ROOT DISTRIBUTION OF 430 PLANTS IN TEMPERATE GRASSLAND OF NORTHERN CHINA

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(Received 13th Jan 2017; accepted 4th Apr 2017)

Abstract. Plants in arid environments tend to have large, deep root systems, so plants living in different environments may have different root morphology. How many types of plant roots exist in the grassland? To answer this question, root morphology of each plant species should be observed, and then summarized. However, very limited data considering root distribution of each grassland species is available due to methods limitation. In this study, 430 plant species (including 542 observations) were selected. The study found that the majority of plant roots in grassland of northern China can be divided into six types: rhizome-rooted plant, fasciculate rooted plants, creeping rooted plants, fibrous rooted plants, tap-rooted plants, the bulb-corm-tuber rooted type. Based on the root types, the average root depth is 63.84 ± 5.96 cm for tap rooted, 49.89±7.06 cm for creeping rooted, 32.03 ± 4.29 cm for fasciculate rooted, 23.72 ± 2.77 cm for rhizome rooted, 20.38 ± 3.83 cm for fibrous rooted, 15.79 ± 2.02 cm for bulb-corm-tuber rooted plants. The unilateral root spread is 44.58 ± 9.26 cm for tap rooted, 43.12 ± 7.64 cm for creeping rooted, 23.82 ± 2.79 cm for rhizome rooted, 21.00 ± 2.93 cm for fasciculate rooted, 13.86 ± 2.64 cm for fibrous rooted, 12.64 ± 2.44 cm for bulb-corm-tuber rooted plants. It was found that plants with deeper tap root and longer lateral roots are mainly distributed in sandy and desert habitats. Plants with shallow tap roots and short lateral roots are mainly distributed in humid meadows, marsh soil and meadow soil. In humid regions, some plants were found to have a very large root system and at the same time large aboveground biomass.
Keywords: *root depth, unilateral roots, steppe, root type, height*

Introduction

When compared with the research concearning aboveground plant parts, the research in plant roots and belowground organs are relatively lacking. Mainly, because it is relatively difficult to sample and observe the root buried in soil. We are aware, that complete root system can only be obtained through the excavation method, yet this method is laborious and time-consuming. Additionally, there are many kinds of plants distributed widely. Therefore, the current data on root morphology is limited to only some

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1503_16251651

species. Efforts to understand the root morphological characteristics of all the plants, should be made through worldwide and long-term cooperation of scientists.

On this account, professor Chen Shihuang, had been aquiring 430 kinds of plant roots and had been gathering observational data for the past 50 years. Because of the identical way of collecting, the results can be well compared. The collected data was analyzed and is summerized in this article.

Review of Literature

Drought tolerance and water use efficiency of plants are important because aridity in many areas of the world severely limits plant growth. Aridity is expected to become more severe, especially in arid and semi-arid areas of the world, such as in central and northern China (Zhang et al., 2016; Fu and Guo, 2008). The depth, lateral spread and degree of overlap of plant root systems are important for plant's adsorption of water and nutrients (Casper and Jackson, 1997). Plants in arid areas have particurally large belowground biomass. According to Ma and Fang (2006), belowground biomass of plants in Inner Mongolian grasslands is six to ten times greater than aboveground biomass. Studying the distribution of plant roots is useful to predict different responses of plants under future drought conditions, and in order to develop strategies to protect local ecological environment and maintain ecological functions in the grassland.

Study of the vertical and horizontal distribution of roots is of particular ecological significance. Most of plant root biomass occurs in the 0-50 cm soil layer, and only a small portion reaches deep soil (for a review see Canadell et al. (1996)). Therefore, it has commonly been assumed that study of plant roots in the 50 cm soil layer can allow to fully understand the function and structure of the root systems on the ecosystem level. However, more and more research has shown the significant role of deep roots, especially for water, carbon and nutrient cycling (Douglas, 2011; Philippot et al., 2009; Yu et al., 2015).

Elongation of lateral roots of adjacent plants can affect the amount of available resources in an ecosystem and thus determine the competitive advantage between plants (Jose et al., 2003; Ruta et al., 2010; Wang et al., 2002). Data on root depth and lateral root spread can help predicting functional differences between plants with different growth under future climate change scenarios. However, the absolute root depth or horizontal extension of roots may even be greater in humid environments, because plants shoots can be relatively large in these regions (Schenk and Jackson, 2002). Study of the vertical and horizontal distribution characteristics of plant roots can provide important reference values for plant root sampling techniques, and can be useful in building models related to roots; and in calculating the carbon retention rates in global grasslands.

Roots are buried in the soil, but soil is an opaque and heterogeneous composite medium containing a lot of gravel. This increases the difficulty of root sampling and research. Therefore, many scholars have tried to employ new methods to study root systems, including the excavation method, the profile method, the root window method, ground penetrating radar and isotope labeling methods.

Compared to other methods, the excavation method is the only method in which relatively intact roots can be obtained. The excavation method is suitable for sampling shallow roots of herbs, but is very laborious and time-consuming when applied to the sampling of shrub and tree roots. Despite the difficulty, inefficiency and labor requirements, we need to use the excavation method to see the full morphology of a root

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system. The plant roots research team led by Chen Shihuang had accumulated abundant primary research data on plants' roots in grasslands over the past 50 years, including data on the basic morphology, depth and horizontal extension of roots in relation to the plants' habitat.

We analyzed the data in order to test some previously formed hypotheses: 1) plants have deeper or wider roots in water deficient environments, and also have deeper or wider roots under water-abundant conditions; 2) root morphology and root types are related to steppe habitats. The main root types in the steppe of northern China include tap roots, creeping roots, rhizome roots and fasciculate roots. This analysis aims to provide the basis for further study of belowground part of grassland ecosystem.

Materials and Methods

Plant roots were mostly sampled from Inner Mongolia Autonomous Region and northeast China, with some samples from Xinjiang Autonomous Region and Gansu Province (*Figure 1*, more details about the sites for each species can be acquired from supplements or from authors). Sampling was done at the beginning of August and at the end of July (which is the period of peak biomass). Typical plants were selected based on the growth of aboveground biomass, root samples were obtained using the excavation method. During the excavation process, it is necessary to obtain a root system, that is as complete as possible. The depth and horizontal distribution of roots and plant height were then measured in the field with a ruler, and the morphology of the roots was drawn on paper. A few observations of plant roots were collected from a special local sites, such as landslide area or a river bank. We analyzed 541 observations of plant roots, which covered 430 species of plants in different habitats. In some cases plants of the same species had different root morphology in different habitats.

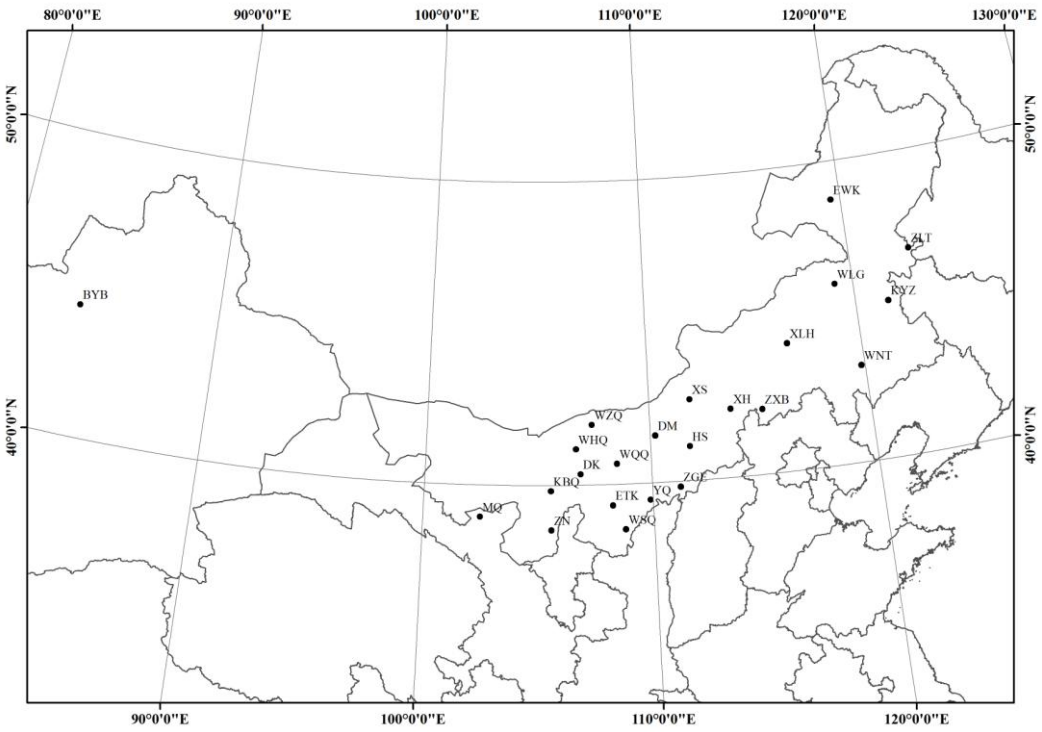

Figure 1. *The sampling sites of the plant in this study*

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The plants were divided into six root types based on the root morphology. Rhizome-rooted plants have a subterranean stem (*Figure 2a*). Creeping rooted plants are characterized by a horizontal root with branches coming from the horizontal root (*Figure 2c*), while fasciculate rooted plants have many branches of the same size coming from both the root and shoots (*Figure 2b*). Fibrous rooted plants have a single long stem with many of thin roots of the same thickness (*Figure 2d*). Tap-rooted plants exhibit a significant difference between the diameter of the main root and lateral roots (*Figure 2e*). The bulb-corm-tuber rooted type refers to plants that have roots with abnormal organs such as tubers, corms or bulbs (*Figure 2f*). More details about the root classification can be found in Liu and Chen (2001) and Armstrong (2001).

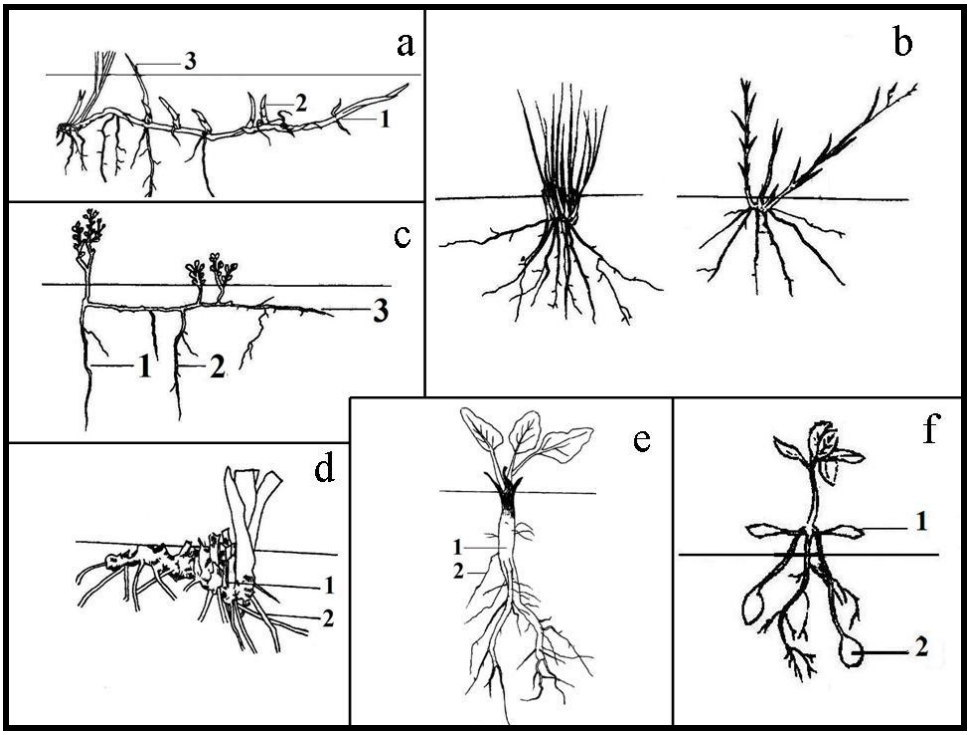

Figure 2. *The different root types of plants found in grassland of northern China. note: a. Rhizome-rooted plant (1, subterranean stem; 2,bud; 3, shoot); b. Fasciculate rooted plants; c. Creeping rooted plants (1, main root;2, vertical root;3, horizontal root); d. Fibrous rooted plants; e.Tap-rooted plants (1,main root;2,lateral roots); f. The bulb-corm-tuber rooted type (1, shoot; 2, abnormal organs)*

Results

Root depth of grassland plants

The average root depth of different life forms is shown in *Figure 3*. The average root depth of shrubs is 140.03 ± 14.63 cm (n = 38), with *Caragana intermedia* Kuang. (620 cm) being the longest. The average root depth of semi-shrubs is 100.14 ± 25.86 cm (n = 50), the longest of which is *Alhagi sparsifolia* Shap. (12 m), which grows in the desert. The average root depth of perennial herbs is 38.01 ± 2.41 cm (n = 367), the longest of which is *Medicago sativa* L. (467 cm). The average root depth of annual herbs is 18.24 ± 1.98 cm (n = 86), the longest of which is *Dracocephalum moldavica* L. (96.67 cm), which grows in fixed sand.

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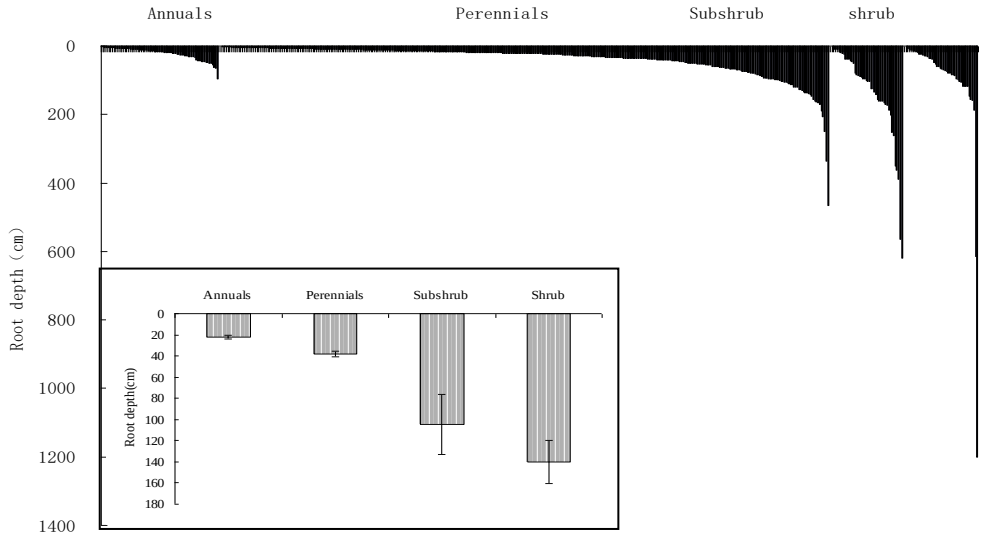

Figure 3. *Root depth of plants with different life forms*

In this study, a total of 541 observations of root depth were used. Most plant roots are distributed in the 0 to 50 cm soil layer, accounting for 72.09% of the total observations (*Table 1*). Sixty six observations of root data were distributed deeper than 100 cm. These observations came from 60 kinds of plants, including perennial herbs (27 species), shrubs (18 species), semi-shrubs (10 species), small shrubs (3), small trees (1) and biennial plants (1). Among these observations, 42 observations were sampled from sandy and arid soils, and 7 from salinized soil and wet meadow environments.

Table 1. *Root distribution interval of 541 data observations used in this study*

	Data observations (proportion %)								
	0≤L*<0.5	0.5≤L<1	1≤L<1.5	1.5≤L<2	2≤L<3	3≤L<4	4≤L<5	L >5	Sum
Depth (proportion)	390 (72.09%)	85 (15.71%)	35 (6.47%)	17 (3.14%)	5 (0.92%)	4 (0.74)	1 (0.18%)	4 (0.74)	541
Lateral root spread (proportion)	472 (87.41%)	40 (7.41%)	9 (1.67%)	7 (1.30%)	5 (0.93%)	2 (0.31)	1 (0.19%)	4 (0.74)	540

* "L" indicates length in meters.

The roots in 85 observations were distributed between 50-99 cm deep. These observations include data from 80 species: annual and biennial plants (7 species), perennials plants (53 species), and shrubs, semi-shrubs and dunga-runga (20 species). Of these 85 observations, 31 observations were from plants sampled in sandy soils.

There were 114 observations from a soil depth of 25-50 cm, including 105 species of annual and biennial plants (20 species), perennials plants (73 species), shrubs, semi-shrubs, undershrubs and sub-shrubs (12 species). Out of these, 46 observations came from sandy soils.

There were 276 observations from a root depth of 0-25 cm, including 243 species. Out of these observations, 136 were distributed in humid, aquatic or river bank environments.

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The root depth of each root type is shown in *Figure 3*. The depth of tap rooted plants is 63.44 ± 5.97 cm (n = 311) on average, of which the root of *Alhagi sparsifolia* Shap. is the deepest. The average depth of creeping rooted plants is 52.56 ± 7.12 cm (n = 55), of which the root of *Thermopsis lanceolata* R. Br., growing in semi-fixed sand, is the deepest (248.89 cm). The average depth of fasciculate rooted plants is 32.03 ± 3.33 cm (n = 51), of which the root of *Stipa baicalensis* Roshev., which grows in dark chestnut soils, is the deepest (113.44 cm). The depth of rhizome rooted plants is 23.72 ± 2.77 cm (n = 69) on average, of which the root of *Psammochloa villosa* (Trin.), which is found growing in sand dunes, is the deepest (120 cm). The average depth of fibrous rooted plants is 20.38 ± 3.83 cm (n = 30), of which the root of *Asparagus gobicus* Ivan. ex Grub. is the deepest (116.84 cm). The depth of tuber-bulb rooted plants is 15.79 ± 2.02 cm (n = 24) on average, among which the root of *Allium ramosum* L., which grows in the litho soils found in hilly areas of meadow steppe, is the deepest (37.14 cm).

Unilateral root spread

Based on the life form (*Figure 4*), the average unilateral root spread of annual plants is 11.88 ± 1.07 cm, of which the root of *Melilotus officinalis* (Linn.) Pall. is the longest (48.89 cm). The lateral root spread of perennials is 19.94 ± 1.20 cm, of which *Glycyrrhiza uralensis* Fisch. (223.5 cm) and *Ephedra sinica* Stapf. (225 cm) have the longest horizontal extension. The lateral root spread of semi-shrubs is 71.20 ± 15.82 cm, of which the root of *Alhagi sparsifolia* Shap. growing in desert areas, extends the longest (6 m). The lateral root spread of shrubs is 186.49 ± 60.29 cm, of which the root of *Salix gordejevii* Y. L. Chang et Skv. extends the longest (20 m).

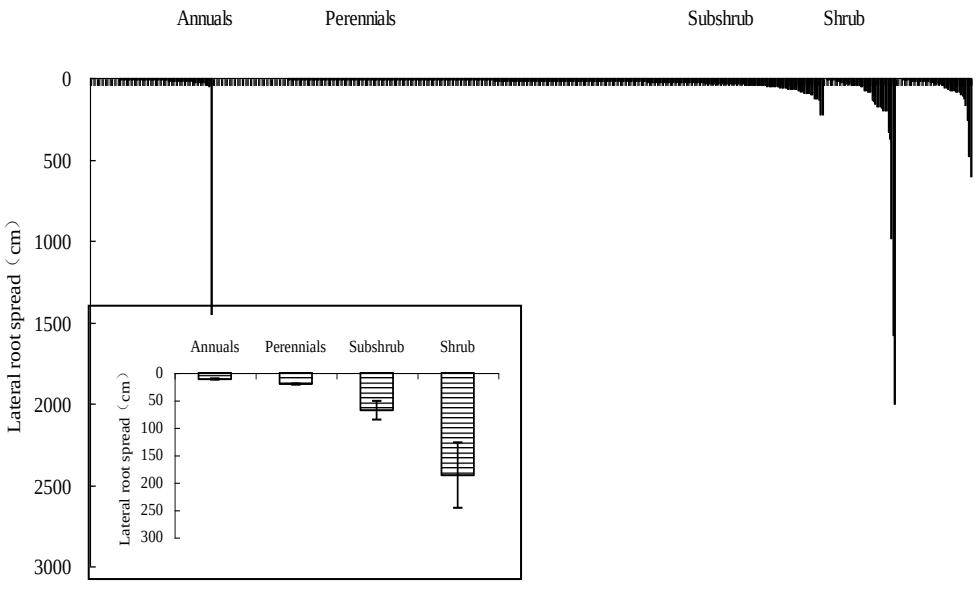

Figure 4. *Lateral root spread of plants with different life form*

There were 540 observation on lateral root spread. 472 observations were distributed between 0 to 50 cm, representing 87.41% of the total observations (*Table 1*). 28 observations of lateral root spread reached 100 cm, including 23 species of plants (4

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observations for perennials, 10 observations for shrubs, 5 observations for subshrubs, 3 observations for undershrubs, 1 observation for dunga-runga), of which 25 observations were located in sandy and desert areas.

The lateral root spread of 40 observations was between 50 and 100 cm, including 40 species (22 perennial herbs, 5 shrubs, 11 semi-shrubs, 1 undershrub and 1 biennial plant). Out of the 40 observations, sandy, desert and brown soils contributed 16 observations, calcic soils, marsh and wetland soils, meadow soils and aquatic environments contributed 10 observations, light chestnut soils 9 observations, dark chestnut soils 4 observations, and a rocky hillside 1 observation.

The lateral root spread of 82 observations was between 25 and 50 cm, covering 79 species. Of these observations, 35 were distributed in sandy soils and desert, and 29 in wet or salty soils, meadow or dark chestnut soils, 6 in light chestnut soils, 5 in chestnut soils, 4 in light brown calcic soil, 1 in alpine meadow of Tibet. Categorized by plant type, 9 observations were from annuals, 52 from perennial grasses, and 18 from shrubs, semi-shrubs and subshrubs.

The lateral root spread of 390 observations was between 0 and 25 cm, covering 330 species, including 64 annual plants, 243 perennial herbs and 23 shrubs, semi-shrubs and undershrubs. Of the 390 observations, 186 observations were distributed in meadow or marsh soils and dark chestnut soils in meadow steppe and mountain areas, saline soil in river wetlands; 107 observations were from sandy soils, fixed dunes and desert areas; 49 observations from chestnut soils, light chestnut soils and dark chestnut soils; 18 observations from brown soils and 17 observations from stony soils and regosols.

The lateral root spread of roots categorized by root type is shown in *Figure 5*. The average lateral spread for tuber rooted plants is 23.82 ± 2.78 cm. The lateral root spread of *Alisma orientale* (G.Sam.) Juz. is the longest (57.10 cm). The average spread for fasciculate rooted plants is 20.99 ± 2.93 cm, of which *Achnatherum splendens* (Trin.) Nevski is the longest (95 cm). The average for rhizome rooted plants is 23.82 ± 2.78 cm, of which the lateral root spread of *Acorus calamus* L. is the longest (121.70 cm). The average lateral spread for tap rooted plants is 44.57 ± 9.26 cm, of which mature *Salix gordejevii* Y. L. Chang et Skv. is the longest (2 m). For creeping rooted plants, the average spread is 43.12 ± 7.64 cm, of which the lateral root spread of *Hedysarum fruticosum* Pall. Lignosum (Trautv.) Kitag. is the longest (257.14 cm).

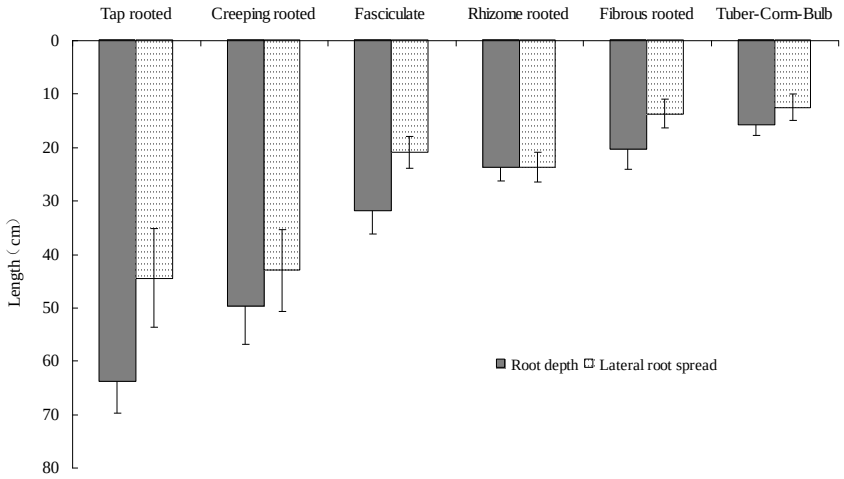

Figure 5. *Depth and lateral root spread of plants with different root types*

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Discussion

Using excavation method to remove the surrounding soil, the complete root morphology of plants was exposed. Since this method requires a large amount of physical labour and time (Smit et al., 2000), adequate data for root studies can only be collected through patient and persistent long-term data accumulation. Although necessary precautions were taken when exposing the roots during sampling process, damage to the roots was still difficult to avoid. Therefore, it is likely that the actual root depth and lateral root spread of some plants is greater than reported.

The root depth and lateral root spead of plants with different life forms follow the order: annuals < perennial herb < subshrub < various shrubs. This is in agreement with reports Schenk and Jackson (2002) and Canadell et al. (1996).

In this study, we classified the plant roots into 6 types (Liu and Chen, 2001). Relatively speaking, tap rooted plants can reach very deep into the soil. Creeping rooted plants have a strong capability to spread roots horizontally. Creeping rooted plants are mainly distributed in the desert steppe and the eastern part of the temperate steppe-desert areas. Tap rooted plants are mainly distributed in forbrich steppe and the western part of the desert steppe zone. The root depth of fasciculate rooted plants is greater than that of rhizome rooted plants, and smaller than tap rooted or creeping rooted plants. Fasciculate rooted plants are mainly distrubted in typical steppe, while rhizome rooted types are mainly distrbuted in meadow steppe and typical steppe (Liu and Chen, 2001). Fibrous rooted and tuber-bulb rooted plants with subsidiary abnormal organs can store a lot of photosynthetic products, which can limit root growth vertically or horizontally.

Plant root depth and lateral root spread are related to habitat. In general, plants found in sandy and water-deficient environments have deeper roots. The deeper roots can absorb water from deep soils and increase plant's adaptation to drought (Yu et al., 2015). Sandy soils are aerated and loose, so roots can spread more easily. Though patterns of lateral root growth are species specific and habitat dependent, roots may be more likely to spread wider in sandy, nutrient-poor, and arid soils (Gour, 2006; Achten et al., 2008; Göttlicher et al., 2008).

Data on lateral root spread may be useful for estimation of belowground competition and the area over which plants interact with neighbours (Zamora et al., 2007; Christine et al., 2002). In this study, 87.41% of the total number of observations were distributed from 0 to 50 cm. Shrubs and trees have a stronger ability to spread lateral root than herbs (*Table 1*), and most shrubs and trees sampled are located in arid areas.

However, we also found that some plants in the meadow steppe or under other humid conditions have large root systems. Some of these plants have a root deeper than 1 m, such as the perennial plants *Stipa grandis* P. Smirn., *Saussurea amara* (L.) DC., *Stipa baicalensis* Roshev., *Oxytropis myriophylla* (Pall.) DC. and *Hedysarum gmelinii* Ledeb., *Erodium stephanianum* Willd., and *Medicago sativa* L. and shrubs such as *Kalidium foliatum* (Pall.) Moq., *Kochia prostrata* (L.) Schrad., *Caragana microphylla* Lam. and *Caragana microphylla* Lam. Var. *cinerea* Kom.. Some other plants, such as *Glycyrrhiza uralensis* Fisch., *Ceratoides arborescens* (Losinsk.) Tsien et C. G., *Acorus calamus* L., have lateral root spead of more than 100 cm.

The plant root to shoot ratio (R/S) is related to the plant's habitat. Typically, plants have a higher R/S in water deficient soils (Woo et al., 2007; Neumann and Cardon, 2012). In this study, we found that plants living in sandy soils and water deficient environments have large root systems and low plant height, although some plants have large aboveground and belowground parts (*Figure 6*), such as *Hedysarum fruticosum*

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Pall. var. *mongolicum* Turcz. ex B. Fedtsch., *Calligonum mongolicum* Turcz., *Myricaria platyphylla* Maxim., *Astragalus melilotoides* Pall., *Medicago sativa* L., *Salix gordejevii* Y. L. Chang et Skv., *Caragana korshinskii* Kom., *Alhagi sparsifolia* Shap., and *Haloxylon ammodendron* (C. A. Mey.) Bunge. Most of these plants are trees and shrubs. Generally, R/S ratio and absolute maximum root depth of plants growing in arid regions are bigger than those of plants living in humid areas, although some studies have found the opposite (Schenk and Jackson, 2002; Mokany et al., 2006; Waring et al., 2017).

Regarding the plant root distribution pattern (*Figure* 6), one group of plants has very deep roots, while another group of plants has very long lateral roots, but no plants had both deep and long lateral roots. This may reflect two different survival strategies to obtain water, and thus seems reasonable from a resource allocation perspective.

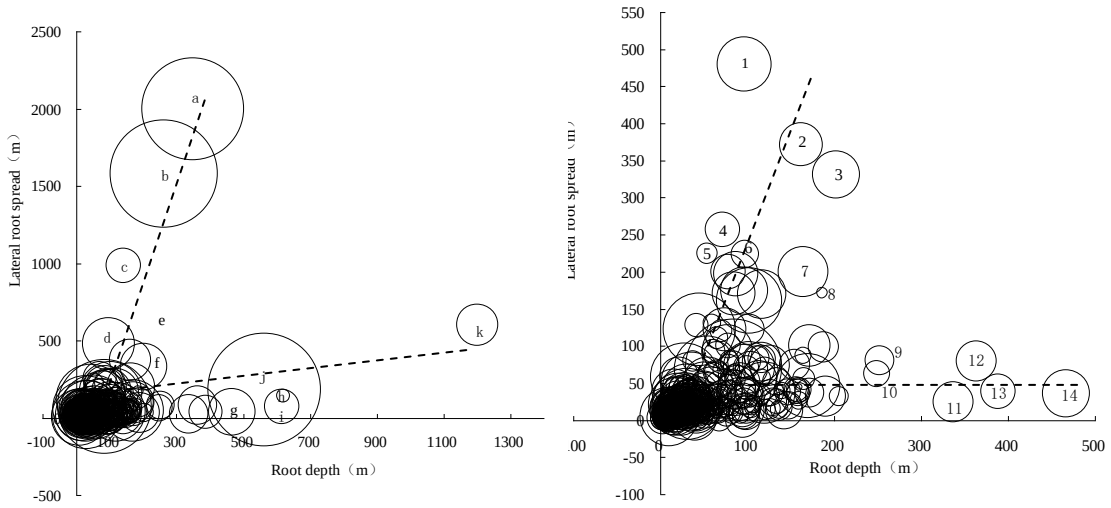

Figure 6. *Height, depth and lateral root spread of plants*
Right part: 1. Hedysarum fruticosum Pall. var. mongolicum Turcz. ex B. Fedtsch. 2. Calligonum mongolicum Turcz. 3. Myricaria platyphylla Maxim. 4. Hedysarum fruticosum Pall. Lignosum (Trautv.) Kitag 5. Ephedra sinica Stapf . 6. Glycyrrhiza uralensis Fisch. 7. Hedysarum scoparium Fisch.et Mey. 8. Artemisia sphaerocephala Krasch. 9. Caragana pygmaea (L.) DC. var. angustissima C. K. Schn. 10. Thermopsis lanceolata R.Br. 11. Astragalus melilotoides Pall. 14. Medicago sativa L.
Left part: a. Salix gordejevii Y. L. Chang et Skv. b. Caragana korshinskii Kom. c. Salix gordejevii Y. L. Chang et Skv. d. Hedysarum fruticosum Pall. var. mongolicum Turcz. ex B. Fedtsch. e. Calligonum mongolicum Turcz. .f. Myricaria platyphylla Maxim. g. Medicago sativa L. h. Caragana intermedia Kuang. i. Hedysarum fruticosum Pall. var. lignosum (Trautv.) Kitag. j. Haloxylon a mmodendron (C. A. Mey.) Bunge. k. Alhagi sparsifolia Shap.

Acknowledgements. This work was supported by the Science and Technology Innovation Team (IRT 1259) of the Chinese Ministry of Education. Many thanks to professor Wang Liqun in Inner Mongolia Agricultural University for providing many valuable suggestions for this article!

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Appendix

Appendix 1. *Rooting distribution by species with soil type or habitat*

Latin name	Root depth	Lateral root spread	Root type	Soil and plant habitat
Achillea millefolium L.	4.90	4.00	Tap	Meadow chernozem
Achnatherum sibiricum (L.) Keng	28.20	32.40	Fasciculate	Steppe
Achnatherum splendens (Trin.) Nevski	77.50	95.00	Fasciculate	Meadow soil in Salinized soil
Achyrophorus ciliatus (Thunb.) Makino	21.23	17.31	Tap	Dark black soils in low wetland between dunes
Acorus calamus L.	45.28	121.70	Rhizome	Bog soils in riverside
Adenophora gmelimii (Spreng.) Fisch.	40.00	1.88	Tap	The gaps between the rocks in forest steppe
Adenophora gmelimii (Spreng.) Fsch. var. *coronopifolia* (Fisch.) Y. Z. Zhao.	24.67	4.00	Tap	Chernozems in shaded side of hills
Adenophora stenanthina (Ledeb.) Kitag.	11.43	12.57	Creeping	Aeolian soils
Adenophora tetrophylla (Thunb.) Fisch.	43.13	7.50	Tap	Dark Kastanozems in ground
Adenophora trachelioides Maxim.	17.00	14.00	Tap	Podzolic soils in hills
Agriophyllum squarrosum (L.) Moq.	16.86	10.00	Tap	Sand in windward slope
Agriophyllum squarrosum (L.) Moq.	21.75	9.50	Tap	Semi-fixed sand
Agriophyllum squarrosum (L.) Moq.	65.00	30.00	Tap	Light brown calcic soils
Agropyron cristatum (L.) Gaertn.	39.86	13.29	Fasciculate	Light Kastanozems
Agropyron cristatum (L.)	5.71	17.14	Rhizome	Black soils in slope

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DOI: http://dx.doi.org/10.15666/aeer/1503_16251651

Gaertn.var. *pectiniforme* (Roem.et Schult.) H. L.Yang				
Agropyron desertorum (Fisch.) Schult.	40.50	31.00	Rhizome	Semi-fixed dune
Agropyron michnoi Roshev.	7.33	14.67	Rhizome	Sandy Kastanozems
Agropyron mongolicum Keng	10.29	10.29	Rhizome	Aeolian soils in meadow steppe
Agropyron mongolicum Keng	33.14	18.29	Rhizome	Fixed dune
Agropyron mongolicum Keng	33.14	18.29	Rhizome	Light Kastanozems in overlying sand
Agropyron mongolicum Keng var. *villosum* H. .L. Yang	6.56	6.44	Rhizome	Sandy steppe
Agrostis clavata Trin.	5.00	6.00	Rhizome	Meadow
Agrostis divaricatissima Mez	5.33	4.17	Rhizome	Meadow in lowland flood plain
Agrostis gigantea Roth	4.86	6.57	Rhizome	Meadow in lowland flood plain
Ajania achilleoides (Turcz.) Poljak. ex Grub.	7.64	3.27	Tap	Stony brown calcic soils
Ajania achilleoides (Turcz.) Poljak. ex Grub.	19.27	11.82	Tap	Gravel sandy soil
Aleuritopteris argentea (Gme'l.) Fe'e	4.44	3.00	Fibrous	Under the shrub in shade
Alhagi sparsifolia Shap.	21.25	6.75	Tap	Semi-fixed dune
Alhagi sparsifolia Shap.	39.00	25.00	Tap	Gray-brown desert soil
Alhagi sparsifolia Shap.	85.00	170.00	Tap	Aeolian soils
Alhagi sparsifolia Shap.	155.00	75.00	Tap	Desert
Alhagi sparsifolia Shap.	1200.00	600.00	Tap	Desert (one year old)
Alisma orientale (G. Sam.) Juz.	28.06	57.10	Tuber	In river
Allium condensatum Turcz.	33.90	18.00	Tuber	Litho soils in slope
Allium mongolicum Regel.	5.67	4.17	Tuber	Desert steppe
Allium polyrhizum Turcz. ex Regel	19.04	8.09	Tuber	Brown calcic soils in desert steppe
Allium ramosum L.	37.14	31.43	Tuber	Litho soils in hills of meadow steppe
Allium senescens L	9.14	5.43	Tuber	Light Kastanozems in hills
Allium senescens L	14.20	12.60	Tuber	Dark Kastanozems in hills
Allium tenuissimum L.	11.20	9.20	Tuber	Steppe and sandy steppe
Alopecurus brachystachyus Marsh. –Bieb.	28.00	22.00	Rhizome	Meadow in lowland flood plain
Amaranthus retroflexus L.	26.63	7.50	Tap	Kastanozems
Anabasis brevifolia C.A. Mey.	48.00	35.50	Tap	Brown sandy soil in ground
Anabasis brevifolia C.A. Mey.	52.32	20.63	Tap	Light Kastanozems in ground between dunes
Androsace longifolia Turcz.	21.20	12.60	Tap	Dark Kastanozems between dunes
Androsace mariae Kanitz	5.04	4.32	Tap	Skeletol soils in hills
Anemarrhena asphodeloides Bunge	20.20	13.40	Fibrous	Meadow steppe
Arctium lappa L.	23.57	9.14	Tap	Forest steppe in hills
Arenaria juncea Bieb.	5.55	3.84	Tap	Light Kastanozems in hills
Aristida adscenionis L.	7.50	5.50	Fasciculate	Brown calcic soils in lowland of desert steppe
Artemisia anethifolia Web. ex Stechm.	28.91	7.64	Tap	Saline and Salinized soil
Artemisia annua L.	18.22	6.44	Tap	Brown earth soil in hills

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DOI: http://dx.doi.org/10.15666/aeer/1503_16251651

Artemisia annua L.	18.46	6.92	Tap	Wetland of riverside in hills
Artemisia annua L.	32.00	25.60	Tap	Light Kastanozems in hills
Artemisia annua L.	54.17	10.42	Tap	Brown earth aeolian soil
Artemisia blepharolepis Bunge	33.50	17.50	Tap	Fixed sand
Artemisia brachyloba Franch.	65.49	87.68	Tap	Mountain
Artemisia desertorum Spreng.	94.80	13.20	Tap	Kastanozems in hills
Artemisia dracunculus Linn.	7.20	9.90	Tap	Light Kastanozems
Artemisia frigida Willd.	23	13.75	Tap	Sandy Kastanozems-in vegetation growth stage
Artemisia frigida Willd.	99	13.5	Tap	Sandy Kastanozems-in reproductive stage
Artemisia halodendron Turcz. ex Bess.	158.47	35.08	Tap	Semi-mobile sand
Artemisia lavandulaefolia D. C.	104.12	68.82	Creeping	Sand
Artemisia mongolica (Fisch. ex Bess.) Nakai.	6.58	5.25	Creeping	Kastanozems in meadow
Artemisia ordosica Krasch.	25.83	21.67	Tap	Sandy brown calcic soils
Artemisia ordosica Krasch.	117.14	78.57	Tap	Semi-fixed sand
Artemisia oxycephala Kitag.	37.50	43.75	Tap	Semi-fixed dune in meadow steppe
Artemisia palustris L.	31.38	16.00	Tap	Sand in forest steppe
Artemisia pubescens Ledeb.	13.80	6.00	Tap	Dry riverbed alluvial soils
Artemisia sacrorum Ledeb.	22.33	17.33	Creeping	Dark Kastanozems in hills
Artemisia sacrorum Ledeb. Var. incana (Barr.) Y. R. Ling	29.10	19.20	Creeping	Sandy dark Kastanozems
Artemisia sieversiana	35.00	25.00	Tap	Kastanozems in dump of coal mine in steppe
Artemisia sphaerocephala Krasch.	74.48	122.07	Tap	Semi-mobile sand
Artemisia sphaerocephala Krasch.	171.43	100.00	Tap	Dune
Artemisia subulata Nakai	16.89	14.89	Creeping	Alluvial soils in dry riverbed
Artemisia tanacetifolia L.	14.70	15.90	Creeping	Forest steppe
Artemisia xerophytica Krasch.	60.00	37.24	Tap	Light brown calcic soils in slope eroded by wind
Artemisia xerophytica Krasch.	73.45	40.34	Tap	Light brown calcic soils in high plains
Arundinella anomala Steud.	24.00	23.50	Rhizome	Aeolian soils
Asparagus dauricus Fisch.ex Link	40.83	17.50	Fibrous	Semi-fixed dune
Asparagus gobicus Ivan.ex Grub.	116.84	82.11	Fibrous	Stony steppe desert
Asparagus oligoclonos Maxim.	12.00	7.56	Fibrous	Litho soils in hills
Aster alpinus L.	21.67	18.00	Tap	Litho soils in hills
Asterothamnus centrali-asiaticus Novopokr.	23.00	9.00	Tap	Gravelly desert soil in desert steppe
Asterothamnus centrali-asiaticus Novopokr.	78.75	75.00	Tap	Brown calcic soils in desert steppe
Astragalus adsurgens Pall.	23.14	11.14	Tap	Fluvo-aquic soils between dunes
Astragalus adsurgens Pall.	55.45	43.64	Tap	Humid sandy soil
Astragalus adsurgens Pall.	205.33	32.00	Tap	Light and stony Kastanozems in slope
Astragalus complanatus	64.90	12.02	Tap	Meadow steppe and alkalization

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1503_16251651

Bunge				meadow
Astragalus efoliolatus Hand.-Mazz.	38.75	10.31	Tap	Desert steppe
Astragalus galactites Pall.	25.05	5.25	Tap	Light brown calcic soils
Astragalus galactites Pall.	40.53	10.00	Tap	Light Kastanozems
Astragalus galactites Pall.	106.97	21.52	Tap	Gravelly brown soil
Astragalus melilotoides Pall.	336.99	24.66	Tap	Fixed sand
Astragalus miniatus Bunge	16.55	10.55	Tap	Stony slope and Salinized lowland
Astragalus scaberrimus Bunge	53.89	28.33	Creeping	Kastanozems in stony slope
Atraphaxis frutescens (L.) Ewersm.	78.33	200.00	Tap	Flat sand
Atraphaxis frutescens (L.) Ewersm.	160.00	40.00	Tap	Sand in high plains
Atraphaxis manshurica Kitag.	156.65	41.77	Tap	Sand in plain
Atraphaxis pungens (Bieb.) Jaub. et Spach.	95.00	No data	Tap	Sandy chestnut soil
Atriplex sibirica L.	63.00	11.50	Tap	Salinized lowland
Bassia dasyphylla (Fsch.et Mey.). Kuntze	8.36	2.91	Tap	Fixed sand
Bassia dasyphylla (Fsch.et Mey.). Kuntze	16.17	11.67	Tap	Desert soil
Bassia dasyphylla (Fsch.et Mey.). Kuntze	31.13	25.50	Tap	Kastanozems in slope
Beckmannia syzigachne (Steud.) Fernald	7.69	2.23	Fasciculate	Swampy meadow and meadow
Blysmus rufus (Huds.) Link	6.20	7.80	Rhizome	Meadow soil in low wetland
Bothriochloa ischamum (L.) Keng	19.13	17.25	Rhizome	Skeletol soils in hills
Bromus ciliatus L. var. *richardsonii* (Link) Y.Q. Jiang	34.00	29.00	Rhizome	Dark Kastanozems
Bromus inermis Leyss.	21.75	58.50	Rhizome	Dark Kastanozems in hills of typical steppe
Bupleurum bicaule Helm	22.00	4.44	Tap	Dark Kastanozems
Bupleurum chinense D. C.	13.78	2.78	Tap	Kastanozems in hills
Bupleurum scorzonerifolium Willd.	29.60	6.40	Tap	Light Kastanozems in hills
Butomus umbellatus L.	17.86	20.71	Fibrous	Bog soils in riverside
Calamagrostis epigeios (L.) Roth	55.00	51.00	Rhizome	Meadow soil in salinized ground
Calamagrostis pseudophragmites (Hall.f) Koel	21.50	46.50	Rhizome	Fixed dune
Calligonum mongolicum Turcz.	162.00	372.00	Tap	Desert steppe sand
Calystegia haderacea Wall. Ex Roxb.	13.56	10.22	Creeping	Aeolian soil
Caragana intermedia Kuang.	620.00	142.11	Tap	Dry riverbed in desert steppe
Caragana korshinskii Kom.	262.77	1576.6	Tap	Aeolian soil
Caragana microphylla Lam.	363.64	79.55	Tap	Light Kastanozems in hills(typical steppe)
Caragana microphylla Lam.	388.89	38.89	Tap	Light Kastanozems in slope of hills(desert steppe)
Caragana microphylla Lam.	160.00	43.84	Tap	Typical steppe

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Var. *cinerea* Kom.				
Caragana pygmaea (L.) D. C. var. *angustissima* C. K. Schn.	252.71	80.62	Tap	Light Kastanozems in slope of hills(Desert steppe)
Caragana stenophylla Pojark.	172.17	36.52	Creeping	Sandy soil in desert steppe
Caragana tibetica Kom.	133.75	25.00	Tap	Steppe Desert
Carex duriuscula C. A. Mey.	7.89	15.79	Rhizome	Fixed sand
Carex duriuscula C. A. Mey.	97.06	79.41	Rhizome	Light Kastanozems of gentle slope in hills
Carex gotoi Ohwi.	3.67	3.67	Rhizome	Meadow soil in between dunes
Carex gotoi Ohwi.	5.44	14.25	Rhizome	Meadow soil in wetland
Carex kobomugi Ohwi.	14.67	23.33	Rhizome	Riverside sandy soil
Carex lithophila Turcz.	6.25	1.25	Rhizome	Meadow soil in forest steppe
Carex raddei kukenth.	54.00	69.00	Rhizome	Meadow soil in valley
Carex rigescens (Franch.) V. Krecz.	18.86	16.57	Rhizome	Sandybrown calcic soils in typical steppe
Carex stenophylloides V. Krecz.	12.25	16.50	Rhizome	Bog soils in riverside
Carex stenophylloides V. Krecz.	35.00	36.50	Rhizome	Fluvo-aquic soils in lowland of Hills
CaryopteriS mongholica Bunge	117.27	169.09	Tap	Light Kastanozems between dunes
Centaurtum pulchellum (Swartz) Druce var. *altacum* (Griseb.) Krtag.	9.56	1.78	Tap	Meadow between dunes in mobile sand
Ceratoides arborescens (Losinsk.) Tsien et C. G. Ma	187.69	98.46	Tap	Light Kastanozems in meadow
Ceratoides lateens (J. F. Gmel.) Reveal et Holmgren.	61.11	64.44	Tap	Brown calcic soils in steppe desert
Ceratoides lateens (J. F. Gmel.) Reveal et Holmgren.	84.55	31.36	Tap	Light Kastanozems in hills of steppe desert
Chamaenerion angustifolium (L.) Scop.	14.67	16.67	Tap	Black soils in hills
Chamaerhodos altaica (Laxm.) Bge.	45.00	32.63	Tap	Litho soils in hills
Chamaerhodos canescens Krause	16.00	9.33	Tap	Dark Kastanozems in hills
Chamaerhodos erecta (L.) Bge.	32.00	6.29	Tap	Sandy brown soil in slope
Chamaerhodos erecta (L.) Bge.	45.43	12.43	Tap	Stony Kastanozems in slope
Chamaerhodos trifida Ldb.	21.20	5.60	Tap	Litho soils in hills
Chenopodium album L.	10.00	5.00	Tap	Mesophytic weed
Chenopodium acuminatum Willd.	9.30	6.60	Tap	Light Salinized soil in low wetland
Chenopodium acuminatum Willd.	13.83	9.33	Tap	Sandy Kastanozems in hills
Chenopodium aristatum L.	48.21	22.14	Tap	Fixed sand
Chenopodium glaucum L.	5.92	5.67	Tap	Sand between dunes
Chloris virgata Swartz.	20.00	27.78	Fasciculate	Fluvo-aquic soils in lowland
Chloris virgata Swartz.	26.67	14.67	Fasciculate	Light brown calcic soils
Cirsium segetum (Willd.) M B.	10.00	8.17	Creeping	Alluvial soils
Cistanche salsa (C. A. Mey) G. Beck.	38.73	19.91	Fibrous	Saline-alkali soil in lake basin of desert steppe
Cleistogenes polyphylla Keng.	7.30	4.40	Fasciculate	Stony Kastanozems in typical steppe

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Cleistogenes polyphylla Keng.	12.00	4.50	Fasciculate	Aeolian sand in hills
Cleistogenes songorica (Roshev.) Ohwi.	23.11	9.78	Fasciculate	Light brown calcic soils in desert steppe
Cleistogenes squarrosa (Trin.) Keng.	10.13	7.25	Fasciculate	Sandy Kastanozems in typical steppe
Clematis aethusifolia Turcz.	38.33	11.11	Tap	Sandy light Kastanozems
Clematis canescens (Turcz.) W. T. Wanget M.C. Chang.	49.44	20.00	Tap	Fixed sand
Clematis hexapetala Pall.	43.13	20.00	Tap	Dark meadow soil in valley
Cnidium dahuricum (Jacq.) Turcz. ex Fisch. et Mey.	5.58	2.00	Tap	Light salined meadow soil
Codonopsis pilosula (Franch.) Nannf.	18.57	10.86	Tap	Shrub in forest edge of hills
Convolvulus ammannii Desr.	12.52	3.52	Tap	Sandy light Kastanozems
Convolvulus ammannii Desr.	18.58	2.71	Tap	Saline soil in meadow
Convolvulus ammannii Desr.	36.57	6.57	Tap	Light brown calcic soils in hills
Convolvulus ammannii Desr.	55.56	10.00	Tap	Brown calcic soils
Convolvulus arvensis L.	9.25	8.50	Creeping	Light Kastanozems
Corispenmum puberulum lljin	46.64	14.73	Tap	Sand in steppe
Corispermum mongolicum Iljin.	21.20	10.40	Tap	Sandy Kastanozems in hills
Corsipermum declinatum var. *tylocarp* Um (Hance) Tsien et C.G. Ma.	24.50	11.00	Tap	Semi-fixed sand
Corsipermum declinatum var. *tylocarp* Um (Hance) Tsien et C. G. Ma.	45.00	13.13	Tap	Light brown calcic soils
Crepis crocea (Lam.) Babcock.	51.00	28.50	Creeping	Skeleton chernozems
Crypsis aculeata (L.) Art.	10.13	9.47	Fasciculate	SalinizedSalinized meadow or humid saline in riverside of desert steppe
Cymbaria dahurica L.	10.00	29.00	Tap	Salinized Kastanozems
Cymbaria dahurica L.	21.33	24.67	Tap	Light Kastanozems
Cynanchum chinense R. Br.	61.00	31.90	Creeping	Salinized sand
Cynanchum komarovii Al. Iljinski.	29.20	9.60	Fibrous	Sand(two years old)
Cynanchum thesioides (Freyn) K. Schum.	70.00	120.00	Creeping	Semi-fixed sand
Cynomorium songaricum Rupr.	31.14	14.86	Fibrous	Lowland between dunes in desert
Datura metel L.	16.40	13.00	Tap	Kastanozems
Delphinium grandiflorum L.	4.00	3.78	Tap	Dark Kastanozems in hills
Dendranthema zawadskii (Herb.) Tzvel.	15.60	15.00	Creeping	Skeleton dark Kastanozems
Deyeuxia langsdorffii (Link) Kunth.	31.25	21.25	Rhizome	Dark Kastanozems
Dgitaria ischaemum (Schreb.) Schreb.	13.27	11.45	Fasciculate	Humid areas and sandy
Dianthus chinensis L.var. *subulifolius*（kitag）Y. c.Ma.	34.33	6.67	Tap	Skeletol soils in hills
Dianthus chinesis L.	25.33	2.67	Tap	Skeletol soils in hills
Dictamnus dasycarpus Turcz.	19.50	10.50	Tap	Chernozems
Dontostemon crassifolius (Bunge) Maxim.	28.24	44.12	Creeping	Light brown calcic soils in overlying sand
Dontostemon eglandulosus	5.80	1.80	Tap	Light Kastanozems in hills

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(D. C.) Ledeb.				
Dontostemon integrifolius (L.) Ledeb.	14.00	20.67	Creeping	Light Kastanozems
Dracocephalum heterophyllum Benth.	51.50	7.50	Tap	Light Kastanozems in ground of hills
Dracocephalum moldavica L.	29.63	12.75	Tap	Gravel and sandy brown calcic soils in slope
Dracocephalum moldavica L.	96.67	25.56	Tap	Fixed sand
Echinochloa crusgalli (L.) Beauv.	17.50	10.50	Fasciculate	Humid areas
Echinops gmelini Turcz.	17.67	4.00	Tap	Sandy Kastanozems in high plains
Echinops gmelini Turcz.	19.00	2.67	Tap	Wet saline soil
Eleocharis intersita Zinserl.	9.60	7.60	Rhizome	Wetlands in riverside
Elymus dahuricus Turcz.	53.33	33.33	Fasciculate	Meadow or mountain meadow steppe
Elymus excelsus Turcz.	10.09	4.36	Fasciculate	Mountain meadow or meadow steppe
Elymus purpuraristatus C. P. Wang et H. L. Yang.	7.75	5.00	Rhizome	Chernozems
Elymus sibiricus L.	8.67	4.25	Fasciculate	Meadow or meadow steppe
Enneapogon borealis (Griseb.) Honda.	6.22	3.33	Fasciculate	Desert and Desert steppe
Ephedra przewalskii Stapf.	125.77	73.85	Creeping	Sand
Ephedra sinica Stapf.	53.75	225.00	Creeping	Sandy soil in fixed sand
Equisetum fluviatile L.	32.57	7.71	Rhizome	Swampy or swampy grassland in forest steppe
Equisetum pratense Ehrh.	9.80	12.00	Rhizome	Sandy meadow soil in wetland
Equisetum sylvaticum L.	10.63	7.25	Rhizome	Low-lying land in riverside
Eragrostis minor Host.	24.67	26.67	Fasciculate	Sandy brown calcic soils in slope of hills
Eragrostis pilosa (L.) Beauv.	4.11	1.67	Fasciculate	Meadow
Eragrostis pilosa (L.) Beauv. var. *imbenbis* Franch.	19.33	20.00	Fasciculate	Semi-fixed sand
Erodium stephanianum Willd.	142.50	12.50	Tap	Low wetland in riverside
Euphorbia esula L.	17.20	1.90	Creeping	Brown earth types of sandy soil
Euphorbia esula L.	36.00	34.29	Creeping	Fixed sand
Euphorbia esula L.	61.50	93.00	Creeping	Semi-fixed sand
Euphorbia esula L.	73.60	16.40	Creeping	Kastanozems
Euphorbia fischeriana Steud.	30.50	25.00	Tap	Dark Kastanozems
Euphorbia humifusa Willd. ex Schlecht.	5.00	3.75	Tap	Aeolian sand in slope
Euphorbia humifusa Willd. ex Schlecht.	16.25	5.63	Tap	Aeolian soils in flat groud
Ferula bungeana Kitag.	137.42	13.55	Tap	Aeolian soil
Festuca ovina L.	7.00	5.09	Fasciculate	Dark Kastanozems
Festuca rubra L.	7.63	7.00	Rhizome	Dark Kastanozems in hills
Filifolium sibiricum (L.) Kitam.	24.75	18.50	Tap	Litho soils in hills
Filifolium sibiricum (L.) Kitam.	43.00	19.00	Tap	Kastanozems in hills
Galium verum L.	61.71	16.00	Tap	Loamy and sandy typical Kastanozems
Garex pediformis C. A. .Mey.	12.00	5.43	Rhizome	Dark Kastanozems of sunny slope in hills （Meadow steppe ）

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1503_16251651

Gentiana dahurica Fisch.	51.00	15.00	Tap	Light Kastanozems in high plains
Gentiana macrophylla Pall.	16.57	6.57	Tap	Meadow soil in riverside
Geranium sibiricum L.	22.78	21.67	Fibrous	Meadow soil in riverside
Glaux maritime L.	20.20	8.40	Fibrous	Bog soils in fluvial sand of riverside
Glycine soja Sieb. et Zucc.	12.29	10.00	Tap	Flood plain
Glycyrrhiza uralensis Fisch.	97.50	223.50	Creeping	Typical steppe
Goldbachia iaevigata (M. Bieb.) D. C.	50.00	13.18	Tap	Light Kastanozems
Gueldenstaedtia gansuensis H. P. Tsui.	35.33	12.00	Tap	Semi-fixed dune
Gueldenstaedtia stenophylla Bunge	37.00	3.75	Tap	Sandy steppe
Gymnadenia conopsea (L.) R. Br.	15.20	11.20	Tuber	Dark Kastanozems in low wetland
Gypsophila licentiana-Mazz.	25.14	11.43	Tap	Litho soils in hills
Gysophila desertorum (BLlrIge) Fenzl.	92.73	6.36	Tap	Sandy light Kastanozems
Halenia comiculata (L.) Comaz.	5.00	2.00	Tap	Meadow soil
Halerpestes ruthenica (Jacq.) Ovez.	6.62	6.92	Fibrous	Low wetland in steppe and desert steppe
Haloxylon a mmodendron (C.A.Mey.) Bunge.	97.14	174.29	Tap	Sand (three years old)
Haloxylon a mmodendron (C. A. Mey.) Bunge.	170.00	46.25	Tap	Dune (ten years old)
Haloxylon a mmodendron (C. A. Mey.) Bunge	563.64	181.82	Tap	Salinized fixed dune (six years old)
Haloxylon persicum Bge. ex Boiss. et Buhse.	87.69	40.00	Tap	Sandy desert in grassland
Haplophyllum dauricum (L.) G. Don.	12.57	4.86	Tap	Kastanozems type of litho soils
Haplophyllum dauricum (L.) G. Don.	25.43	18.29	Tap	Kastanozems
Hedysarum brachypterum Bunge	66.55	17.45	Tap	Typical steppe and desert steppe sandy brown calcic soils
Hedysarum frutcosum Pall.	65.71	110.48	Creeping	Fixed dune
Hedysarum fruticosum Pall. Lignosum (Trautv.) Kitag.	71.43	257.14	Creeping	Semi-mobile dune in Kubuqi desert (three years old)
Hedysarum fruticosum Pall. Lignosum (Trautv.) Kitag.	102.63	121.58	Creeping	Semi-fixed sand (six years old)
Hedysarum fruticosum Pall. var. *lignosum* (Trautv.) Kitag.	615.60	72.00	Tap	Semi-mobiles sand
Hedysarum fruticosum Pall. var. *mongolicum* Turcz. ex B. Fedtsch.	97.14	480.00	Tap	Kubuqi desert
Hedysarum gmelinii Ledeb.	97.14	8.57	Tap	Light Kastanozems
Hedysarum gmelinii Ledeb.	137.14	17.14	Tap	Typical steppe Kastanozems
Hedysarum scoparium Fisch.et Mey.	87.10	197.42	Tap	Kubuqi Desert
Hedysarum scoparium Fisch.et Mey.	164.71	200.00	Tap	Tenggeli Desert (three years old)
Helianthemum songaricum Schrenk.	8.88	11.25	Tap	Gravelly brown calcic soils in the foot of a mountain
Helictotrichon schellianum (Hack.) Kitag.	37.00	10.00	Fasciculate	Mountain meadow steppe and mountain steppe

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Hemarthria altissima (Poir.) Stapf et C. E. Hubb.	11.50	5.25	Rhizome	Sandy meadow soil
Hemerocallis minor Mill	18.00	12.43	Fibrous	Dark Kastanozems
Herminium monorchis (L.) R. Br.	3.00	1.75	Tuber	Meadow soil in low wetland
Herminium monorchis (L.) R. Br.	4.17	3.00	Tuber	Meadow soil in reiverside
Heteropappus altaicus (Willd.) Novopokr.	8.10	8.20	Tap	Eutrie fluvisio in dry riverbed of steppe desert
Heteropappus altaicus (Willd.) Novopokr.	8.64	2.91	Tap	Light Kastanozems in desert steppe
Heteropappus altaicus (Willd.) Novopokr.	8.70	18.60	Tap	Eroded slope by wind
Heteropappus meyendorffii (Reg. et Maack) Komar. et Klob. –Alis.	12.00	17.33	Tap	Aeolian soil in fixed sand
Hierochloe glabra Trin.	3.63	13.38	Rhizome	Meadow Kastanozems
Hippolytia trifida (Turcz.) Poljak.	18.00	13.40	Tap	Light brown calcic soils between dunes
Hippolytia trifida (Turcz.) Poljak.	31.82	21.36	Tap	Light Kastanozems in sandy high plains
Hippolytia trifida (Turcz.) Poljak.	35.91	20.00	Tap	Sandy light brown calcic soils
Hippolytia trifida (Turcz.) Poljak.	70.63	35.00	Tap	Light Kastanozems in desert steppe
Hordeum brevisubulatum (Trin.) Link.	33.13	30.00	Rhizome	Salinized meadow in valley
Hvpecoum erectum L.	40.63	19.38	Tap	Fixed sand
Hylotelephium purpureum (L.) Holub.	9.27	7.91	Tuber	Dark Kastanozems
Incarvillea sinensis Lam.	8.22	5.33	Tap	Lowland of fixed sand
Inula britanica L.	5.00	5.00	Tap	Low wetland between dunes
Inula britanica L.	11.55	8.36	Tap	Flood plain
Inula britanica L.var. *Japonica* (Thunb.) Franch.	10.67	16.67	Tap	Fluvo-aquic soils between dunes
Inula lineariifolia Turcz.	22.64	11.73	Tap	Meadow
Inula salsoloides (Turcz.) Ostenf.	9.88	17.25	Creeping	Aeolian soil
Inula salsoloides (Turcz.) Ostenf.	120.88	14.12	Tap	Fixed sand
Iris bungei Maxim.	111.43	83.57	Fasciculate	Light Kastanozems
Iris dichotoma Pall.	12.40	6.40	Fibrous	Sandy soil in riverside of seasonal river
Iris dichotoma Pall.	18.25	7.00	Fibrous	Dark Kastanozems
Iris lactea Pall. var. *chinensis* (Fisch.) Koidz.	80.00	35.56	Fasciculate	Meadow soil
Iris tenuifolia Pall.	15.78	7.56	Fasciculate	Desert steppe
Iris tigridia Bunge.	8.00	5.67	Fasciculate	Upland meadow
Ixeridium chinense (Thunb.) Tzvel.	6.14	10.43	Creeping	Humid sandy soil
Ixeridium graminifolium (Ledeb.) Tzvel.	45.00	4.55	Tap	Fixed sand
Juncellus serotinus (Rottb.) C. B. Clarke.	20.00	28.75	Rhizome	Bog soils
Juncus bufonius L.	4.38	3.25	Rhizome	Bog soils in riverside
Juncus effusus Linn.	7.29	2.57	Rhizome	Bog soils of lowland between

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				dunes
Juncus gracilicaulis A. Camus.	32.50	18.75	Rhizome	Swampy Meadow between dunes
Kalidium cuspidatum (Ung.-Sternb.) Grub.	86.25	53.75	Tap	Salinized Sandy soil between dunes
Kalidium foliatum (Pall.) Moq.	17.25	9.25	Tap	Salinized meadow soil in steppe and desert
Kalidium foliatum (Pall.) Moq.	100.00	71.11	Tap	Saline soil of lowland
Kalidium gracile Fenzl.	17.40	18.00	Tap	Sandy soil between dunes
Kalidium gracile Fenzl.	124.00	34.00	Tap	Saline soil
Kochia prostrata (L.) Schrad.	147.50	20.00	Tap	Meadow steppe
Kochia scoparia (L.) Schrad. var. *Sieversiana*（Pall） Ulbr.ex Aschers.et Graebn.	42.75	15.00	Tap	Kastanozems in base of hills
Kochia scoparia (L.) Schrad. var. *Sieversiana*（pall.） Ulbr.ex Aschers.et Graebn.	54.38	10.00	Tap	Salinized sand
Koeleria cristata (L.) Pers.	25.45	23.27	Fasciculate	Light Kastanozems in gentle slope of hills
Kummerowia striata (Thunb.) Schindl.	6.92	4.46	Tap	Fixed sand
Lagochilus ilicifolius Bunge.	21.43	25.00	Tap	Sandy light Kastanozems
Lathyrus quinquenervius (Miq.) Litv.et Kom.	7.64	6.82	Creeping	Meadow soil in riverside
Lathyrus quinquenervius (Miq.) Litv.et Kom.	16.20	38.40	Creeping	Meadow soil in terrace of riverside
Latuca tataricum (L.) D. C.	25.56	32.22	Creeping	Fluvo-aquic soils in lowland between dunes
Leontopodium leontopodioides (Willd.) Beauv.	7.27	7.27	Fibrous	Meadow bog soils
Leontopodium leontopodioides (Willd.) Beauv.	10.33	7.00	Fibrous	Sandy meadow soil
Leonurus sibiricus L.	28.50	38.50	Tap	Sandy Kastanozems in hills
Lepidium apetalum Willd.	20.00	11.09	Tap	Light Kastanozems in hills
Lepidium cartilagineum (J. May.) Thell.	11.20	8.60	Creeping	Saline soil in steppe
Lespedeza bicolor Turcz.	102.56	35.90	Tap	Light Kastanozems
Lespedeza davurica (Laxm.) Schindl.	67.64	28.36	Tap	Slope in hills of typical steppe
Lespedeza juncea (linn. f.) Pers.	14.50	4.25	Tap	Dark Kastanozems in meadow steppe
Lespedeza potaninii Vass.	7.86	4.29	Tap	Aeolian sand
Lespedeza potaninii Vass.	116.84	56.84	Tap	Semi-fixed sand
Leymus chinensis (Trin.) Tzvel.	72.50	41.67	Rhizome	Meadow steppe
Leymus secalinus (Georgi) Tzvel.	21.00	13.50	Rhizome	Alluvial soils
Leymus secalinus (Georgi) Tzvel.	26.11	18.33	Rhizome	Aeolian soil in dry riverbed terraces
Leymus secalinus (Georgi) Tzvel.	43.33	37.33	Rhizome	Loamy and sandy Kastanozems
Ligularia mongolica (Turcz.) D C.	21.82	20.00	Fibrous	Dark Kastanozems

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Ligularia sibirica (L.) Cass.	20.71	20.00	Rhizome	Meadow soil
Lilium pumilum D. C.	20.20	8.00	Tuber	Gravelly dark Kastanozems in slope
Limonium aureum (L.) Hill.	80.63	21.25	Tap	Salinized meadow soil
Linaria vulgaris mill. subsp. *sinensis* (Bebeaux) Hong.	4.80	1.50	Tap	Chernozems
Linaria vulgaris mill. subsp. *sinensis* (Bebeaux) Hong.	6.40	1.40	Tap	Sandy Kastanozems in flood land
Linum perenne L.	9.91	2.00	Tap	Stony chestnut soils in hills
Lolium perenne L.	12.22	15.56	Fasciculate	Artificial grassland
Lomatogonium rotatum (L.) Fries ex Num.	2.91	1.64	Tap	Meadow soil
Lysimachia baryrstachys Brnge.	33.13	22.50	Tap	Dark Kastanozems between dunes
Lysimachia thyrsiflora L.	20.00	29.50	Rhizome	Bog soils
Malva uertieillata L.	42.22	12.22	Tap	Skeletol soils
Medicago falcata L.	36.50	48.00	Tap	Aeolian soilin Drains
Medicago falcata L.	69.17	66.67	Tap	Riverside
Medicago lupulina L.	2.00	2.00	Tap	Meadow soil in riverside
Medicago lupulina L.	9.00	2.30	Tap	Dark Kastanozems in hill
Medicago sativa L.	467.00	35.67	Tap	Bog soils in meadow
Medicago varia Martyn.	7.50	4.88	Tap	Dark Kastanozems in meadow steppe
Melilotoides ruthenica (L.) Sojak.	30.00	19.88	Tap	Aeolian sand in hills
Melilotoides ruthenica (L.) Sojak.	47.00	13.50	Tap	Light Kastanozems
Melilotoides ruthenica (L.) Sojak.	83.03	9.66	Tap	Light Kastanozems
Melilotoides ruthenica (L.) Sojak.	96.00	23.00	Tap	Kastanozems in typical steppe
Melilotoides ruthenica (L.) Sojak.	105.00	24.75	Tap	Sandy Kastanozems
Melilotus dentata (Waldst. et Kit.) Pers.	12.00	15.43	Tap	Meadow soil in steppe
Melilotus dentata (Waldst. et Kit.) Pers.	36.67	50.00	Tap	Floodland in meadow soil
Melilotus officinalis (Linn.) Pall.	51.11	48.89	Tap	Fluvo-aquic soils in lowland between dunes of meadow
Mentha haplocalyx Briq.	1.79	1.47	Tap	Sandy Kastanozems
Mentha haplocalyx Briq.	16.86	9.71	Tap	Low wetland near river
Messerschmidia sibirica L. var. *angustior* (D. C.) W. T. Wang.	75.00	18.89	Creeping	Meadow soil in low wetland
Myricaria platyphylla Maxim	202.78	330.56	Tap	Mobile dune in desert steppe and steppe desert
Neopallasia pectinata (Pall.) Poljak.	5.68	3.64	Tap	Litho soils in hills
Neopallasia pectinata (Pall.) Poljak.	10.93	1.71	Tap	Light Kastanozems in slope
Nitraria tangutorum Bobr.	186.43	171.43	Tap	Aeolian soils
Nitrraria sibirica Pall.	37.94	79.41	Tap	Aeolian soils in sub-fixed sand
Olgaea leucophylla (Turcz.) Iljin.	40.00	12.67	Tap	Fixed sand
Olgaea lomonossowii (Trautv.) Iljin.	68.62	2.19	Tap	Brown calcic soils in overlying sand

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Orobanche coerulescens Steph.	37.50	24.75	Fibrous	Dune in steppe
Orobanche pycnostachya Hance	7.20	3.00	Fibrous	Dune in steppe
Orostachys fimbriatu s(Turcz.) Berger	4.11	4.67	Tap	Dark Kastanozems in hills
Orostachys malacophyllus (Pall.) Fisch.	8.22	9.56	Tap	Dark Kastanozems between dunes
Oxytropis aciphylla Ledeb.	105.75	16.50	Tap	Gravelly Kastanozems in desert steppe
Oxytropis bicolor Bunge	20.00	12.67	Tap	Gravelly sand in arid high plains
Oxytropis bicolor Bunge	126.36	14.55	Tap	Sandy steppe sand
Oxytropis filiformis D. C.	78.75	15.00	Tap	Gravelly sand in hills of forest or typical steppe
Oxytropis glabra (Lam.) D. C.	68.18	34.09	Tap	Low wetland in desert steppe
Oxytropis grandiflora (Pall.) D. C.	51.88	43.13	Tap	Meadow steppe in hills
Oxytropis leptophylla (Pall.) D. C.	62.73	17.73	Tap	Gravelly sand in hills of forest or typical steppe
Oxytropis myriophylla (Pall.) D. C.	36.88	9.38	Tap	Sandy
Oxytropis myriophylla (Pall.) D. C.	133.85	51.92	Tap	Dark Kastanozems in meadow steppe
Oxytropis racemosa Turcz.	140.00	39.12	Tap	Semi-fixed sand
Oxytropis racemosa Turcz.	160.00	26.67	Tap	Mobile dune
Oxytropis squammulosa D. C.	165.52	55.86	Tap	Brown calcic soils in desert steppe
Oxytropis subfalcata Hance	19.33	8.33	Tap	Sandy Kastanozems in hgh plains
Paeonia lachfiona Pall.	30.86	11.14	Tap	Aeolian sandy soils
Papaver nudicaule L.	51.60	10.20	Tap	Low wetland in riverside
Parnassia palustris L.	2.00	2.00	Fibrous	Bog soils in riverside
Patrinia rupestris (Pall.). Juss. Subsp. *scabra* (Bunge) H. J. Wang	18.33	4.67	Tap	Aeolian sandy soils
Pcnzeria alaschanica Kupr.	20.25	2.81	Tap	Sandy brown calcic soils in dry riverbed
Pcnzeria alaschanica Kupr.	96.00	33.00	Tap	Fixed sand
Pedicularis striata Pall.	31.50	22.00	Tap	Dark Kastanozems in hills
Pedicularis venusta Schangan ex Bunge	15.00	15.71	Creeping	Dark meadow soil in riverside
Pedicularis verticillata L.	5.63	2.13	Tap	Meadow soil in riverside
Peganum multisectum (Maxim.) Bobr.	60.00	131.05	Creeping	Semi-fixed sand
Peganum nigellastrum Bunge	157.14	38.57	Creeping	Sandy brown calcic soils
Pennisetum centrasiaticum Tzvel.	21.38	15.38	Rhizome	Sandy meadow in fixed sand
Phalaris arundinacea L.	8.33	7.67	Rhizome	Swampy meadow in hills
Phlomis tuberosa L.	26.80	4.40	Tuber	Skeletol soils in hills
Phragmites australis (Cav.) Trin. ex Steud.	23.00	32.00	Rhizome	Wetlands
Plantago asiatica L.	19.64	20.00	Fibrous	Meadow soil
Plantago depressa Willd.	7.40	1.80	Tap	Meadow soil
Plantago lessingii Fisch. et Mey.	7.38	7.50	Tap	Brown calcic soils in hills
Plantago lessingii Fisch. et Mey	25.50	2.25	Tap	Light Kastanozems

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Plantago minuta Pall.	48.13	12.50	Tap	Halophytic meadow in desert steppe
Platycodon grandiflorus (Jacq.) A. D C.	34.44	21.11	Tap	Meadow dark Kastanozems between dunes
Poa botryoides (Griseb.) Roshev	39.17	18.33	Fasciculate	Lowland in Between dunes
Poa nemoralis L.	5.75	8.25	Rhizome	Woodland
Poa pratensis L.	9.75	12.25	Rhizome	Meadow steppe
Poa sphondylodes Trin,ex Bunge	23.40	16.20	Fasciculate	Dark Kastanozems in meadow steppe
Poa sphondylodes Trin,ex Bunge	44.80	30.40	Fasciculate	Kastanozems
Poa subfastigiata Trin.	10.80	13.20	Rhizome	Meadow in valley
Polygala tenuifolfa I, Willd.	7.18	1.09	Tap	Aeolian soils
Polygala tenuifolfa I, Willd.	11.50	1.80	Tap	Desert
Polygala tenuifolfa I, Willd.	18.00	10.00	Tap	Skeletol soils in hills
Polygonatum sibiricum Delar.ex Recdoute	30.00	43.13	Rhizome	Dark Kastanozems
Polygonum alopecuroides Tuecz. ex Besser	10.00	7.67	Fibrous	Meadow
Polygonum aviculare L.	9.54	2.31	Tap	Meadow soil in low wetland of riverside
Polygonum divaricatum L.	20.50	5.50	Tap	Aeolian sand
Polygonum sibiricum Laxm.	32.25	48.75	Rhizome	Meadow soil in riverside Salinized
Portulace oleracea L.	6.70	1.20	Tap	Kastanozems
Potamogeton panormitanus Biv.	14.25	5.25	Rhizome	Swampy land
Potaninia mongolica Marim.	42.27	128.18	Tap	Grey brown desert soil
Potenilla vertcillaris ex Willd.	8.60	15.60	Tap	Sandy black soils in slope
Potenilla vertcillaris ex Willd.	18.30	21.30	Tap	Kastanozems litho soils
Potentilla betonicifolia Poir.	21.25	19.25	Tap	Litho soils in hills
Potentilla acaulis L.	11.56	6.44	Creeping	Chernozems
Potentilla acaulis L.	24.44	12.00	Creeping	Brown earth type of Kastanozems
Potentilla anserina L.	15.64	7.82	Tuber	Low wetland in riverside
Potentilla anserina L.	19.88	15.00	Tuber	Bog soils in meadow
Potentilla anserina L.	22.00	26.00	Tuber	Aeolian sand indry riverbed
Potentilla bifurca L.	21.75	6.00	Creeping	Loamy and sandy typical Kastanozems in vally
Potentilla bifurca L. var. *major* Ledeb.	164.29	87.14	Creeping	Light Kastanozems
Potentilla flagellaris Willd.ex Schlecht	10.64	6.27	Fibrous	Brown soil between dunes in hills
Potentilla parvifolia Fisch.ap. Lehm.	19.33	15.11	Tap	Litho soils in hills
Potentilla tanacetifolia Willd. ex Schlecht	32.67	13.00	Tap	Light Kastanozems in slope
Potentilla tanacetifolia Willd. ex Schlecht	40.80	6.40	Tap	Light saline soil in low wetland
Potentilla strigosa Pall. ex Pursh	15.40	17.60	Tap	Litho soils in hills
Psammochloa villosa (Trin.) Bor	120.00	36.36	Rhizome	Mobile dune

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Ptilotrichum conescens (DC.) C. A. Mev.	36.86	2.57	Tap	Saline soil in meadow
Puccinellia distans (Jacq.) Parl.	3.27	2.45	Fasciculate	Salinized meadow or water area in riverside
Puccinellia hauptiana (Trin.) Krecz	11.08	14.46	Rhizome	Swampy meadow in riverside sand
Pucnellia tenuiflora (Turcz.) Scribn. et Merr.	14.40	6.60	Fasciculate	Fluvo-aquic soils in low wetland saline
Pucnellia tenuiflora (Turcz.) Scribn. et Merr.	31.36	21.82	Fasciculate	Fluvo-aquic soils in lowland between dunes
Pucnellia tenuiflora (Turcz.) Scribn.et Merr.	36.67	23.89	Fasciculate	Salinized sandy
Pugionium cornutum (L.) Gaertn.	127.78	36.67	Tap	Dune
Pulsatilla turczanninovii Kryl.et Serg.	12.86	12.57	Tap	Typical light Kastanozems in hills
Pycreus globosus (AlI.) Reichb.	5.65	3.53	Rhizome	Meadow soil between dunes
Reaumuria songarica (Pall.) Maxim.	14.13	6.00	Tap	Brown calcic soils
Rheum undulatum L.	15.78	4.89	Tap	Stony slope in hills
Rheum uninerve Maxim.	17.25	8.25	Tuber	Sandy and gray desert soils in high plains
Rorippa islandica (Oed.) Borb	51.50	7.50	Tap	Fluvo-quic soil in low wetland
Rubia cordifolia L.	61.00	22.00	Tap	Between dunes Low wetland meadow soil
Rumex acetosella L.	190.00	32.00	Tap	Sand in meadow steppe
Sagittaria trifolia L.	9.86	16.29	Tuber	Bog soils in riverside
Salicornia europaea L.	9.00	4.00	Tap	Lowland of Fixed dune between dunes
Salix gordejevii Y. L.Chang et Skv.	142.86	985.71	Tap	Semi-fixed dune in steppe
Salix gordejevii Y. L.Chang et Skv.	350.0	2000.0	Tap	Semi-fixed dune in steppe
Salix psammophila C. Wang et Ch. Y. Yang	24.83	7.00	Tap	Fixed sand
Salsola collina Pall.	19.43	10.00	Tap	Light Kastanozems in hills
Salsola laricifolia Turcz.ex Litv.	83.75	76.25	Tap	Light brown calcic soils in hills
Salsola passerina Bunge	29.11	14.89	Tap	Litho soils in hills
Salsola passerina Bunge	37.50	17.50	Tap	Brown calcic soils in ground between dunes
Salsola passerina Bunge	80.00	80.00	Tap	Saline soil
Sanguisorba offiacinalis L.	13.25	11.25	Tap	Meadow soil in riverside
Saposhnikovia divaricata (Turcz.) Schischk.	130.00	24.00	Tap	Typical Kastanozems in loamy and sandy ground
Sarcozygium xanthoxylon Bunge	37.86	41.43	Tap	Desert soil
Saussurea amara (L.) D. C.	65.00	63.75	Tap	Light Kastanozems
Saussurea amara (L.) D. C.	105.00	16.20	Tap	Typical Kastanozems
Saussurea japonica (Thunb.) D. C.	40.67	16.67	Tap	Light Kastanozems
Saussurea salsa (Pall.) Spreng.	10.36	7.27	Tap	Meadow soil in Salinized sand
Scabiosa comosa fisch. ex	20.63	8.25	Tap	Fixeds and

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Roem.et Schult.				
Scabiosa comosa fisch. ex Roem.et Schult.	24.89	4.44	Tap	Aeolian soils
Scabiosa comosa fisch. ex Roem.et Schult.	29.57	19.71	Tap	Sand at the base of fixed dune
Scirpus planiculmis Fr. Schmidt	9.00	17.50	Tuber	Bog soils in riverside
Scirpus tabernaemontani Gmel.	84.55	70.91	Rhizome	Bog soils
Scorzonera albicaulis Bunge	60.00	38.75	Tap	Dark Kastanozems
Scorzonera muriculata Chang	17.00	14.00	Creeping	Light brown calcic soils in overlying sand
Scorzonera muriculata Chang	18.80	2.20	Creeping	Kastanozems
Scutellaria baicalensis Georgi	15.14	18.86	Creeping	Typical Kastanozems in hills
Scutellaria scordifolia Fisch. ex Schrank	2.86	4.43	Creeping	Kastanozems
Scutellaria viscidula Bunge	14.00	19.50	Creeping	Kastanozems between duned
Sedum aizoon L.	14.89	6.22	Tap	Podzolic soils in hills
Sedum aizoon L.f. *angusifolium* Franch.	8.63	2.50	Tap	Kastanozems in high plains
Senecio argunensis Turcz.	21.67	15.00	Fibrous	Fixed dune
Serratula polycephala Iljin	98.00	32.00	Tap	Steppe
Setaria glauca (L.) Beauv.	14.86	11.43	Fasciculate	Dark Kastanozems
Setaria viridis (L.) Beauv.	11.43	15.71	Fasciculate	Dark Kastanozems
Setaria viridis (L.) Beauv.	30.56	23.33	Fasciculate	Fixed sand
Silene jenisseensis Willd.	36.43	20.57	Tap	Skeletol soils in hills
Silene repens Patr.	113.33	33.33	Tap	Base of mobile dune
Solanum septemlobum Bunge	120.00	66.00	Tap	Sub-fixed sand
Sonchus arvensis L.	37.08	13.33	Creeping	Salinized and sandy lowland
Sophora alopecuroides L.	21.86	33.86	Creeping	Desert and steppe desert
Sophora flavescens Soland	42.00	4.00	Tap	Steppe or Sandy steppe
Sparganium simplex Huds.	28.75	22.50	Rhizome	Bog soils
Sparganium stoloniferum (Graebn.) Buch.	3.13	9.38	Tuber	Bog soils
Sphaerophysa salsula (Pall.) D. C.	20.75	25.00	Creeping	Meadow soil in low wetland
Spiraea pubescens Turcz.	10.67	11.83	Tap	Podzolic soils
Spiranthes sinensis (Pers.) Ames	7.17	3.33	Tuber	Wetland in forest
Stellaria dichotoma L. var. *lanceolata* Bunge	14.50	7.25	Tap	Semi-fixed dune
Stellaria dichotoma L. var *lanceolata* Bunge	77.00	10.50	Tap	Sand in windward slope
Stellaria discolor Turcz.	5.80	1.80	Tap	Kastanozems in hills
Stellaria discolor Turcz.	7.00	2.60	Tap	Chernozems
Stellera chomaejasme L.	68.18	16.82	Tap	Salinized Kastanozems
Stellera chomaejasme L.	93.08	27.69	Tap	Dark Kastanozems
Stemmacantha uniflora (L.) D. C. Dittrich	34.91	16.09	Tap	Litho soils in hills
Stipa baicalensis Roshev.	113.44	55.31	Fasciculate	Dark Kastanozems
Stipa breviflora Griseb.	4.80	6.50	Fasciculate	Desert steppe
Stipa bungeana Trin.	14.29	9.39	Fasciculate	Typical steppe
Stipa glareosa P. Smirn.	50.00	27.78	Fasciculate	Gritty brown calcic soils in high plains
Stipa grandis P. Smirn.	11.25	8.88	Fasciculate	Kastanozems

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Stipa grandis P. Smirn.	102.67	70.67	Fasciculate	Dark Kastanozems
Stipa purpurea Griseb.	88.50	48.00	Fasciculate	Meadow soils in alpine steppe
Stipa sareptana Becker var. *krylovii* (Roshev.) P. C. Kuo et Y. H. Sun	42.18	16.00	Fasciculate	Typical steppe
Stipa tianschanica Roshev. Var. *gobica* (Roshev.) P. C. Kuo et Y. H. Sun	101.11	42.22	Fasciculate	Sandy brown calcic soils
Stipa tianschanica Roshev.var. *klemenzii* (Roshev.) Norl.	30.00	12.55	Fasciculate	Sandy Kastanozems
Stipa tianschanica Roshev.var. *klemenzii* (Roshev.) Norl.	87.10	61.94	Fasciculate	Light Kastanozems in desert steppe and typical steppe
Suaeda glauca (Bunge) Bunge	12.11	8.33	Tap	Desert soil
Tamarix ramoslssima Ledeb.	102.78	161.11	Tap	Salinized soil in desert
Tamarlx chinensis Lour.	92.00	50.00	Tap	Sub-fixeds
Taraxacum asiaticum Dahlst.	98.92	11.35	Tap	Base of dune
Taraxacum borealisinense Kitam.	26.09	5.22	Tap	Sandy meadow soil
Taraxacum borealisinense Kitam.	67.17	11.09	Tap	Salinized meadow soil
Taraxacum ohwianum Kitam.	7.44	3.60	Tap	Low wetland
Thalictrum petaloideum L.	14.67	48.67	Rhizome	Light Kastanozems in desert steppe
Thalictrum petaloideum L.	15.50	13.75	Rhizome	Aeolian sandy soils
Thalictrum petaloideum L. var. *supradecompositum* (Nakai) Kitag.	21.43	19.29	Fibrous	Dark Kastanozems in hills
Thalictrum simplex L.	4.38	5.75	Fibrous	Dark Kastanozems
Thalictrum squarrosum staph.ex Willd.	15.14	16.00	Rhizome	Meadow soil
Thalictrum squarrosum staph.ex Willd	78.32	99.79	Rhizome	Light Kastanozems
Thermopsis lanceolata R. Br.	146.67	37.78	Creeping	Dark Kastanozems
Thermopsis lanceolata R. Br.	248.89	62.22	Creeping	Semi-fixed sand
Thymus mongollcus Ronn.	11.14	6.71	Tap	Dark Kastanozems between dunes
Thymus mongollcus Ronn.	12.33	19.00	Tap	Semi-fixed sand
Tragus racemosus (L.) All.	14.00	13.50	Fasciculate	Sandy Kastanozems in slope of hills
Tribulus terrestris L.	21.40	9.60	Tap	Kastanozems in hills
Trifolium lupinaster L.	8.67	3.33	Tap	Swampy meadow soil in meadow steppe
Triglochin palustre L.	8.73	9.55	Rhizome	Meadow-riverside bog soils
Tugarinovia mongolica Iljin	59.21	17.37	Tap	Stony light Kastanozems
Urtica cannabina L.	36.00	15.00	Tap	Stony and gravelly slope in forest steppe
Veratrum nigrum L.	7.40	3.80	Tuber	Under the shrub in meadow
Veratrum nigrum L.	30.67	13.78	Tuber	Low wetland in meadow
Veronica dahurica Stev.	8.50	6.83	Fibrous	Chernozems in hills
Veronica incana L.	6.56	3.44	Fibrous	Meadow chernozems in vally
Veronica linariifolia Pall. ex Link	13.00	16.00	Fibrous	Skeletol soils
Vicia amoena Fisch. ex D. C.	17.78	10.44	Creeping	Chernozems in meadow steppe

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Vicia amoena Fisch. var. *Oblongifolia* Regel.	47.78	23.33	Creeping	Meadow steppe and meadow
Viola yedoensis Makino	14.50	2.00	Tap	Kastanozems in alluvial plain
Xanthium sibiricum Patrin ex Widder	16.00	14.00	Tap	Meadow soil
Youngia tenuicaulis (Babcock et Stebbins) Czer.	19.64	7.82	Tap	Litho soils in hills

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