Taxonomy of Seabuckthorn (*Hippophae* L.)

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ABSTRACT

In this paper, a brief taxonomic history and the classification of the genus Hippophae L. are reviewed. Some Latin names are essentially discussed and a complete classification system of Hippophae L. is given. A systematic, practical key and morphological characteristics as well as geographical distribution of all species and subspecies of seabuckthorn are described and new ones discovered by the authors are also presented. In addition, some taxonomic and evolutionary problems, which should be further researched upon are put forward.

Key words: Seabuckthorn (Hippophae L.), classification and taxonomy.

INTRODUCTION

The genus Hippophae L. belongs to the family of Elaeagnaceae, and it is the most evolutionary one in the family. The genus is similar to the American genus Shepherdia Nutt, in the dioecism, but it differs from the latter by the bifid calyx and 4 stamens. In composition of floristics, the genus belongs to Eurasian temperate distribution pattern. Because of the occurrence of many bioactive substances, nodules in the root system, high regeneration, Hippophae has a great potential for improving the environment, economical returns and social benefits. Therefore, many countries have paid a lot of attention to the research and utilization of the plants in the genus. We have made a complete study of the seabuckthorn since 1986, and this paper reports on the classification of the genus.

BRIEF TAXONOMIC HISTORY OF THE GENUS HIPPOPHAE L.

The genus Hippophae L. was founded by C. Linnaeus with H.rhamnoides, as the typical species, including only two species, H. rhamnoides L. and H. canadensis L, which were recorded in Species Plantarum in 1753. Nuttall transferred the H. canadensis L. to the genus Shepherdia Nutt., because H. canadensis was different from the other species of the genus Hippophae L.,with the 4-fid calyx and eight stamens. In 1825, D. Don described a Himalayan species of H. salicifolia D. Don from Nepal. In 1863, von Schlechtendal, D.F.L. described another species of *G.* tibetana Schlecht from Qing-Zang Plateau (Linnaea 32: 296). The type specimen was collected from Xizang Autonomous Region of Tibet. In 1908 and 1909, C. Servettlaz merged H. salicifolia and H. tibetana with H. rhamnoides and treated it as subspecies. (Bull. Herb. Boiss. Serv. 2 (8) 387, 1908 and Bot. Central Bl. Beih. 25:18, 1909). However, most taxonomists did not agree with this view. In 1915 and 1916, A. Rehder, based on specimens of E.H. Wilson (No. 928) and Veitch Expedition (No. 4421) (collected from the western part of Sichuan), nominated H. rhamnoides L. var. procera Rehd. in Bailey. A. Rousi (1971) considered the type specimen of var. procera, a mixture and listed var. procera as a basionym of H. rhamnoides subsp. sinensis. The author of Fl. Reip. Popul. Sin. accepted this view. We have carried out the field exploration in the distribution region of var. procera, i.e. Daocheng, Kangding, Xiangcheng in Sichuan Province and Zhongdian in Yunnan Province. We consider that var. procera indeed is a mixture, one part should belong to subsp. sinensis and the other part (distributed in Kangding, Daocheng and Xiangcheng), which is growing taller, with conspicuous stellate tomentum on tender branchlets and the upper surface of leaves, should be treated as subsp. yunnanensis.

In 1952, J.L van Soest divided the European H. rhamnoides into two subspecies subsp. maritima and subsp. fluviatilis. The fonner is found on the seashore, the latter in the Alps. According to the rules of autonyms in International Code of Botanical Nomenclature, A. Rousi (1971) pointed out that the correct name of subsp. maritima should be subsp. rhamnoides. In 1971, Rousi, based on his studies with 2200 specimens, collected in 33 herbaria, 34 populations growing in gardens and 8 mass collections in nature, published “The genus Hippophae L. - A taxonomy study”. In his classic monograph, he recognized 3 species, H. rhamnoides L., H. salicifolia D. Don and H. tibetana Schlecht. The first species was divided into 9 subspecies,

7 of which, subsp. carpatica, caucasia, turkestanica, mongolica, sinensis, gyantsensis and yunnanensis were newly described subspecies. After research on earlier works of Linnaeus, he thought that the original specimen of the genus were probably collected from seashore of north Europe, and designated the type locality of Linnaeus Botanical Garden in Upsala, Sweden. In 1978, the Chinese taxonomists, S.W. Liuand and T.N. He studied the plants of this genus, collected from Qing-Zang Plateau and published "The genus Hippophae from Qing-Zang Plateau". In the paper, they recognized 3 species: H. rhamnoides L., H. tibetana Schlecht. and H. neurocarpa S.W. Liu et T.N. He. The third species was a newly described species, with conspicuous characteristics. They also supplemented and revised the classification of the genus Hippophae L.

In 1981, V.I. Avdeev, described a new subspecies of H. rhamnoides L. subsp. pamiroalaica from Pamirs (,Journal of Tadzhikistan Science Academy, Biology Fascicle No.l, 82). But in the paper, he didn't compare the new subspecies with the other taxa, especially the sympatric subspecies, turkestanica. The essential differences between the new subspecies and subsp. turkestanica could not be found from his description. We think that the name subsp. pamiroalaica should be the later synonym of subsp. turkestanica (Fl. Reip. Popul. Sin. 52 (2): 60-66, 1983 and Fl. Xizang 3: 331-334, 1986) included 4 species 5 subspecies and 4 species 4 subspecies of the genus Hippophae L., respectively. The author of the genus completely followed the taxonomic view of A. Rousi.

There are also some confusing names presented in the earlier literature, such as Osyris rhamnoides Scopoli (Fl. Cam. ed. 2, II. 261, 1772), rhamnoides hippophae Moench (Meth. 343, 1794), H. littoralis Salisbury (Prodr. 71, 1796), H. rhamnoides B.H. sibirica (Hort. Belv. Apud Steudel, Nomencl. 410 nomen nudum, 1821), H. sibirica (Hort. ex Steudel, Nomencl. II. 770 pro synom. (1841), Hippophaes rhamnoideum St. Lager ex Jackson (Ind. Kew. I. 1164 pro synom, 1895), Elaeagnus rhamnoides (L.) A. Nelson (Amer. Journ. Bot. 22. 682, 1935), E. salicifolia (D Don) A.Nelson (Amer. Journ. Bot. 22. 682, 1935). However, some scholars, such as Avdeev (1983) and Eliseev (1983), still hold the view that there is only one species in the genus Hippophae L. Obviously, this point of view does not conform to the fact that there are large differences among species and subspecies of the genus.

Lian and Chen have made a thorough study and field explorations including collections of the genus Hippophae L. since 1986. Research has dealt with the areas of classification, eco-geographical distribution, origin and evolution, differentiation of sexual system, intraspecific patterns, characteristics of evolution and speciation of the genus, the relationships among the basic study of the genus with the introduction and breeding, the planting system and the water and soil conditions. We found that the seed characteristics and the characteristics of flower buds in winter have particularly important significance for the classification and evolution study of the genus Hippophae L. Based on the characteristics, as mentioned above, we have classified the genus into two sections: Sect. I Hippophae and Sect. II Gyantsenses Lian, and upgraded subsp. gyantsensis Rousi as an independent species, H. gyantsensis (Rousi) Lian and transferred to Sect. II Gyantsenses. We discovered a new species and two new subspecies, H. goniocarpa Lian, X.L. Chen et K.Sun, H. goniocarpa subsp. litangensis Lian et X.L. Chen and H. neurocarpa S.W. Liu et T.N. He subsp. stellatopilosa Lian et X.L. Chen. As a result of considering the morphological characters as the key indicators and taking the evolutionary state as background, a completely new taxonomic system of the genus Hippophae L. has been devevloped.

It is necessary to stress three main points, i.e., the field explorations and collections of the plants of the genus Hippophae L. are still very limited, especially in the region of Xizang Autonomous Region, Yunnan and south part of Xinjiang Autonomous Region. There are, however,more taxa distributed in the regions and their characteristics obviously differ, because of the complicated and varied ecological environments. It can be said that the taxa resources of the genus have not been clarified. In 8 subspecies of H. rhamnoides, many characteristics of a few subspecies are intricate and have an obvious transition nature, and the dividing line among the taxa is not clear. But a few characteristics of other subspecies are very stable. These subspecies have to be upgraded to a species level. In short, obvious problems still exist in the division of taxa under H. rhamnoides, such as the relationship between subsp. sinensis and other subspecies, and between Asian subspecies and Europian subspecies. It is necessary that the evolutionary relationship among taxa in the genus be further studied. We suggest that the International Center for Research and Training on Seabuckthorn, should develop a monographic study programme for a thorough investigation into the resources of Hippophae L. and advance introduction and breeding of seabuckthorn.

CHARACTERISTICS AND TAXONOMIC OUTLINE OF HIPPOPHAE L.

Characteristics

Seabuckthorn is a deciduous shrub, small tree or tree, often with branched thorns. All organs are usually covered with scale-hairs or stellate hairs. Flower bud shape is conspicuous and stable. The male flower buds are 4-angled, tower-shaped, spiral tower-shaped, cruciform or bifid ovate, where as the female flower buds

are cruciform, low spiral tower-shaped, ovate or bifid ovate. Leaves are simple alternate, opposite or three leaves in whorled; petioles short, 13 mm long. Flowers are unisexual and dioecious, flowering before the leaf bud burst. The male flowers appear from the axils of deciduous bracts, sessile, calyces almost 2-parted, stamens 4, 2 of which alternate and the other 2 opposite with the lobes of calyx, short filaments and anthers oblong. The female flowers are solitary axillary or clustered into inflorescence-like, short pedicels, calyces pocket-like, 2 teeth-lobed at apex, superior ovary with single carpel and loculus and with one ovule, styles lightly exerted. Fruits included with in the succulent calyx-tube, drupe-like; carpodermis membranous or thin leathery, separating from or combing with the seed coat, single seed with a bony seed coat. Pollen grains are 3 or 4 (5) colporate, with a psilate or granulate or verrucate ornamental surface. The fruits and leaves are rich in many bioactive substances. The chromosome number is 2n = 24. With xeromorphic structure of above ground parts of plants, seabuckthorn has high tolerance to atmospheric drought. It can grow in the areas, where the annual rainfall is more than 350 mm or in areas of less than 350 mm, having high level of ground water or surface runoff. Because, its root systems is well developed with high suckering capability and root nodules, seabuckthorn fixes atmospheric nitrogen and improves the soil fertility.

The Taxonomic outline

Section I. Hippophae
1. H. salicifolia D. Don
2. H. rhamnoides Linn.
   2a. subsp. sinensis Rousi
   2b. subsp. yunnanensis Rousi
   2c. subsp. turkestanica Rousi
   2d. subsp. mongolica Rousi
   2e. subsp. caucasia Rousi
   2f. subsp. carpatica Rousi
   2g. subsp. rhamnoides Rousi
   2h. subsp. fluviatilis van Soest
3. H. goniocarpa Lian, X.L. Chen et K. Sun
   3a. subsp. litangensis Lian et X.L. Chen
   3b. subsp. goniocarpa

Section II. Gyantsensis Lian
4. H. gyantsensis (Rousi) Lian
5. H. neurocarpa S.W. Liu et T.N. He
   5a. subsp. stellatopilosa Lian et X.L. Chen
   5b. subsp. neurocarpa
6. H. tibetana Schlecht.

Key to species and subspecies

Section I

Carpodermis is separate from the seed coat and easily get separeted at maturity, seed with shining surface, or carpodermis adhering to seed coat in part. Flower buds are 4-angled, tower-shaped, cruciform, near cruciform, spiral tower-shaped and rare ovate. Leaves are lanceolate or narrowly lanceolate, petioles being 1.5-3 mm long (Hippophae L.).

1. Carpodermis is separate from the seed coat and easily segregated at maturity, seed with shining surface; fruits and seeds have no longitudinal angles. Leaf margin commonly revolute, the lower surface of leaves densely covered with stellate hairs or scale-hairs of the hair part well developed, outwardly appearing as velvet-felted, branched thorns faintly developed (H. salicifolia D. Don).

2. Leaf margin does not revolute, the lower surface of leaves densely covered with scale-hairs of the hair part degraded, outwardly appearing as scale-like; branch-thorns strongly developed (H. rhamnoides L.).

a) Male flower buds are 4-angled tower-shaped, female flower buds cruciform, near cruciform or bifid ovate; carpopodium 1-2.5 mm long; length of fruits mostly less than or equal to breadth. Male flower buds are obviously 4-angled tower-shaped; female flower buds being cruciform. Most leaves are opposite or sub-opposite, petioles 1.5-3 mm long, midrib on the above impressed into sulcus but up to top shallowed or vanished, the adaxial surface covered with white scale-hairs or rarely rusty-red scale-hairs. Branchlets of the current year stiff; most of fruits tangerine, carpodermis separting from seed coat easily (H. rhamnoides subsp. sinensis Rousi).

b) Male flower buds are inconspicuous 4-angled tower-shaped; female flower buds near cruciform or bifid ovate. Most leaves alternate, petioles 1-1.5 (2) mm long, midrib on the above impressed and up to top appearing as deeper sulcus, the adaxial surface having more rusty-red scale-hairs. Branchlets of the current year soft; most of fruits yellow, carpodermis sometimes hard to separate from seed coat, seeds usually flat (H. rhamnoides subsp. yunnanensis Rousi).

c) Flower buds are minor, spiral tower-shaped; carpopodium 1-7 mm long; the length of fruits greater than breadth in most fruits. The adaxial surface of leaves are densely covered with silvery scale-hairs, sometimes mixed with a few rusty-red scale-hairs. Epidermis of branches is silvery, with more and usually branched thorns; leaves narrower, 2-4 (5) mm wide, both surface commonly silvery; carpopodium 3-4 (7) mm long (H. rhamnoides subsp. turkestanica Rousi).

d) Epidermis of branches are not silvery, thorns less and not branched; leaves wider, (3) 4-8 mm wide, above often green, below silvery; carpopodium 1-4 mm long. Shurb are usually 2-5 m rarely up to 6 m high; the widest of leaves commonly above the middle, apices obtuse (H. rhamnoides subsp. mongolica Rousi).

e) Tree, usually is up to 10 m in height; the widest portion of leaves commonly below the middle, apices acuminate (H. rhamnoides subsp. caucasia Rousi).

f) The lower surface of leaves are usually mixed with most rusty-red scale-hairs. Most of leaves are 3-6 mm wide, seeds being ovate (H. rhamnoides subsp. fluviatilis V. Soest).

g) Most of leaves are 5-10 mm wide, seeds more or less compressed. Branches are straight, dried fruits 6-8 mm long, 5-7 mm wide (H. rhamnoides subsp. carpatica Rousi).

h) Branches are more or less curved, dried fruits 8-11 mm long, 5-7 mm wide (H. rhamnoides subsp. rhamnoides).

3. Carpodermis is adhering to seed coat in part. Seeds are with shining surface at top; fruits and seeds have 3-5 longitudinal angles.

a) Young branchlets and the lower surface of leaves are densely covered with stellate hairs; leaf margin usually manifestly revolute, the midrib on the above impressed and up to top appearing as deeper sulcus; fruits tangerine or dark tangerine, 6-7.6 mm long, 4.5-5.3 mm wide, 1.4 times longer than wide (H. goniocarpa subsp. litangensis Lian et X.L. Chen).

b) Young branchlets and the lower surface of leaves are densely covered with scale-hairs; leaf margin usually explanate, never manifestly revolute, midrib on the above impressed into sulcus but up to top shallowed or vanished; fruits apricot-coloured or straw-yellow, (5.5) 6-10 mm long, (3.5) 4-5.9 mm wide, (1.26) 1.45-2.1 times longer than wide (H. goniocarpa Lian, X.L. Chen et K. Sun).

Section II

Carpodermis is adhering to and tightly attached with seed coat when ripe, seed with no shining surface. Flower buds are ovate. Leaves linear or nearly linear, petioles often less than or equal to 1 mm long (Sect. II Gyantsenses Lian)

4. Plants are higher, 1.5-8 m high, branches spreading; fruits yellow, apricot-coloured, dark tangerine or black-brown, no stellate ornamentation at apices, fruits and seeds with 5-7 longitudinal angles. Plants are 5-8 m high, the crown cover not appearing as platform in the adult plants; branches soft, the current year branchlets brown-yellow, red-brown or dark brown. Fruits yellow, juicy, with longitudinal and nearly 6-wing-shaped angles, seeds plano-convex, with 6 angles, nearly dihedral (H. gyantsensis (Rousi) Lian).

5. Plants are 1.0-3.5 m high, the crown cover appearing as platform in the adult plants; branches stiff, the young branchlets grayish-white. Fruits black-brown or faintly orange-coloured, curved prism, with little or very little juice; seeds prism with 5-7 longitudinal angles, one end of seeds thinner.

a) Young branchlets and the adaxial surface of leaves are densely covered with stellate hairs, leaf margin usually manifestly revolute, the midrib on the above impressed and up to top appearing as deeper sulcus; fruits faintly orange-coloured or yellow brown, 5.6-6.5 mm long, 2.5-3.3 mm wide, 2.1 times longer than wide (H. neurocarpa subsp. stellatopilosa Lian et X.L. Chen).

b) Young branchlets and the lower surface of leaves densely covered with scale-hairs; leaf margin usually explanate never manifestly revolute, the midrib on the above impressed into sulcus but up to top shallowed or vanished; fruits niger when the scales falling off, 7.0-8.4 mm long, 2.8-3.3 mm wide, 2.5 times longer than wide (H. neurocarpa S.W. Liu et T.N. He).

6. Plants are dwarf, 8-60 (80) cm high, branches pointing upwards, usually broom-like; fruits dull tangerine, with (5) 6 (9) brown-black stellate ornamentation at the apices, fruits and seeds no longitudinal angles (H. tibetana Schlecht).

Diagnosis of species and subspecies

Section I

The essential characteristics of the section are carpodermis separating from the seed coat and easily segregated at maturity. The seed surface is shining. The plants are widely istributed in Eurasia, i.e. from valleys on the southern slopes of the Himalayan mountains to the vast temperate areas of Europe and Asia, at the elevations of 800-3500 (3800) m. From an ecological point of view, the plants of this section tend to be drought-resistant. The section perhaps occured earlier, and is a more primitive group in the genus.

1. H. salicifolia D. Don, Prodr. FI. Nepal. 68. 1825; Rousi in Ann. Bot. Fennici 8 (3): 215. 1971.

Characteristics: Trees are about 5 m high. Leaf is margin revolute, adaxial surface densely covered with stellate hairs or scale-hairs of the hair part well developed, outwardly appearing as velvet-felted. Branched thorns are faintly developed. Seeds are with shining surface. Distribution: China: Xizang (Cuona, Yadong, Jilong); Bhutan, Nepal, India and Pakistan. It is an endemic species of the Himalayan regions. Habitat: In valleys, on mountain slopes, in woodlands and at forest edges, at an elevations of 1500-3000 m (3700 m). Type locality: Nepal.

2. H. rhamnoides Linn. Sp PI. 1023, 1753; A. Rousi 8 (3): 201, 1971.

2a. subsp. sinensis Rousi in Ann. Bot. Fennici 8 (3): 212. Fig. 22, 971. H. rhamnoides var. procera Rehd. (Bai. Stand. Cycl. Hort. 3: 1495, 1915) (sine descrip latina) and in Sarg. PI. Wils. 2: 409, 1916, quoad specim.

Characteristics: Tree, is a small tree or shrub, 2-18 m high. The current year branchlets are stiff. Leaves are opposite or subopposite, the midrib on the above impressed into sulcus but up to top shallowed and vanished, the scale-hairs on the lower surface, white or rarely rusty-red; petioles 1.5-3 mm long. Male flower buds 4-angled tower-shaped, female flower buds cruciform. Most of fruits are tangerine. Seed surface is shining. Distribution: Sichuan, Qinghai, Gansu, Shaanxi, Ningxia, Inner Mongolia, Shanxi, Hebei, Beijing (scattered in west mountains) and Liaoning (cultivated in Jianping County). Habitat: In hills, on mountain slopes, valley bottoms, river banks or river beds of dried up, between 400-3100 (3700) m. It is very common in the Loess Plateau. It is the main resource for seabuckthorn development in China. Type locality: Shanxi (Jiaocheng County).

2b. subsp. yunnanensis Rousi in Ann. Bot. Fennici 8 (3): 2 13, 1971. H. rhamnoides var. procera Rehd. (Bail Stand. Cycl. Hort. 3: 1495, 1915 (sine descrip latina) and (Sarg. PI. Wils. 2: 409, 1916) quoadspecim.

Characteristics: It is a tree or small tree, over 20 m high. The current year branchlets are soft. Most leaves are alternate, the midrib on the above impressed and up to top appearing as deeper sulcus, with most rusty-red scale-hairs on the lower surface; petioles 1-1.5 (2) mm long. Male flower buds are inconspicuous 4-angled tower-shaped, female flower buds near cruciform or ovate bifid. Most of fruits yellow, sometimes the carpodermis is hard to be separated from seed coat. Seed are usually flat. Distribution: Yunnan, Xizang, Sichuan, Qinghai (Nangqian alt. 3700 m). Habitat: It is in valley bottoms, river banks and woodlands in foothills, (1000) 2200-3500 (4000) m. Type locality: Yunnan (zhongdian)

2c. subsp. turkestanica Rousi in I 8 (3): 208. 1971. H. rhamnoides subsp. pamiroalaica V.I. Avdeev (Journal of Tadzhikistan Science Academy, Biology Fascicle No. 1 (82), 1981.

Characteristics: It is a small tree or shrub, 4-7 (15) m high. Epidermis of branches is silvery, with more and usually branched thorns. Leaves alternate, narrower, 2-4 (5) mm wide, both surface silvery. Flower buds spiral tower-shaped. The length of most fruits greater than breadth. Carpopodium is 3-7 mm long. Distribution: China: Xizang, Xinjiang, Gansu (valley of Danghe river in Subei County, alt. 1200-1700 m). Himachal Pradesh, Uttranchal and Kashmir), Hindu-Kush mountains, Tadzhikistan, Kirghizia, Kazakhstan and Uzbekistan. Habitat: It is found in river terrace, mountain slope and commonly in flood lands, between (570) 1200-3700 (4200) m. Type locality: Kazakhstan.

2d. subsp. mongolica Rousi in Ann. Bot. Fennici 8 (3): 210. 1971.

Characteristics: It is a shrub, 2-6 m high. Branches are brown, with less and no branched thorns. Leaves are alternate, the widest usually above the middle, 5-8 mm wide, above green, adaxial surface silvery, acuminate at apices. Flower buds are bifid ovate or near cruciform. Carpopodium is i -4 mm long. Distribution: China (Altai mountains), Mongolia, Russia and Eastern Kazakhstan. Habitat: It is found in river terrace or flood land, between (420) 1200-1800 m. Type locality: Mongolia.

2e. subsp. caucasia Rousi in Ann. Bot. Fennici 8(3): 206. 1971.

Characteristics: It is a tree, usually up to 10 m high. Branches are brown, with less and no branched thorns. Leaves are alternate, the widest commonly below the middle, 3-7 mm wide, abaxial usually green, adaxial surface silvery, acuminate at apices. Carpopodium is 1-3 mm long. Distribution: Azerbaijan, Georgia, Armenia, Russia, Turkey and Iran. Habitat: It grows along river banks and in flood lands, between 1000- 2500 (3000) m. Type locality: Caucasia.

2f. subsp. carpatica Rousi (Ann. Bot. Fennici 8 (3): 205, 1971).

Characteristics: It is a shrub or small tree. Branches are straight. Leaves are alternate, 5-7 mm wide, adaxial surface is usually mixed with most rusty-red scales. Fruits are 6-8 mm long, 5-7 mm wide, carpopodium 1-3 mm long. Seeds are flat. Distribution: Romania, Ukraine, Yugoslavia, Hungary, Austria and Germany. Habitat: In valley of Alps, Carpathian mountains, Danube valley and the shore of the Black Sea, from sea level to 380 m. Type locality: Romania.

2g. subsp. rhamnoides Characteristics: It is a shrub or small tree. Branches are more or less curved. Leaves are alternate, mostly 5-8 mm wide. Fruits are 8-11 mm long, 5-7 mm wide. Seeds are compressed. Distribution: Poland, Germany, Denmark, Sweden, Finland, Russia, Norway, the Netherlands, Belgium, France and Britain. Habitat: On sea shores and valley bottoms, from sea level to 1100 m. Type locality: Sweden (Linnaeus Botanical Garden in Upsala).

2h. subsp. fluviatilis van Soest in Mitt. Florsoz. Arb. N.F. 3: 88, 1952. Characteristics: shrub or small tree. Leaves are alternate,3-6 mm wide, adaxial surface is usually mixed with most rusty-red scale-hairs. Fruits are 5-6 mm long, 4-6 mm wide, carpopodium 1-5 mm long. Seeds are ovate. Distribution: Austria, Italy, Switzerland, France and Spain. Habitat: It grows in open land, river bottoms, river banks and hillsides, between 100-1900 m. Type locality: Alps.

Summing up our studies and related literatures and reference materials, it seems that the taxonomic placement of 8 subspecies of H. rhamnoides still present some problems, but owing to the limitations of our knowledge about the subspecies, which are distributed in Europe, the taxonomic position still follows that of A. Rousi.

3. H. goniocarpa Lian, X.L. Chen et K. Sun. Worldwide research and development of Seabuckthorn. In: Proceedings of International Workshop on Seabuckthorn, 1995: 60-63, (sine descrip, latina).

3a. subsp. litangensis Lian et X.L. Chen (In: Proceedings of International Workshop on Seabuckthorn, 1995: 62 (sine descrip, latina)

Characteristics: This subspecies differs from the typical subspecies by the young branchlets and the lower surface of leaves densely covered with stellate hairs, the leaf margin usually manifestly revolute, the midrib on the above side impressed and up to top appearing as deeper sulcus; the fruits tangerine or dark tangerine, 6-7.6 mm long, 4.5-5.3 mm wide, 1.4 times longer than wide. Distribution: Sichuan, Litang (Jiawa). Habitat: It grows in valley terraces, hills, at 3700 m altitude. Type locality: Sichuan (Litang).

3b. subsp. goniocarpa

Characteristics: It is a small tree, 5-8 m high. Branches are soft, branchlets of the current year red-brown or dark brown. Leaves adaxial surface are densely covered with scale-hairs, leaf margin usually explanate, never manifestly revolute, the midrib on the above impressed into sulcus but up to top shallow or absent. Buds of male flower are cruciform, of female flower near cruciform (bifid ovate, the second pair of the bud scales is clearly visible). Fruits are terete, juicy, apricot-colored or straw-yellow, (5.5) 6-10 mm long, (3.5) 4-5.9 mm wide, (1.26) 1.45- 2.1 times longer than wide. Seeds are slightly flat, with 3-5 inconspicuous longitudinal angles. Distribution: Sichuan (Sunpan, Ruoagai, Hongyuan, alt. 3500-3650 m), Qinghai (Qilian, alt. 2500-3200). Habitat: It grows on mountain slopes, river banks, flood lands and valley terrace, at elevations of 2650-3650 m. Type locality: Sichuan (Sunpan).

Section II

Gyantsenses Lian in Acta Phytotax. Sin. 26 (3):235 (1988). This section differs from the Sect. I, as the carpodermis is combining with seed coat, carpodermis tightly enclosed in seed coat at maturity, and the seed surface is not shiny. In the section, the petioles are usually less than 1 mm in length. Most of the leaves are nearly linear. Flower buds of both male and female are ovate or ovate bifid in winter. Fruits are (1.25) 1.7-3 times longer than wide. The plants of the section are concentrated on the Qing-Zang Plateau and its adjoining areas, and apparently restricted to elevations over (2500) 3000 m. The plants tend to be dwarf and winter-hardy. It is evident that, accompanying the uplift of the Himalayan system, the section is derived from the Sect. I. It is the most evolved group in the genus Hippophae L.

4. H. gyantsensis (Rousi) Lian in Acta Phytotax. Sinica 26 (3): 236 (1988). H. rhamnoides subsp. gyantsensis Rousi in Ann. Bot. Fennici 8 (3): 214 (1971).

Characteristics: It is a small tree 5-8 m high. Branches are soft, branchlets of the current year brown-yellow. Leaves abaxial surface are scattered stellate hairs and scale-hairs, adaxial surface is densely covered scale-hairs. Flower buds are ovate bifid. Fruits are yellow, longitudinal angles almost developed in towing-shaped. Seeds are plano-convex, with 6 longitudinal angles nearly dihedral. Distribution: China (Xizang), Sikkim in India. Habitat: In river banks, flood land and valley terrace, between 2600-5000 m. Type locality: Xizang (JIangzi).

5. H. neurocarpa S.W. Liu et T.N. He in Acta Phytotax. Sinica 16 (2): 107 (1978).

5 a. subsp. stellatopilosa Lian et X.L. Chen (In: Proceedings of International Workshop on Seabuckthorn, 1995: 63-65, t. 2 (sine descrip, latina).

Characteristics: This subspecies differs from the typical subspecies by the young branchlets, and the adaxial surface of leaves densely covered with stellate hairs. The leaf margin usually manifestly revolutes, the midrib on the above impressed and up to top appearing as deeper sulcus; the fruits faintly orange-coloured or yellow-brown, 5.6-6.5 mm long, 2.5-3.1 mm wide, 2.1 times longer than wide. Distribution: Sichuan (Daocheng, Litang, alt. 3700-4000 m); Xizang (Jomda, river banks ofYuqu Riverin Basu, Zuogong, Mangkang, Leiwuqi, Lhasa, alt. 3400-4400 m); Qinghai (Nangqian, Yushu). Habitat: It grows on river banks, flood land and river terrace, between 3400-4400 m. Type locality: Sichuan (Litang).

5b. subsp. neurocarpa

Characteristics: Plants are 1-3.5 m high, the crown cover appearing is as platform in the adult plants. Branches are stiff, Branchlets of the current year are gray-white. Leaves adaxial surface are densely covered with scale-hairs, commonly explenata never manifestly revolute at margin, the midrib on the above impressed into sulcus but up to top shallowed or vanished. Flower buds are ovate or ovate bifid. Fruits are black-brown, curved prism, with little or very little juice, one end thinner, with 5-7 longitudinal angles, 7.8-8.4 mm long, 2.8-3.3 mm wide, 2.5 times longer than wide. Distribution: Sichuan. Qinghai and Gansu. Habitat: It grows on river banks, flood land and river terrace, between 2700-3900 m. Type locality: Qinghai (Henan).

6. H. tibetana Schlecht. (Linnaea 32: 296,1863); Rousi in Ann. Bot. Fennici 8 (3): 217. 1971, S.W. Liu et T.N. He in Acta Phytotax. Sinica 16 (2): 107 (1978).

Characteristics: Plants are dwarf, 7-60 (80) cm high. Branches are pointing upwards, usually broom-like. Leaves are whorled, linear. Flower buds are ovate or ovate bifid. Fruits are dark tangerine, with (5) 6 (9) brown-black stellate ornamentation at apices, fruits and seeds, no longitudinal angles. Distribution: China (Sichuan, Xizang, Qinghai, Gansu), Nepal and India (Sikkim). Habitat: It grows on river bottoms, on river banks and steppes on higher mountains, at the elevations of 2700-5300 m. Type locality: Xizang.

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