with relatively mild winters (the anomaly of temperature for January is for Germany about $+9^{\circ}$ on the 50th degree of latitude) and *warm sunny* summers is the condition best suited for the vegetation of the temperate zone.

Flushing, June, 1884.