

Geographical Adaptation and Distribution of Seabuckthorn (*Hippophae* L.) Resources

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ABSTRACT

Seabuckthorn (*Hippophae rhamnoides* L.) is a plant of cold regions of Asia and Europe. Six species and nine subspecies of the plant, majority in Asia, have been found. Seabuckthorn is sun-loving plant and avoid shades. There is a natural distribution of seabuckthorn in the regions with the temperature isolines over 25°C on the average in the summer. Therefore, the optimum temperature during summer for natural distribution of seabuckthorn is between 15-25°C. The maximum radiation in the sunny days of May-July is 23.5-26.5 kcal/cm² between the isolines. This indicates, that seabuckthorn plants, though favour cold climatic conditions, require a certain high temperature condition during the active growth period. Natural distribution of seabuckthorn varies from 60 to 5300 m above sea level. Under natural conditions, seabuckthorn grows on slope, well-drained soil with silt, riversides and lakes and seashores, and wastelands. Each species has been found to prefer certain specific site conditions. Plant is well adapted to dry conditions, as it takes root easily even in dry and infertile soil due to presence of nitrogen fixing bacteria, Frankia, in its roots. Seabuckthorn grows in about 30 countries of Asia and Europe and it has been introduced in north and south America. About 80-90 percent of the world resources of seabuckthorn (about 1.2 million ha) have been found in China. Other countries rich in seabuckthorn resources are India, Russia and Mongolia.

Key words: Seabuckthorn, geographical adaptation, climatic and soil factors and distribution.

INTRODUCTION

Seabuckthorn generally grows in cold and low rainfall areas of Asia and Europe. It has been reported growing in about 30 countries and introduced in North and South America. Rich resources of seabuckthorn have been found in the surveys in China, Russia and Indian Himalayas; however, its natural distribution has been affected in many countries of Europe. With the discovery of rich nutritional and medicinal properties in the fruit and leaves of seabuckthorn, its systematic cultivation has started in many parts of the world. Large-scale plantations on the mountainous wastelands have also been carried out mainly to control soil erosion in countries like China. While seabuckthorn is a widely distributed plant, it requires specific temperature, rainfall and habitat conditions. Different species have been evolved and adapted to varying geographical, climatic, soil and local conditions. The present paper describes the factors affecting geographical adaptation and distribution of seabuckthorn in various parts of the world.

GEOGRAPHICAL ADAPTATION

Environmental conditions

Himalayas and its adjacent areas spread from northwest Himalayas to the Hengduan mountains and middle or Mediterranean Asia are the distribution as well as origin centers of majority of seabuckthorn resources from where it is believed to have spread to European countries (Zhuode et al., 1989). There are two groups of genus *Hippophae*, i.e. coat and coatless groups. The coat group includes 3 species i.e., *H. neurocarpa*, *H. tihetana* and *H. gyantsensis*, in which, fruit rind and seed coat bind each other, also known as high frigid brush formation, often found in high altitude regions (generally from 3000 m to 5300 m asl). They are tolerant to extreme sub-frigid climatic conditions of tree line, even alpine and subalpine zones and make pure dominant community there. *H. rhamnoides* and *H. salicifolia* belong to coatless group, i.e. in which fruit rind and seed coat do not bind each other. They are generally distributed in lower regions and are classified as temperate brush formation. They are spread from subtropical to temperate zone, having distribution from 1500 to 3800 m asl. The species of seabuckthorn of this group have a greater ability against formed trees, they occur often in the dry and poor sites, e.g., hill ridge or hill top, valley terrace, moist sandy ground like riversides and slopes (Zhuode et al., 1989).

Temperature and light

In Asian mountains, it has been found growing at an altitude range of 1500-5300 m asl, however, vigorous growth has been observed in China at an altitude of 1500-2500 m with annual mean temperature range of 4-8°C. In cold desert areas of Indian Himalayas, it has been found with vigorous growth at 2550-3760 m (In Lu Rongsen, 1992; Singh et al., 1995). Seabuckthorn is a thermophilic plant, which is indicated even by higher temperature (24-26°C) requirement for germination of its seeds as compared to apple and cherry, which germinate at 1-3°C, having passed through their physiologically dormant period. However, the adult plants can withstand as low as -40°C in winter for long duration. While low winter temperature is not an important requirement, however, temperature higher than 30°C can kill the seedlings, which is the main cause of failure of introducing seabuckthorn from mountain to plain areas. Seabuckthorn grows under varied conditions of temperature, i.e., *H. rhamnoides* ssp. *sinensis* grows very widely in vast mountainous areas with mean annual temperature range of 3.6-10.7°C in China, *rhamnoides* ssp. *turkestanica* grows at an annual temperature range of 2.7-7.5°C in central Asia, whereas *H. tibetana* grows from -4.7 to 1 .1°C in Tibet (In Lu Rongsen, 1992).

All scientists agree that seabuckthorn is a light demanding species and highly intolerant of shade. This requirement is more pronounced in seabuckthorn than in birch (*Betula* sp.), which is also known as a light demander. The light limit for seabuckthorn is in the range of 1615-1700 lx as compared to 430 lx in birch (Ranwell, 1972). Climatic studies in China indicate that natural distribution of seabuckthorn is greatly influenced by temperature. Seeds require a temperature of 2-5°C for a period of pre-treatment, before they germinate. There is natural distribution of seabuckthorn in the regions with the temperature isolines over 25°C on an average in the summer. Therefore, optimum temperature during summer for natural distribution of seabuckthorn is between 15-25°C. The maximum radiation in the sunny days of May-July is 23.5-26.5 kcal/cm² between the isolines, which indicates that seabuckthorn plants though favour cold climatic conditions, however this plant requires a certain high temperature condition during the active growth period. Further, the annual available photosynthetic radiation for seabuckthorn distribution is 60 kcal/cm and annual daily sunshine requirement is 2400 hours or so. Therefore, seabuckthorn requires a lot of sunshine and a certain radiation intensity (Ruiling et al., 1989). Seabuckthorn grows naturally in temperate regions of Asia and Europe zones. It has been reported even in subtropical zones at higher altitudes.

Rainfall

The moisture requirement of seabuckthorn is not considered important, as this plant occurs in the regions with low rainfall. However, availability of moisture is beneficial for its vigorous growth. Seabuckthorn is predominantly a plant of well-drained soils. The altitude and latitude play an important role in regulating such factors as heat, sunshine and moisture, which influence seabuckthorn distribution. Therefore, there is a tendency of seabuckthorn distribution from low latitude and high altitude to the high latitude and low altitude. Seabuckthorn has been found growing in the areas with rainfall range of 0-900 mm per year. While naturally seabuckthorn can grow even in arid conditions with out rainfall, however, certain amount of moisture is required for its cultivation. However, high rainfall may cause the fall of flowers and fruits. In dry conditions, irrigation with proper drainage promotes its growth. However water logging and marshy land condition kills the plants. In order to adapt to dry conditions, it has developed some xerophytic features. It has narrow and small leaves with thick cuticle and dense stellate hairs on the lower side and there are a lot of thorns on the branches to lower the transpiration rate. The plant requires cloud less hot and sunny days for active growth and enough fruit development. Shade of the adjacent trees on the seabuckthorn plants has been found to lower the fruit yield (In Lu Rongsen, 1992; Singh et al., 1995).

Habitat

Under natural conditions, seabuckthorn grows on slope, well-drained soil with silt, riversides lakes and seashores, other wastelands, where conditions do not suit many other agricultural crops. Such sites provide adequate moisture as well as nutrients. It has been found growing even on stony sites. However most suitable sites are river banks, which provides sandy soil with enough aeration for fast spreading root system and adequate moisture for vigorous growth. It has also been found growing in sand dunes (Ranwell, 1972) and with ages, the plants harden to drought conditions. Plant is well adapted to dry conditions, as it takes root easily even in dry and infertile soil due to presence of nitrogen fixing bacteria, *Frankia*, in its roots (Jike and Xiaoming, 1992). Plant can grow even in site with heavy clays with adequate drainage. Since plants cannot survive under condition of excess and standing or stagnation of water and poor porosity of the soil, therefore, sandy soil with proper drainage is most suitable for its cultivation. Chinese studies indicate that plants grows best at a pH range of 6-7, however, it also tolerate pH of 5.5-8.3. Seabuckthorn is a salt tolerant plant, as it has been found growing in salt rich sites like wastelands, seashores, sand dunes, rich in salt content. While seabuckthorn can grow on nutrient deficient and dry sites, but it responds well to irrigation and fertilizers. While it obtains nitrogen from atmosphere through fixation, it was found growing in phosphorus deficient soil in Loess Plateau, China. It was also found that seabuckthorn rhizosphere soil contains 2-5 times higher available P than soil with out roots, indicating that root secretion of seabuckthorn can transform the

insoluble phospho-calcium compound of $[Ca_2 (PO_4)_2]_3 CaCO_3$ into soluble P, which is then absorbed by the roots (In Lu Rongsen, 1992). Breadmore (1987) claimed that Ca was not limiting for seabuckthorn on a Ca poor site, but degeneration was more rapid. Many workers agree that a low pH is detrimental to the growth of seabuckthorn (Bond, 1954). Each species of seabuckthorn grows in certain habitat conditions. For example, *H. rham.* ssp. *turkestanica* grows generally in arid conditions on terraces of river valleys, open slopes and river banks and beds in China and South Asian countries. *H. tibetana* Schlechtend, an undershrub is distributed in grassland, meadow and riverbanks in high altitudes.

The plant is well adapted to extreme low temperature conditions of alpine and subalpine conditions of the mountains. *H. neurocarpa* is found growing in the river valleys or plateau. *H. rham.* ssp. *yunnanensis* grows on terraces and riverbanks at 3200-3800 m in valley of Yalu Tsangpo river in Tibet. It grows well where rainfall is below 300 mm. Trees of *H. salicifolia* grows in gorges, edges of forests as well as flat lands at 2800-3200 m asl in Himalayas (Singh et al., 1995).

DISTRIBUTION OF SEABUCKTHORN RESOURCES

Seabuckthorn is believed to be originated in Himalayas and dominantly grows cold regions of Himalayan countries. China is known to possess world maximum seabuckthorn resources (about 80% of total), however, rich resources of this plant have also been found in Ladakh region in Indian Himalayas, Mongolia and Russia. Seabuckthorn grows almost in all European countries, however they lack big forests. Considering its economic and ecological potential, many countries in Asia, Europe and north America have started cultivation of seabuckthorn.

ASIA

China

Seabuckthorn is an arboreous shrub or small tree, which is widely distributed and adapted to varied geographical and climatic conditions of China. For long time, it has only been used as a source of fuel and for conservation of soil and water with the exception that Tibetans and Mongolians have used it traditionally for medicines. With the information reaching from Russia in 1983, that seabuckthorn has tremendous potential in health and food industries, a lot of work started both on new resources development and their commercial utilization in China. Since then, several surveys have been carried out on seabuckthorn resources in many provinces of China. About 1.2 million ha has been found under seabuckthorn in China, half of which has been artificially cultivated.

Seabuckthorn resources are distributed between 75°32'-120°45' E longitude and 27°44'-48°35' N latitude, in the provinces of Liaoning, Hebei, Shanxi, Shaanxi, Gansu, Qinghai, Sichuan and Yunan, inner Mongolia, Ningxia, Xijiang and Tibet. The altitudinal range varies from a minimum of 420 m above sea level in hilly region in western part of Liaoning to a maximum of 5200 m in Mount Qomolangma.

Various regions in different provinces, which have natural seabuckthorn are: Zhaoyang region in Liaoning, Chende and Zhangjiako regions in Hebei, Luliang and Taihang Mountain areas in Shanxi, Huangnong and Laoshan mountain areas in Shaanxi, Qingyang, Pingliang and Tianshui regions in Gansu, Keshe, Hetian, Buerjing and Alitai areas in Xinjiang, Qilian, Datung, Gueide and Galmu counties in Qinghai, Ganzi and Arba regions in Sichuan and Zhongdian area in Yunan (Ruiling et al., 1989).

There are 6 species of seabuckthorn in China, i.e. *H. rhamnoides* L., *H. salicifolia* D. Don, *H. tibetana* schlechtend, *H. neurocarpa* S.W. Lin et T.N. He and *H. gyantsensis* (Rousi) Lian and *H. goniocarpa* Lian. *H. rhamnoides* has four subspecies, namely ssp. *sinensis*, *yunnanensis*, *turkestanica* and *mongolica* (Yongshan, 1988; Yongshan et al., 1995). Among these species, *H. rhamnoides* ssp. *sinensis* is the most dominant and widely distributed, whereas *H. salicifolia* has the most narrow distribution. While all the species can be found at 2700-3500 m, the most favoured zone, only one species has distribution below 2200 m. The estimated area under seabuckthorn is about 1.2 million ha, half of which are man made. The regions, with rich resources of seabuckthorn are found in the upper and middle reaches of the yellow river, which includes Shanxi, Shaanxi, Gansu, Inner Mongolia and Ningxia (Ruiling et al., 1989).

H. rham. ssp. *sinensis* Rousi is distributed in the largest area and dominantly grows in Shanxi, Shaanxi, gansu, Qinghai, Sichuan, Nei Mongol, Hebei and Liaoning at 60-3800 m asl. This is the most commonly planted and utilized for commercial purpose in China. *H. rham.* ssp. *turkestanica* Rousi is found in arid regions of western Xinjiang and Tibet. *H. rham.* ssp. *yunnanensis* Rousi is found in northwestern Yunnan, southwestern Sichuan and eastern Tibet. *H. rham.* ssp. *yunnanensis* grows on terraces and riverbanks at 3200-3800 m in valley of Yalu Tsangpo river in Tibet. It grows well where rainfall is below 300 mm. Trees of *H. salicifolia* grows in gorges and the edges of forests in alpine mountains at 2800-3700 m asl in southern Tibet. *H. tibetana* schlechtend, an undershrub is distributed in grassland, meadow and riverbanks in the provinces of

Qinghai, Gansu, Tibet and Sichuan, at an altitude of 3000-5200 m asl. The plant is well adapted to extreme low temperature conditions of alpine and subalpine conditions of the mountains. *H. neurocarpa* is found growing in the river valleys or plateau of Qinghai, Gansu, Sichuan and Tibet at 2800-4300 m asl (Lu Rongsen, 1993). A new species *H. goniocarpa* Lian with two subspecies *nova* and *litangensis*, have been discovered in China. Subspecies *nova* was found in Songpan County in Qinghai province, whereas, *ssp. litangensis* was found in Litang County in Sichuan province (Yongshan et al., 1995).

India

After China, Indian Himalayas is believed to possess about 1,00,000 ha, the world's second largest seabuckthorn resources. Seabuckthorn has been found in cold deserts and other regions of Himalayas, comprising the states of Himachal Pradesh, Ladakh in Jammu-Kashmir, Uttranchal, Sikkim and Arunachal Pradesh. Three species, namely *H. rhamnoides* ssp. *turkestanica*, *H. salicifolia* and *H. tibetana* have been found in Indian Himalayas. More are believed to exist. In Himachal Pradesh, seabuckthorn grows mainly in the district of Lahaul-Spiti, which is surrounded by Tibet state of China and Kinnour district in the east and Ladakh region of Jammu and Kashmir state in the north on the southern side. Rain falls fluctuates from 50 to 700 mm per year depending on place to place. The mean temperature in Kelong, district headquarter and center place of Lahaul, shows considerable variation in temperature throughout the year (a maximum of 27°C in July and minimum of -16°C in February). During the winter this region is affected by a series of western disturbances, which causes heavy snowfall (200-400 cm per year). It grows throughout the length of the Chandra valley (2958-3110 m) in the villages, i.e. Sissu, Khorpani, Raling, Khongsar, Gondhla and Dalang. In Chandra-Bhaga (Chenab) valley, seabuckthorn is found as component of agroforestry systems in the villages Kirting, Sansa, Jhalma, Jhunda, Jasratha and Madhgaon. In Mayar valley, seabuckthorn is spread in Urgos and Chaling villages. Since, there a well developed irrigation system in the area, a lot of wastelands can be brought under seabuckthorn in the region (Singh et al., 1995).

Spiti, a cold desert valley of district Lahaul-Spiti, which adjoins Tibet on its eastern border and Ladakh on its north. At base, the altitude varies from 3120 m at Sumdoh to 4500 m asl near Kunjam pass. Spiti is a broad and flat valley, which is intersected by high vertical cliffs of black, grey and brown sand. Rainfall rarely crosses to 100 mm/yr. The winter temperature may drop to -30°C due to chilling wind during winter. *H. rhamnoides* grows widely from Sumdoh (3100 m) to upper area (3900 m asl). There are excellent stands of this species at Shego-Lara (3760 m), Lingthi (3889 m) and Shichling (3560 m). It grows mainly on riversides and beds; some farmers have also raised windbreaks around their fields. *H. rhamnoides* have also been reported growing in upper areas of Spiti in villages like Kiato, Kiamal, Morang, Sumling and Rangrik. H.

tibetana have been reported growing in higher altitude areas at Losar (4100 m) to Takcha (4500 m asl), Kibbar (4100 m) and Chicham (4200 m). Both *H. rhamnoides* and *H. salicifolia* have been found in upper Kinnaur. Seabuckthorn has been also found in upper areas of Shimla and Kullu districts (Singh et al., 1995).

Cold deserts of Ladakh in the Jammu-Kashmir state, a high altitude zone of northwestern Himalayas, lies between latitude 32 to 36° north and longitude 76 to 79° East. It comprises Leh and Kargil districts of Jammu and Kashmir state. The region covers 67,000 sq.km. area. The topography is rugged with rocky terrains. Valleys are sandy, open, long and broad with some water bodies. Indus, Syele, Zanskar, Nubra, Luru and Drass are the main rivers of the region. The climate is extremely dry and cold. Seabuckthorn is the only dominant woody plant of the region. Seabuckthorn has been reported growing in four of the five valleys of Ladakh, i.e. Indus, Nubra, Zanskar and Suru. It grows well on the riverbeds, riversides and slopes. It has been found growing upto 4100 m asl in the region. In Indus valley, seabuckthorn grows from Thiksey to Shey, Choglamsar, Spituk, Phyang, Nimmu, Bazgo and Saspol. It also grows well in villages like Turtuk, Thoise, Partapur, Hundar and Khalsar. The region is believed to possess very rich resources under seabuckthorn (Dwivedi et al., 2001). Recent surveys have estimated over 50,000 ha under seabuckthorn in this area. However, many new areas are yet to be surveyed in this part of Himalayas.

In north-east India, Sikkim, a small state of 7096 sq.km area lies between 28° 07' 48" and 27° 04' 46" N latitude and 88° 00' 58" and 88° 55' 25" E longitude located in north-east Indian Himalayas. Seabuckthorn grows in dry temperate regions in north district of Sikkim at an altitude of 2280-3100 m asl. (Basistha et al., 2001). Seabuckthorn has also been recorded in Dibang valley in Arunachal Pradesh, another state in northeast India (Tiwari and Singh, 2001). Further surveys are required to study the possibilities of occurrence of other species in the Himalayas.

Nepal

In this small Himalayan country, it was found that *H. salicifolia* is distributed between 2000- 3850 m., whereas *H. tibetana* was found occurring between 2900-4500 m. Seabuckthorn forests were found in the higher areas, far away from the river system in Manang, Mustang, Dolpa, Humla, Mugu, Jumla and part of western Dolpa. *H. tibetana* occurs frequently in alpine tundra (Nepal et al., 2001).

Bhutan

While survey on seabuckthorn resources have not been carried out in Bhutan, however two species have been found in Bhutan. *H. salicifolia* was found in the trans-Himalayas at an altitude of 1500-3500 m asl. *H. tibetana* was found at an altitude of 4000-5000 m asl (In Lu Rongsen, 1992).

Pakistan

Seabuckthorn (*H. rham.* ssp. *turkestanica*) is distributed in 3000 ha in northern area of Pakistan. Its main forests lie in Baltistan, Gilgit (Ghizer and Hunza valleys etc.), Chitral (Mastuj, Garam Chasma etc.), Swat (Gabral) at an altitudinal range of 2200-2800 m asl. There are 3000 ha natural forest of seabuckthorn in Pakistan (Lu Rongsen, 1996). National Arid Land Development and Research Institute, Islamabad has started an afforestation programme in the region. Some 0.25 million plants of seabuckthorn have been planted in Balochistan with 10-90% success rates. Attempts are also been made to increase seabuckthorn resources by aerial seeding (Jasra and Khan, 2001).

Afghanistan

Having conditions similar to that of Pakistan, *H. rham.* ssp. *turkestanica* is distributed widely at a range of 2300-3000 m in mountains of Bamian, Kabul, Parwan, Gulbahar and Nuristan in Afghanistan (In Lu Rongsen, 1992).

CENTRAL ASIA

In the countries of former Soviet Union, seabuckthorn grows in Russia, Kazakhstan, Caucasus, Ukrain, Uzbekistan and Azerbaijan. Several surveys were carried out on seabuckthorn resources in the valleys of more than 70 rivers, coasts of the Issyk-Kul, Sevan lakes, the Black Caspian and Baltic Sea Shores. Seabuckthorn has been characterized on the basis of geographical distribution into different ecotypes, i.e. Siberian type (Trasbaikal, the east Sayan, the west Sayan and Altai ecotypes), the Middle Asian types (east Kazakhstan, the Dzhungarian, the Tien-Shan, the Pamirs-Alay, the western pamirs ecotypes), the Caucasian type (the northern Caucasian, the Azerbaijani, the Sevan, the central Caucasaian, the Black Sea ecotypes), and the east European type (the Danube and Baltic ecotypes). Therefore, this whole region has vast and different types of seabuckthorn resources (Korovina et al., 1993). In Azerbaijan, seabuckthorn grows naturally in the valleys of rivers of Kishchay, Girdimanchay, Lenkoranchay and Sara peninsula. A lot of variations have been observed in these forms and two forms have been selected for the plantation purpose (Novruzov et al., 2001). Vast resources of seabuckthorn have been found in Kazakhstan, where it was found growing in Altay, Zaisan hollow, Djungar Alatau, north Tianshan, Zailiysky Alatau, Cungey Alatau, Ketmen range and Kara-Tau range, west Tian Shian, Kirgiz range and Issik-Kul lake valley (Besschetnov personal commu.).

Mongolia

Mongolia lies between China and Russia in east-central Asia. It is a rugged land. Plateaus and towering mountain ranges cover much of the country. The bleak Gobi Desert blankets much of southeastern Mongolia. Mongolia is a high altitude country. No part of Mongolia lies below 1,700 feet (518 meters) above sea level. Dense forests cover the Hentiyan mountains, northeast of Ulaanbaatar, the capital of Mongolia. Mongolia gets very hot as well as cold days. Temperature ranges from -57 to 96°F (-49 to 36°C), recorded in Ulaanbaatar. Snowfall and rainfall are usually low. Often and strong winds are characteristic of the spring. Autumn is long with often frosts. Weak winds, stable frost (-20-35°C, sometimes it reaches to -50°C), clear days rare snows and dryness are characteristic features of the winter.

Natural seabuckthorn areas in Mongolia are large and it covers more than 20,000 hectares. Western part of Mongolia is the main natural area of seabuckthorn. In the northern part of Mongolia, it is isolated and spread only on the banks of the rivers, Selenge and Orhon. The western areas of seabuckthorn are situated at the steppe (Bogd-Borh river), desert-steppe (Zavhan, Hovd, Tes rivers) and desert (Bulgan river) zones. The northern areas are situated in the forestry (Selenge, Orhon, Eroo rivers) zone of Mongolia, at the altitude of 600 m, and western areas, 1400-2000 m. Type of the land, where seabuckthorn is growing is floody or sandy. According to Rousi (1971), there are two different subspecies of *Hippophae* in Mongolia, *H. rhamnoides* ssp. *turkestanica* Rousi and *H. rhamnoides* ssp. *mongolica* Rousi. Populations of seabuckthorn growing in the regions of Bulgan and Hovd river belongs to the *H. rhamnoides* ssp. *turkestanica* and populations of the other areas belongs to *H. rhamnoides* ssp. *mongolica* (Jamyansan and Badgaa, 2003).

EUROPE

Although European countries lack the adequate resources of seabuckthorn, as most of the resources have been destroyed due to developmental activities, however plant is widely scattered in Europe. Subspecies of seabuckthorn i.e., *H. rhamnoides* ssp. *maritima*, *H. rham.* ssp. *rhamnoides*, ssp. *fluviatilis*, ssp. *carpatica* and ssp. *caucasia* have been found growing in Europe. In view of increasing global trade in seabuckthorn, large-scale cultivation of the plant has been started in many countries. Countries like Germany, Finland and Sweden have successfully commercialized seabuckthorn and developing its orchards.

Russia

Seabuckthorn is widely spread with a lot of morphological variations over vast territory of Russia, i. e. Kaliningrad region, subcaucasus, southern part of Siberia (Altai) and eastern Siberia (Korovina and Fefelov, 2003). Interest in seabuckthorn as ornamental and fruit plant started as early as in 17th century and people started raising its gardens in places like St. Petersburg. Work on introduction of seabuckthorn into new areas started as early as 1850 at Tavricheskyi Garden in St. Petersburg. However, seabuckthorn was used as ornamental plant.

Once nutritional and medicinal value of seabuckthorn was discovered, a number of promising forms were selected; they were introduced in European part of Russia, the Urals and new areas of Siberia. M. Lisavenko (1897-1967) was the first Russian scientist, who started the pioneering work on selection of suitable forms for plantation purpose. At present, seabuckthorn is cultivated as a fruit crop from Arkhangelsk in the north, through to Tomsk and Chita to southern part of the country (Burmistrov, 1995). A number of institutes and universities have been working on the development of promising forms and their spread, developing new resources. Particularly very fruitful work on seabuckthorn has been done at M.A. Lisavenko Institute of Horticulture for Siberia, where 14 promising cultivars have been developed. Other institutions, working on development of seabuckthorn resources are Nizhni Novgorod Agriculture Institutes, Novosibirsk Zonal Fruit and Small Berries Experiment Station and Botanical Garden, Moscow State University etc. Siberia comprises 57% of the total area of Russia. The region has many useful populations of seabuckthorn especially in Altai area. The survey of natural populations of seabuckthorn was followed by selections and breeding of promising forms. The cultivars, developed by Russians are characterized by cold tolerance, resistant to pests, dwarfness, few or no thorns, large fruits (0.6-0.9 g), high yield (4-15 kg/plant and 8-49 tons/ha), tall fruit stalk (4-10 mm), no fruit damage during harvesting and high oil content (4-9 %). Above ground and below ground parts of Siberian forms are known to be frost tolerant up to -50°C and -20°C respectively. Some of the high yielding cultivars developed in Russia are "Vitamnaya, Dar Katuni, Shcherbinki-1, Churykaya, Oranzhevaya and Obilnaya, Jivko, Inya, Panteleevskaya" etc. (Kalinina, 1988). In view of the great contribution of Russian workers made to the science of seabuckthorn, Russia is truly known as father of seabuckthorn.

Belarus

Seabuckthorn in Belarus is believed to be introduced plant from Russia as early as 1930, with the efforts of Central Botanic Gardens. Intensive research work began with trials of the new Russian cultivars like 'Vitamnaya', 'Dar Katyni', 'Golden Cob', 'Maslichnaya', 'Novost Altaya' of the Institute of Gardening in Siberia at Barnaul. It was established that the forms from Kaliningrad region are the most promising for selections (Garonovich, 1995).

Ukraine

Seabuckthorn have been studied in Ukraine by Lebeda (2001) in delta of Danube, which has some 250 ha area under the species. He made some useful selections for the plantation purpose.

Germany

Seabuckthorn widely grows in Germany. *Hippophae rhamnoides* ssp. *rhamnoides* (syn. *H. rhamnoides* ssp. *maritima*) occurs along the coast sides of north sea and Baltic sea. Homogeneous populations can be found on the islands, Hiddensee and Ruegen within the Baltic sea. *Hippophae rhamnoides* ssp. *fluviatilis* is distributed mainly outside of Germany, from Suisse to Italy and France. Only the northern part of its population can be found in south Germany (near river Rhine and in the Bodensee area). The third subspecies *carpatica* is distributed between the rivers Danube and Isar, also in the southern part of Germany (Albrecht, 2003). Various birds eat the berries and excrete the seeds. From recent studies, it is known that 42 bird species eat the berries of seabuckthorn in Middle Europe and many are responsible for its dispersal, especially the bigger ones are important for distribution of *Hippophae* seeds (*Turdus pilaris*, *Turdus merula*, *Turdus viscivorus*, *Nucifraga caryocatactes* and *Bombycilla garrulus*).

Recognizing their ability to fix nitrogen from soil air, *Hippophae* was planted as a pioneer plant for different locations especially for re-cultivation of industrial dumps and dumps from coal mining. In some regions, *Hippophae* was also planted along the highways, where the shrubs provided a supplementary ornamental value by the orange colored fruits. Only small remainders can be found there presently. During the last century

seabuckthorn had also been planted for its ornamental value mainly for the silver colored leaves and the orange colored berries (Albrecht, 2003).

With the discovery of rich vitamin C in its fruit, seabuckthorn became a great importance for the plant breeders in Germany. Selection and breeding of seabuckthorn were carried out at the Experimental Station of Floriculture and Nursery Management in Friesdorf, near Bonn, Department of Fruit Culture of Technical University, Munich and the Breeding Station of the Nursery Berlin-Baumschulenweg. A number of seabuckthorn cultivars like Askola', 'Dorana', 'Frugana' 'Hergo' 'Leikora', 'Pollmix 1' 'Pollmix 2' and Pollmix 4' have been developed, which are likely to increase seabuckthorn resources, which may meet the commercial demands of Germany (Albrecht, 2003).

Britain

Seabuckthorn distribution has been studied on the sea shores around Britain. Naturally, it was found growing on the east coast of Britain, from Berwickshire to Kent. Initially it was confined to sand dunes and occasionally on sea cliffs from Yorkshire to Sussex, but it was later planted on other sites, mainly to control the sand dunes and extended to other sites by birds as well (Baker, 1996; Clapham et al., 1957). For example, it was introduced to the Merthyr Mawr dune system in 1984, with a view to stabilize the moving sand dunes, where it remained highly successful by spreading horizontal root systems, which gave birth to new plants and stands.

Sweden

Seabuckthorn grows naturally along the northern coast from latitude 59° to latitude 66°. It is common in south and rarely found in the north Sweden. It is distributed on the Swedish coast along the gulf of Bothnia and west coast of Sweden. Since 1930s, using seabuckthorn branches for ornamental purpose was a fashion in large cities of Sweden. A new project to use seabuckthorn as a berry crop was started in 1986 at Balsgard, supported by Food Industries. By breeding programme, hybridization has been carried out between male plants of Swedish origin and female plants of Russian origin. Growth of natural seabuckthorn has been studied at Balsgard, which now has both local and exotic collections (Wahlberg, 1995).

Poland

Natural distribution of seabuckthorn in Poland has been studied by Srodon (1970). It is found on the Baltic coast of Poland. However, it is being cultivated for reclamation of wastelands and industrial dumps.

Hungry

With the success of seabuckthorn in Russia, Hungry has introduced a number of improved cultivars, which are being cultivated at small scale. It has also been planted for the reclamation of the red mud, which contains industrial wastes of oxides of metals, without any humus content and cause serious pollution problems. It not only successfully grew on the red mud, but also had fruits (Balink et al., 1989). Wild seabuckthorn stands are occasionally seen growing in few sites. In order to promote seabuckthorn cultivation in Hungry, some improved cultivars were introduced at Research Institute for Medicinal Plants, Budakasz from Russia (Bemath and Foldesi, 1992).

Norway

While in the past, seabuckthorn was quite common in Norway, it has been found in few sites on river banks and along the coasts from Trondheim in the south to Harstad in the north. In southern part, it also grows on one site Boverdaien at an altitude of 1100 m (Habjorg, 1978).

Czech

Information about the natural distribution is not available in this country, but its orchards have been established near Velky Osek about 50 km to the east of Prague (In Blahovec et al., 1995).

Finland

Natural distribution of seabuckthorn has been reported in Finland, from Aland Inlands up the west coast along the Bothnian gulf to the valley of the Tornio river in the north. However, as early as 1960s, seabuckthorn strains from various European and Asian countries, were introduced at the Institute of Horticulture, Piikkio. In 1990, first Finnish cultivars 'Raisa' (female) and 'Rudolf' (male) were released (Hakala et al., 1990). Seabuckthorn of this area belongs to *H. rham. ssp. rhamnoides* (Rousi, 1971).

Netherlands

Seabuckthorn (*H. rham. ssp. rhamnoides*) has been reported growing as a pioneering shrub species on calcareous coastal sand dunes like places Meijendel, near Hague in Netherlands (Pearson and Rogers, 1967). Community composition of seabuckthorn was studied by Jong et al. (1995).

Romania

Seabuckthorn has been found growing in eastern and southern sub-Carpathians in Danube delta area and black coast on the sunny river banks in Romania. Surveys have been carried out in south-eastern Romanian Carpathian mountains and several biotypes were identified. Some efforts have been made to develop high yielding cultivars by Mladin et al. (2001).

NORTH AMERICA

Canada

Seabuckthorn was first introduced at Dropmore, Manitoba by L. Skinner in 1930s from Siberia, Russia. The exotic was identified to be *H. rham. ssp. mongolica*. In most of the sites, it has been raised as an ornamental plant, whereas it has been planted in Prairies for the conservation of wild life, reclamation of wastelands and control of soil erosion. For this purpose, PFRA Shelterbelt Centre at Indian head in Saskatchewan has distributed over one millions plants of seabuckthorn. Seabuckthorn stands have grown rapidly in Rafferty, Saskatchewan, mainly under conservation programmes. In Canada, seabuckthorn is utilized for enhancement of wildlife habitat, farmstead protection, erosion control, riparian protection and land reclamation. The PFRA Shelterbelt Centre at Indian Head, Saskatchewan has been growing seabuckthorn since 1982. Seedlings have been distributed and planted through out the prairies and has become one of the hardiest and most adaptable woody plants in prairie conservation programs. These stands ensure that wildlife have adequate food, thermal cover and protection. Wildlife plantings may be multi-row field shelterbelts, bluff extensions or block plantings. The number of seabuckthorn plants at Rafferty, Saskatchewan has increased rapidly through colonization by suckering (Schroeder and Walker, 1996).

Farmstead shelterbelts are important components of agriculture in the Canadian prairies. These multi-row shelterbelts improve the climate surrounding the farmstead, reduce energy costs for home heating, reduce noise, filter pollutants and attract useful wildlife. Seabuckthorn is planted in the outer row of multi row shelterbelts surrounding farmsteads. It provides effective snow trapping in the winter (Li and Schroeder, 1996). In 1999, more than one hundred thousand seabuckthorn (120 kilometers of tree row) were planted in farmstead shelterbelts (Li and Schroeder, 1999). Since 1996, a research scheme to develop better forms of seabuckthorn has been started for the commercial utilization at PFRA Shelterbelt center, Indian Head, Saskatchewan, by PFRA Shelterbelt center and University of Saskatchewan, which is likely to increase seabuckthorn resources in Canada (Schroeder et al., 2001; Li, 2003).

America

With the realization of rich medicinal properties of seabuckthorn fruit and leaves, seabuckthorn has been introduced in some parts of United States of America.

SOUTH AMERICA

Bolivia

Seabuckthorn has been introduced in dry high lands of Bolivia, a south American country. Seedlings introduced from China although showed slow growth, but survived, whereas they showed fast growth at Patacamaya Research Station and had fruits, which indicate that seabuckthorn can be cultivated under the conditions of this country.

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