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RESULTS OF FAR EASTERN ORIGIN HERBACEOUS PERENNIALS' INTRODUCTION TO THE BOTANICAL GARDEN OF THE UNIVERSITY OF LATVIA

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The purpose of this study was to evaluate the changes in plant development for herbaceous perennials with Far Eastern origin (from Russia, Korea and Japan). Research was based on the historical experience about introducing plants from this region and focused on the analysis of change in flowering time, seed maturation and the height of habitus. The overall condition and phenological observations were made in three-year cycle from 1991 to 2017, and during this time data about 44 plant taxa from 16 families were collected.

When compared phenology in Latvia with the region of origin, results showed that 14 taxa had no change in flowering and seed ripening starting phases, 20 taxa had belated blooming and start of seed ripening phase, whereas six taxa had earlier both the start of blooming and seed ripening. Six taxa were fruitless, and for five taxa seeds did not ripen. Habitus height remained in the same limits as in literature for 31 taxa, was higher for six taxa and lower – for seven taxa. The results are discussed according to the difference of climate parameters in regions of origin and in Riga.

Key words: plant habitus changes, phenological phases, plant condition, ex-situ protection.

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INTRODUCTION

Phenological observations are the basis for the evaluating the introduced species in botanical gardens. Two methods are often used. First one is based on phenological data with large set of introduced taxa (not less than 400) with simmilar growth form. Data should be collected at the same time. In result, objective integrated assessment is obtained that respects the phenophase complex with lagging or overtaken data array norms. Obtained value of the phenological atypical index reflects the geographical location of the taxon's primary range (Zaytsev 1978).

The second method compares overall condition of the plant to situation in the wild. The parameters, that point to the state of the introducent and could be compared, are as follows: the height of plant habitus, start of blooming, seed ripening time or when seeds are buried, but do not ripen or are fruitless. This method is used in case of small number of evaluators or if phenological observations are not collected at the same time, but literature or data collected from natural growth sites are available (Trulevich 1991). Both methods provide an opportunity to detect the pro-active or delayed development of phenophases for each taxon.

The aim of this paper was to evaluate the total plant condition as one of the parameters for introducents with origin in Far East. Research was performed in the Botanical Garden of the University of Latvia (BGUL). Therefore not only phenophase complex but also the height of habitus was analised. Changes in habitus determine the impact of complex local conditions on the plant (soil fertility, precipitation, air pollution etc.).

MATERIAL AND METHODS

A group of collection plants from Far East was observed – these are territories that are researched by botanists of former Soviet Union area and traditionaly includes floristic regions such as Primorskiy, West Amur, East Amur, South Amur regions, Priokhotsky Mainland, Kamchatka, Commander, Sakhalin and Kuril Islands (Voroshilov 1982) and also includes Japan and Korea. Geografically this region ranges between 35^0 to 70^0 latitude and 125^0 to 175^0 longitude.

Total plant condition of introduced plants from Far East were determined based on observations of phenological and biological parameters. Phenological observation records of 44 plant taxa from 16 families in period from year 1991 to 2017 were used. Observed plants mainly had been grown from seeds that were received from other botanical garden, only for seven taxa seeds were collected in wild.

Phenological observations in BGUL were accomplished for each taxon during three-year cycle. Observations began after snow removal in spring. Observations were made regularly every 5th day in period of active growth and every 7th day in other growing period. Each sample included only plants in generative stage of development, total number of plants was over five. From observation protocols three positions were used in this paper: the height of plant habitus, start and finish time of blooming, seed ripening time.

The calculation of average dates of the occurrence of phenophases was done according to Zaytsev (1978). The blooming and seed ripening time from literature is given in months, therefore given results of observing were rounded to months (see Appendix 1).

Literature data about plant habitus, flowering and seeding phases were taken from e-flora platform (www.efloras.org), *Flora of China* and *Ornamental plants from Russia* (Brach & Song, 2006) and a list of other plant keys and handbooks (Voroshilov 1982, Kharkevich 1987, Eggli 2012), and monographs about genus *Hosta* (Schmid 1991) and *Sedum* (Stephenson 1994) (see Appendix 1).

The values and information about climate of studied territories was taken from meteorological agencies from Japan, Korea, Latvia, Russia (LEGMC 2019, KMA 2019, JMA 2019, HRCRF 2019).

Total plant condition was evaluated by comparing the *ex-situ* plant habitus and development in the BGUL with *in-situ* samples according to the literature data. It should be noted that, in general, plants growing in *ex-situ* conditions outperform the *in-situ* scores. However, it was reported recently that unconventional augmentation of plant shoots, increasing number of metamers, exaggerate blooming, etc. which refer to *ex-situ* introduction or intensive nursing, leads to a reduced longevity of perennials, even turning long-lived into short-lived plant (Trulevich 1991, Mazurenko 2002). Hence, successful adaptation is questionable. Newertheless, three-point scale was used: 1 point- if growing and/or flowering intensity is worse if compared to specimens growing in their area of origin (total plant condition – bad); 2 points- growth and/or blooming intensity exceed certain parameters if compared to specimens in their area of origin (total plant condition – tolerable); 3 points- growth and/or flowering intensity are no different if compared to specimens in their area of origin (total plant condition – well).

RESULTS AND DISCUSSION

The Republic of Korea lies in the temperate zone with four distinct seasons. Climate characteristics reveal both continental and oceanic features (KMA, 2019). Conditions are different between Southern and Central part of Korean Peninsula. The annual mean temperature ranges from +10 to +16^{0}C except in high mountain areas (KMA 2019). The warmest month is August (temperature ranges +23 to +27^{0}C), whereas January is the coldest one (-6 to +7^{0}C). Average winter temperature is -4.5^{0}C. The annual precipitation ranges from 1,000 to 1,800 mm. More than half of the annual precipitation falls when a stationary front lingers across the Korean Peninsula for about a month in summer (ocasionaly July). The winter precipitation is less than 10% of the total annual precipitation (100-140 mm). Growing period lasts from April to October.

Japan has four distinct seasons with a climate ranging from subarctic in the North to subtropical oceanic in the South (Okinava). Western and Eastern part of Japan differ in precipitation (annual average precipitation ranges from 1467 mm (Eastern Japan (by Tokyo)) to 1825 mm (Western Japan (Fukidae)) (JMA 2019). Average annual temperature ranges from +9.7^{0}C (Hokaido) to +20.5^{0}C (Okinava). Winter temperature ranges from -1.8^{0}C (Hokaido) to +17.6^{0}C (Okinava). Driest month usually is December or January (39.6-95 mm). In the Northern part the most wet month is May (140 mm), while in other parts it is July (208-225 mm). Western Japan has very hot and humid summers and moderate cold winters (+8^{0}C). It's the main reason why in Western part and in Okinava the growing period continues through the whole year. In Northern part the growing period lasts from March to September.
The climate of the Russian Far East varies from arctic in the North and North-east of the region near the Arctic Ocean to the subarctic (Verkhoyansk Range, Cherskoye, Kolyma Highlands) to moderate monsoon in the South (Primorsky and Amur Regions) and sea-marine in Northern Sakhalin, Kamchatka, Kuriles (HRCRF 2019). Average annual temperature ranges from +0.9^{0}C (Petropavlovsk-Kamchatsky) to +6.8^{0}C (Vladivostok). Winter lower temperature in January ranges from -22.5^{0}C (Blagoveschensk) to -8.7^{0}C (Petropavlovsk-Kamchatsky). Average winter temperature ranges from -7.5^{0}C (Petropavlovsk-Kamchatsky) to -20.2^{0}C (Blagoveschensk). Winter lasts from November to March. The warmest month is July or August (temperature ranges from +21.7^{0}C (Blagoveschensk) to +12.4^{0}C (Petropavlovsk-Kamchatsky). The annual precipitation ranges from 575 mm (Blagoveschensk) to 995 mm (Petropavlovsk-Kamchatsky). More than 80% of the annual precipitation falls during summer when the evaporation is low, so the waterlogging occures. Drier months are January and February in Blagoveschensk (5mm) and April in Petropavlovsk-Kamchatsky (54 mm). The growing period increases from North to South from 130 to 200 days.

Latvia is under the influence of warm and humid air masses of the Atlantic Ocean and lies in the humid continental climate zone. For 56-58^0 latitude, the average air temperature in Latvia is 4-6 degrees higher, while the winter temperatures are 9 degrees higher (Kļaviņš et al. 2008). Under the influence of the Baltic Sea and the Gulf of Riga, the average temperature in Latvia decreases in the direction of the meridian away from the sea. Average annual temperature ranges from +7.5^{0}C to +8.7^{0}C (in Riga +7.2^{0}C) (LEGMC, 2019). Average winter temperature ranges from -2.5^{0}C to -7.5^{0}C (in Riga -2.5^{0}C). Winter lower temperature in January ranges from -6.3^{0}C to -6.6^{0}C (in Riga -2.3^{0}C). Frequent thaws are tipical with low precipitation intensity in winter, therefore, a steady/permanent snow layer in a wide area of Latvia does not usually develop. Warmest month is July (+16.3^{0}C to +17.4^{0}C), in Riga +18.5^{0}C. The annual precipitation ranges from 576 mm to 757 mm (in Riga 511 mm). Driest month usually is March 27-47 mm (in Riga 27 mm). Wettest month is July 61-100 mm (while in Riga it is August). The growing period lasts from April to October.

Observed data were compared with literature for 44 plant taxa. In total, 10 combinations of responses to the introduction were observed

(Table 2). In the Table 2, taxa are arranged according to changes of their phenological parameters. The total plant condition was rated with "+" when the parameter had positive value or rated with "-" or left blank when the taxa showed no correlation with definite parameter. In order to find out the trends of change, four taxa with known seed sites in nature were chosen (marked in bold letters). For 44 taxa three specifed datathree specifed data parameters are presented in Appendix 1.

Group of taxa that has been rated with three points (total plant condition – well) included 31 taxa (70%) with growth and/or flowering intensity no different if compared to specimens in their area of origin and had three diferent types of changes (Table 2). There were 10 taxa (1st row in Table 2) that had any changes in habitus and phenological. These taxa have large areas of origin that include several climatic zones and they are fully integrated into the vegetation period of the site of introduction. From this group the smallest origin site has *Patrinia gibbosa* that is native in Japan only.

Another large group that has been rated with three points includes 12 taxa (4th row in Table 2) for which the habitus have not changed and phenological phases started later. Between them, the long vegetation period in origin did not fit completely to a new place of growth and they did not ripen seeds. Five taxa (3rd row in Table 2) startet the blooming and seed ripening earlier, so they ripened the seeds sucessfully.

Campanula punctata was the only species rated with three points (iii) with earlier seed ripening than in it's origin. This is somewhat at odds with the overall trend, probably due to the particular growth site where the plant suffers from drought in the blooming time.

From the group rated with three points, *Geranium soboliferum var. kuisianum* and *Hosta clausa var. ensata* were inspected closer. The seeds of *G. soboliferum var. kuisianum* were collected by botanists of Ofuna Botanical Garden in Kyushu Island (Japan) in the Aso-Kuju region and sent to BGUL in 2002. This perennial herb is distributed in wetlands of high-altitude grassland areas in the Aso-Kuju region. It is glacial relict plant, only several hundred individuals grow in the wild (Kurata, Sakaguchi & Ito 2019). In BGUL it was observed in time period 2011-2013. Comparative analysis showed that plant habitus in BGUL did not differ from the literature data (Table 3), blooming and ripening phases started for two months later and seeds did not have time to mature. Comparing climate data in Riga and Fukuoka (Kyushu island), on Japanese island there is subtropical climate, vegetation period lasts over a year, the annual average temperature is +17.3^{0}C (for 10^{0}C higher than in Riga, Latvia), but the average coldest winter temperature is for 9^{0}C higher than in Riga. Warmest summer temperature differs for 6.5^{0}C (Table 1). In result, the generative and vegetative shoots developed more slowly in Riga and the fruits had not time for ripening.

Hosta clausa var. ensata was inspected as one of taxa without changes in habitus and with earlier start of phenological phases. Seeds were collected by botanists of Vladivostok Botanical Garden near of Korean border direct from wild and sent to BGUL in 1982. Taxon was observed in time period 1992-1994. Habitus of collection plants did not seriously differ from origin in Manchuria, North Korea, while the blooming and seed ripening phases started one month earlier than in origin (Table3). Comparing climate data between Riga and Vladivostok, from April to July average month temperature in Riga is higher and it fits the time when *Hosta* form the generative shoots. The plants responded with phenological phases starting one month earlier.

Group of taxa that has been rated with two points (total plant condition – tolerable) included six taxa (14%) with growth and/or blooming intensity exceeding certain parameters if compared to specimens in their area of origin and had two tipes of changes (6th and 7th row in Table 2). Two taxa that had no fruits in BGUL have a narrow area of origin: *Hosta venusta* naturally grows on 33.3^{0}N latitude in Korea, *Sedum pluricaule* grows on 54.4^{0}N latitude in Japan and Russian

Table 1. Climate parameters for four regions where samples of plants were collected

Parameter	Value			
	Riga (Latvia)*	**Fukuoka (Japan)*****	**Ofuna (Japan)****	**Vladivostok****** **(Russia)**
Average annual temperature (^{0}C)	+7.2	+17.3	+16.3	+6.8
Average winter temperature (^{0}C)	-2.5	+8.0	+7.1	-10.5
Average temperature (^{0}C) of coldest month	-2.3 (I)	+7.0(I)	+7.05 (II)	-12.6 (I)
Average temperature (^{0}C) of warmest month	+18.5 (VII)	+25.0 (VII)	+27.6	20.2 (VIII)
The precipitation of driest month (mm)	27 (III)	80 (I)	42.1 (II)	15 (I)
The precipitation of wettest month (mm)	64 (VIII)	225 (7)	228.8 (X)	153 (VIII)
Annual precipitation (mm)	511	1825	1579	799
Growing period (above +5^{0}C) in month	IV-X	all year	all year	IV-X

*- data by LEGMC; *[1]- data from LEGMC climate change analysis tools for period 1995-2010; **- data by Ofuna BG (for period 1998-2010); ***- data by JMA; ****- data by HRCRF (for period 1961-1990).

Table 2. Evaluation of the changes of studied plants after the introduction in BGUL

Parameter name, score of condition overal	Taxa name	Seeds are + or not -	Origin		
			Japan	**Korea**	**Russian Far East**
Habitus and the start of phenological phases have not changed (3)	*Aconitum voluble*	+	+	+	
	Adonis amurensis	+	+	+	+
	Carex siderosticta	+	+	+	
	Filipendula palmata	+	+		+
	Hemerocallis esculenta	+	+		+
	Hemerocallis middendorffii	+	+	+	+
	Hemerocallis minor	+	+		
	Patrinia gibbosa	+	+		
	Primula sieboldii	+	+	+	+
	Rodgersia podophylla	+	+	+	
Habitus and start of blooming have not changed, seeds ripen later (3)	*Ligularia stenocephala*	+	+		
	Pachisandra terminalis	+	+		+
	Potentilla flagelaris	+			+

Parameter name, score of condition overal	**Taxa name**	**Seeds are + or not -**	**Origin**		
			Japan	**Korea**	**Russian Far East**
Habitus have not changed, phenological phases start earlier (3)	*Astilboides tabularis*	+		+	
	Filipendula kamtschatica	+	+		+
	Geranium wlassovianum	+	+		
	Hosta clausa var. ensata	+		+	
	Hosta minor	+	+		
Habitus have not changed, phenological phases start later (3)	*Allium tomentosum*	+	+		
	Fallopia japonica	-	+		
	Fallopia sachalinensis	-			+
	Filipendula koreana	+	+		
	Geranium soboliferum var. kuisianum	-	+		
	Hosta montana	+		+	
	Hylomecon japonica	+	+	+	
	Kirengeshoma palmata	+	+		
	Ligularia dentata	-	+		
	Lilium lancifolium var. splendens	-	+		
	Phytolacca acinosa	+	+		
	Spodiopogon sibiricus	-	+	+	+
Habitus have not changed, blooming starts later, seeds ripen earlier (3)	*Campanula punctata*	+	+	+	
Habitus is higher, phenological phases have not changed (2)	*Hosta venusta*	-		+	
	Sedum pluricaule	-	+		+
Habitus is higher, phenological phases start later (2)	*Cimicifuga dahurica*	+	+		+
	Corydalis ochotensis	+	+		
	Iris ruthenica	+			+
	Iris sanguinea	+	+		
Habitus is lower, phenological phases have not changed (1)	***Bergenia crassifolia var. pacifica***	-			+
	Hosta sieboldiana	+	+		
Habitus is lower, phenological phases start earlier (1)	*Duchesnia indica*	+	+		
Habitus is lower, phenological phases start later (1)	*Hosta nigrescens*	+	+		
	Menispermum dahuricum	-	+		
	Scilla scilloides	+	+	+	
	Sedum sarmentosum	-	+	+	

Table 3. The parameters for four taxa collected in wild sites

Parameters, volume	Taxa name			
	Bergenia crassifolia var. pacifica	*Geranium soboliferum var. kuisianum*	*Hosta clausa var. ensata*	*Scilla scilloides*
Height of habitus in area of origin (cm)	15-30	to 40	vH = 5 - 25, zH=33-35	(10)15-40, zH=7-20
Height of habitus in BGUL (cm)	vH=9, zH=16	vH=34, zH=42	vH=30, zH=52	vH=13, zH=23
Blooming time in area of origin	V-IX	VIII-IX	VIII-IX	VII-XI
Blooming time in BGUL	V	X	IX-X	VIII-IX
Seed ripening time in area of origin	NO DATA	VIII-IX	VIII-IX	VII-XI
Seed ripening time in BGLU	fruitless	seeds are buried, but do not ripen	IX-X	X
Literature data reference	(Wu, Raven, Zhu 2003b)	(Kharkevich 1987)	(Wu, Raven 2000, Schmid 1991)	(Wu, Raven 2000)

vH – height of vegetative part of habitus, zH – height of generative part of habitus.

Far East. Other taxa have wide Asian origin. All of six taxa in introduction site had higher habitus than in origin.

Hosta venusta and *Sedum pluricaule* had no changes in flowering time, but fruits did not ripen, both taxa are from subtropic climate. *S. pluricaule* grows in Sakhalin, Hokkaidõ and Honsjũ where the flowering time lasts from August to September, while in Riga it lasts from August to October. Growing period in Hokkaidõ lasts from March to December and the warmest month is August with average temperature +22.5^{0}C that is for 5^{0}C higher than in Riga (LEGMC 2019); therefore, summ of positive temperature is not enough for seed ripening. Similar climate conditions are for *Hosta venusta* – a Korean endemic growing in Jeju Island (Schmid 1991), where subtropic climate is similar as in Kjusu Island (Table 1, Fikuoka), growing period lasts overyear and the average temperature in July is higher for 6.5^{0}C than in Riga.

Group that has been rated with one point (i) (total plant condition – bad) included seven taxa (16%) with worse growing and/or flowering intensity compared to specimens growing in their area of origin. *Bergenia crassifolia var. pacifica*, *Menispermum dahuricum* and *Sedum sarmentosum* did not ripen seeds. Phenological phases started earlier only for *Duschenia indica*. The origin of species is mountain area in China with colder climate than in Riga. Four taxa started their blooming and seed ripening later than in origin.

Two species of this group were inspected more closely – *Bergenia crassifolia var. pacifica* and *Scilla scilloides*. Live plant material of *B. crassifolia var. pacifica* was collected by BGUL botanists during expedition in Primorskiy region (Russia) in 1982 direct from wild on Vladivostok neighborhood. This clone continues to grow in the Garden all these years and is vegetatively propagated. In BGUL it was observed in time period 2011-2013. The habitus in Riga was lower than in area of origin, blooming in May was identical in both sites, but in Riga the repeated flowering in end of summer was not observed and plants were fruitless (Table 3). Comparing data about climate in Riga and Vladivostok, in Primorskyi region winters are colder and summers – warmer than in Riga, it is defined as moderate monsoon. The annual year temperature in Riga and Vladivostok differs slightly, only by 0.4^{0}C, whereas the average coldest winter month temperature differs for 10.3^{0}C. In warmest summer month, the average temperature reaches +20.2^{0}C (Vladivostok in August) and +18.5^{0}C (Riga in July). Difference in annual precipitation is 200 mm, Riga being drier than Vladivostok (Table 1). Growing period is similar. In general, summer temperature for *Bergenia* was lower in Riga, and that may be the reason for lower habitus and fruitlessness. Plants were evergreen and flowerbuds formed in previous season. Fruitless in Latvia is *Bergenia crassifolia* too, nevertheless that *B. crassifolia* has large continental areal – East and West Siberia, but *B. crassifolia var. pacifica* grows only on South of Russian Far East (Cherepanov 1995).

Seeds of *Scilla scilloides* were collected by botanists of Ofuna Botanical Garden in Kanagawa Prefectura sites (Japan) and sent to BGUL in 2000. Plants grown from these seeds were observed in time period 2013-2015. Habitus of plants did not differ from those in site of origin – China, Taiwan, Japan, Korea, Manchuria, Amur. The blooming time in Riga started one month later and seed ripening – two months later than in origin (Table 3). Comparing climate data in Riga and Ofuna (Eastern Japan), in Ofuna climate is subtropic, vegetation period lasts over a year, annual average temperature is +16.3^{0}C (for 9.06^{0}C higher than in Riga), but the average coldest winter temperature differs for 9.6^{0}C. Warmest summer temperature differs for 12.4^{0}C (Table 1), warmest month in Ofuna is August, in Riga – July. Annual summ of precepitation in Ofuna is three times more than in Riga, that is the reason for plant surviving in Riga's colder climate, whereas the lower summer temperature inhibits growth for one month and delays flowering and seed ripening.

Plants from group that has been rated with one point had a common sign that the habitus was lower, showing a negative reaction to optimal conditions. Only for *Sedum sormentosum,* growing in the BGUL negatively impacted the plant life span transforming it to short-lived perennial.

Response to changes in growth parameters naturally occurs cause of differences in climatic conditions and plant ecological and phytocenotic amplitudes, which depends on habitat diversity in natural areal (Trulevich 1991). Adaptive abilities are higher for plants that are introduced from their natural areal centers. Recessive genes and signs are accumulated on the boundaries of areals and the genome of the population is in bad condition there. On the other hand, the phenological phases deviation (earlier or later) depends to a large extent on the geographical area of the primary range and the climate zone (Zaytsev 1978). If introduced plants have shorter vegetation period than it is usual at new growing places, it can grow in colder climate. If growing period of introduced taxa coincides with that or have slight deviation, it has the optimum condition for growing.

CONCLUSIONS

Out of tested 44 taxa with origin in Far East, 31 taxa (70%) had good total condition. Amongst them, 28 taxa were fully integrated into the vegetation period of the site of introduction. For four taxa with long vegetation period, it did not fit completely with the new place of growth and they did not ripen the seeds.

Six taxa (14%) had tolerable plant condition and their habitus was higher than in area of origin. Two taxa of them (*Hosta venusta* and *Sedum pluricaule*) had no fruits, likely because of narrow area of origin. Other taxa instead have wide Asian origin.

Seven taxa (16%) had lower intensity of growing and flowering and total plant condition was bad. That was negative reaction to deficiency of optimal conditions. *Menispermum dahuricum* and *Sedum sormentosum* with long vegetation period in area of origin did not fit completely in new place of growth and did not ripen the seeds. It negatively impacted the life span of *Sedum sormentosum* in collections, transforming the plant to short-lived perennial.

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Appendix 1.

Latin name of taxa, Authors	Hight of Habitus (cm)		Blooming Period		Fruiting Period		References
	Litera-ture Data	BGUL Data : VH, ZH*	Literat. data	BGUL Data	Literature Data	BGUL Data	
Aconitum volubile Pall. ex Koelle	100-200	130	VII-IX	VII-VIII	no data	X	Wu, Raven, 2001
Adonis amurensis Regel et Radde	5-15	10	III-IV	III-IV	NO DATA	V	Wu, Raven, 2000
Allium tuberosum Rottler ex Spreng.	25-60	47, 56	VII-IX	VIII-IX	VII-IX	IX-X	Wu, Raven, 2000
Angelica gigas Nakai	100-200	103, 167	VII-VIII	VI-VIII	VIII-IX	VIII	Wu, Raven, Hong, 2005
Astilbe chinensis var. *davidii* Franch.	50-100	68,143	VI-IX	VII-IX	VI-IX	X	Wu, Raven, Zhu, 2003b
Astilboides tabularis (Hemsl.)Engl.	100-150	80, 160	VIII-IX	VI-VIII		X	Wu, Raven, Zhu, 2003b
Bergenia crassifolia var. *pacifica* (Kom.) Nekr.	15-30	9,16	V-IX	V	NO DATA	fruitless	Wu, Raven, Zhu, 2003b
Campanula punctata Lam.	40-80	15,44	VI-IX	VII-VIII	IX-X	VIII	Wu, Raven, 2011
Carex siderosticha Hance	(15)20-30	14,22	IV-V	IV-V		VI	Kharkev-ich,1985
Cimicifuga dahurica (Turcz.) Torr. et A.Gray ex Maxim.	TO 100	73, 168	VII-VIII	IX	VIII-IX	veidojas reti, IX-X	Wu, Raven, 2001
Corydalis ochotensis Turcz.	50-90	100, 115	VI-IX	VII	VI-IX	IX-X	Wu, Raven, 2008a
Duchesnea indica (Andrews) Focke	20-30	15, 15	VI-VIII	V-VI	VIII-X	VII-VIII	Wu, Raven, 2003a
Fallopia japonica (Houtt.)Ronse Decr.	100-200	200	VI-IX	IX-X	VII-X	fruitless	Wu, Raven, Hong, 2003
Fallopia sachalinensis (F.Schmidt)Ronse Decr.	150-400	253, 284	VII-VIII	IX-X	IX-X	fruitless	Voroshilov, 1982
Filipendula camtschatica (Pall.) Maxim.	200 (-300)	200	VII-VIII	VI-VIII	VIII-IX	VII-IX	Shulkina, 2004
Filipendula koreana Nakai	50-150	77, 95	VI-VIII	VII-VIII	VI-VIII	VIII	Wu, Raven, 2003a
Filipendula palmata (Pall.)Maxim.	60-150	77, 100	VII-IX	VII-VIII (SAISINĀTS)	VII-IX	VIII-IX	Wu, Raven, 2003a

Latin name of taxa, Authors	Hight of Habitus (cm)		Blooming Period		Fruiting Period		References
	Litera-ture Data	BGUL Data : VH, ZH*	Literat. data	BGUL Data	Literature Data	BGUL Data	
Geranium soboliferum var. *kiusianum* (Koidz.) Hara	TO 40	34, 42	VIII-IX	X		X	Kharkev-ich,1987
Geranium wlassovianum Fisch. ex Link	TO 50	30, 40	VII-VIII	VI-IX		VIII	Kharkev-ich,1987
Hemerocallis esculenta Koidz.	40-80	57, 64	V-VI	V-VI	NO DATA	VIII	Wu, Raven, 2000
Hemerocallis middendorffii Trautv. et C.A.Mey	40-80	41, 46	V-VI	V-VI	NO DATA	VIII	Wu, Raven, 2000
Hemerocallis minor Mill.	50 (20-60)	41, 46	V-VI	V-VI		VII	Wu, Raven, 2000
Hosta clausa var. *ensata* (Maekawa) W.G.Schmid	5-25 cm, ZH=33-55	30, 52	VIII	VII-VIII	VIII-IX	IX-X	Wu, Raven, 2000 Schmid, 1991
Hosta minor Nakai	16-20	12, 20	VII	VI-VIII	FERTILE	IX	Schmid, 1991
Hosta montana Maekawa	100 (40-100)	65, 72	VI-VII	VII-VIII	FERTILE	IX	Schmid, 1991
Hosta nigrescens Maekawa	60-70, ZH=140	46, 122	VI-VIII	VII-IX		IX	Schmid, 1991
Hosta sieboldiana Engl.	70-90	34, 39	VI	VI-VIII		X	Schmid, 1991
Hosta ventricosa Stearn	6-30, ZH=60-100cm	40, 100	VI-IX	VII-VIII	VI-IX	seeds do not ripen	Schmid, 1991
Hosta venusta F.Maek.	VH=8, ZH=18-24	24, 35	VII	VII-VIII	FERTILE	seeds do not ripen	Schmid, 1991
Hylomecon japonica (Thunb.)Prantl et Kuendig	15-40	24, 35	IV-VII	V	V-VIII	VII	Wu, Raven, 2008a
Iris ruthenica Ker-Gawl.	VH=7-25, ZH=2-20	58, 31	V-VI	VI	VII	VII	Wu, Raven, 2000
Iris sanguinea Hornem. ex Donn	VH=20-60, ZH=40-60	76, 95	V-VI	VI	VII	IX	Wu, Raven, 2000
Kirengeshoma palmata Yatabe	80-120	108, 119	III-IV	VIII-IX	V-VIII	X	Wu, Raven, Zhu, 2003b

Latin name of taxa, Authors	Hight of Habitus (cm)		Blooming Period		Fruiting Period		References
	Litera-ture Data	BGUL Data : VH, ZH*	Literat. data	BGUL Data	Literature Data	BGUL Data	
Ligularia dentata (A.Gray)Hara	30-120	90, 120	VII-X	VIII-IX	VII-X	seeds do not ripen	Wu, Raven, 2001a
Ligularia stenocephala (Maxim.)Mats. et Koidz.	40-170	70, 112	VII-XII	VII-VIII	VII-XII	VIII-IX	Wu, Raven, 2001a
Lilium lancifolium var. *splendens* Leichtl. ex Van Houtte	TO 150	141	VII-VIII	VIII-IX	VIII-IX	fruitless	Kharkev-ich,1987
Menispermum dahuricum DC.	500	160	V-VII	VI	VIII-IX	fruitless	Wu, Raven, 2008a
Pachysandra terminalis Siebold et Zucc.	30	25, 30	IV-V	IV-V	IV-V	V	Wu, Raven, 2008
Patrinia gibbosa Maxim.	to 60	27, 40	V-IX	VIII		VIII	Kharkev-ich,1987
Phytolacca acinosa Roxb.	50-150	102, 115	V-VIII	VI-VIII	VI-X	VII-#	Wu, Raven, Hong, 2003
Potentilla flagellaris Willd. ex Schlecht.	4-10	9, 11	V-IX	V-VIII	V-IX	VIII	Wu, Raven, 2003a
Primula sieboldii E.Morren	4-12(18), ZH=12-25(30)	10, 20	V	V-VI	VI	VI	Wu, Ra-ven,1996
Rodgersia podophylla A.Gray	60-100	85, 102	VI-VII	VI-VII		X	Wu, Raven, Zhu, 2003b
Scilla scilloides (Lindl.)Druce	(10)15-40, ZH=7-20,	13, 23	VII-XI	VIII-IX	VII-XI	X	Wu, Raven, 2000
Sedum pluricaule Kudo	5-10	11, 14	VIII-IX	VIII-X	NO DATA	fruitless	Stephenson, 1994, Eggli, 2012.
Sedum sarmentosum Bunge	10-25 cm	6	V-VI	VI-VII	VIII	seeds do not ripen	Wu, Raven, Zhu, 2003b
Spodiopogon sibiricus Trin.	70-200	130, 150	SUM-MER-AU-TOMN	VIII-X	SUM-MER-AU-TOMN	seeds do not ripen	Wu, Raven, Hong, 2006

*VH- hight of vegetative shoots, ZH- hight of generative shoots.