UPPSALA
UNIVERSITET

Resemblances and Disparities of two Biotas

A Comparison Study of Vascular Plant Biodiversity of two Locations in Uppsala and Beijing

Ziwei Zhang

Degree project in biology, Bachelor of science, 2013
Examensarbete i biologi 15 hp till kandidatexamen, 2013
Institutionen för biologisk grundutbildning och Avd för växtekologi och evolution, Uppsala universitet
Handledare: Håkan Rydin

Abstract

This paper focuses on the flora distribution and difference in biodiversities of two chosen locations in Uppsala and Beijing, through inventorial and analytic methods. The factors that may cause the difference were also discussed from theoretical perspectives. Inventories of vascular plant species were carried out in two locations of the two cities. The collected species data were then grouped into families as well as life forms; and were compared with each other as well as with the statistics from the entire species pool in the chosen city. Both resemblances and disparities were found. The statistical analyses with Minitab supported the hypotheses that the floral compositions of these two locations differ to a great extent. Various factors such as climate, grazing, human impacts, historical reasons, precipitation, humidity and evolution, can account for the disparities.

Contents

1. Introduction

1.1 Motivation and Content of this paper

The biotas of Uppsala and Beijing are located in two different continents and biomes, although they share certain common features and similarities. Inventory lists were generated from both field trips as well as existing data so that differences in plant composition can be analysed and displayed. Two nature reserves were studied in Uppsala and Beijing in order to do this. It should be noted that these two chosen areas cannot fully represent the biotas; with limited time and resources, this study only aims to show trends and patterns of similarities as well as dissimilarities.

The most common families of both biotas are then compared with the largest families worldwide, under the hypothesis of a high degree of overlap. The five largest families of the world are Asteraceae, Fabaceae, Orchidaceae, Rosaceae and Poaceae. The reasons for the highly occurring families were discussed from viewpoints such as unique features of these families; the reasons for the disparities in species distribution between these two biotas are also argued, such as the climate, biome, evolution, elevation, etc.

The resemblance and correlation with the two biotas of Uppsala and Beijing are studied. The hypothesis is that the compositions of flora in these locations differ, both in forms of families as well as life forms. In order to testify this, Minitab was used and a null hypothesis is proposed, stating that the compositions of flora in these two locations are somewhat identical; both in the form of families and life forms.

1.2 Biomes of Uppsala and Beijing

A biome is a natural community of wide extent, characterised by distinctive, climatically controlled groups of plants and animals (Raven *et al*., 2004). Whittaker (1978) established a classification method based on two abiotic factors: precipitation and temperature. According to Sjörs (1999), Uppsala locates in the boreo-nemoral zone (Fig. 1), with long, cold winters and temperate summers. The boreo-nemoral (hemi-boreal) zone is also sometimes referred to as the southern coniferous forest region. Although dominance is usually of conifers, deciduous trees are widespread.

Beijing on the other hand belongs to the biome of temperate deciduous forest (Hou *et al.*, 1982; Haxeltine & Prentice, 1996), with lower average temperature and hotter summers, as well as less precipitation, where deciduous trees are common. In the project BIOME3, detailed vegetation maps of China were generated. In Fig. 2, natural vegetation map of China, consists of 18 BIOME3 categories assigned from 113 vegetation type units digitilised from the ‘Vegetation Map of the People’s Republic of China at 1:4,000,000 scale (Hou *et al.*, 1982).

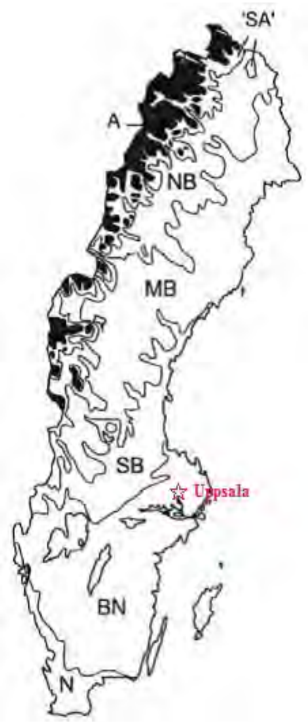

Figure 1. Vegetational zonation in Sweden (Sjörs, 1999) SB = southern boreal, MB = middle boreal, NB =northern boreal, BN = boreo nemoral.

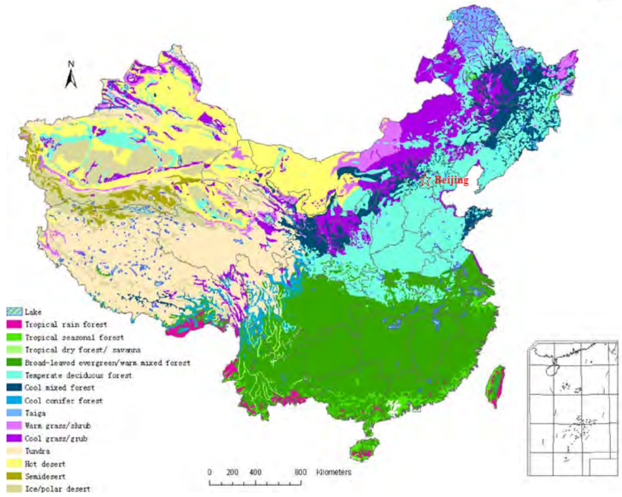

Figure 2. Vegetation map of China (Hou *et al.*, 1982), different colours represent different vegetation types.

China is ranked the 3rd in the world when it comes to biodiversity richness, including 2200 species and 106 families of mosses, accounting for 70% of the world's total number of moss families; 2600 species and 52 families of ferns, accounting for 80% of the total number of fern families. There are a total number of 15 families and 79 genera of gymnosperms in the world and in China alone are 10 families and 34 genera present. China possesses roughly 54% of the total families and 24% of the total genera present in the world (Chen & Ma, 2011).

According to Flora of Beijing (He, 1992), 2056 vascular plants that belong to 869 genera and 169 families are recorded in Beijing, in which, 20 families, 30 genera and 75 species are ferns; 9 families, 18 genera, 37 species are gymnosperms; 104 families, 821 genera and 1944 species are angiosperms. The composition of plant species share common characteristics in Northern China. Moreover, Eurasian Steppe elements are seen in the plains, such as *Tribulus terrestris*, *Salsola collina*, *Tamarix chinensis*, and *Suaeda glauca*. European and Siberian elements are retained in mountain areas, such as *Larix principis-rupprechtii*, *Picea asperata*, *Pyrola rotundifolia*, and *Maianthemum bifolium*. Plants with tropical characteristics are also found in lower mountains and plains, including *Ailanthus altissima*, *Ziziphus jujube*, *Merremia spp.*, and *Bothriochloa ischaemum*. These reflect the complex and diverse composition of vegetation in Beijing.

In the regional flora for the Uppland province in which Uppsala is located (Jonsell 2010), it is mentioned that the inventory Project of "Uppland's Flora" has been carried out from 1929 to the 1970s. During the inventory process, 1991 vascular plant species were registered in total, 1193 of which are local residents and 798 are more or less temporary. It is a typical boreo-nemoral habitat with dominance of *Picea abies* and *Pinus sylvestris* with their companion species (Jonsell 2010).

2. Materials and Methods

The two studied areas chosen were Hågadalen outside of Uppsala and Beijing Botanical Garden located in outer area of Beijing. For detailed locations and a brief overview, see attached maps shown in Figures 3 and 4.

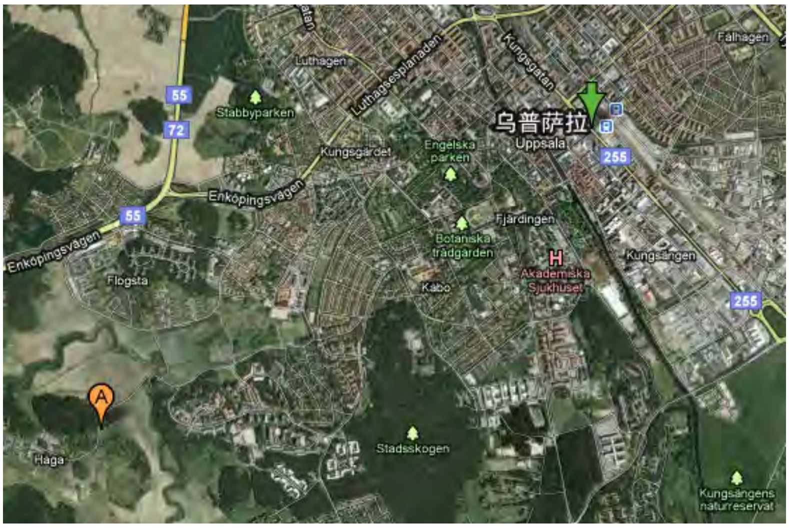

Figure 3. Map of Hågadalen (Source: Google Map); green arrow represents city centre while the orange arrow "A"represents Hågadalen.

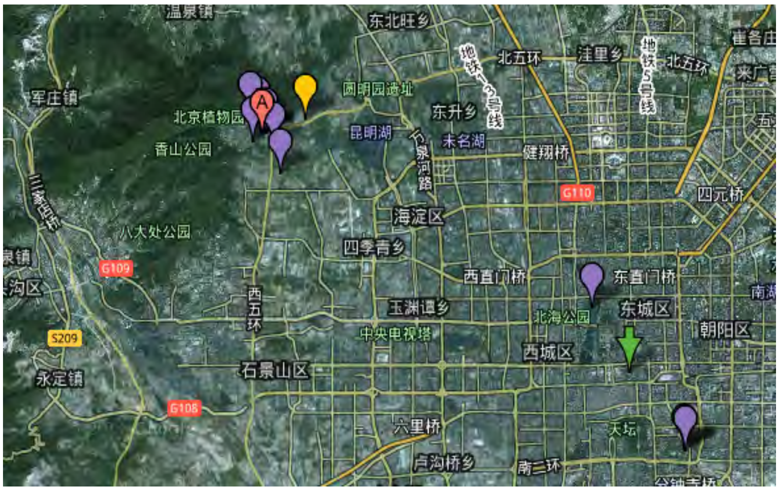

Figure 4. Map of Beijing Botanical Garden (Source: Google Map); green arrow represents city centre while the red arrow "A" represents Beijing Botanical Garden.

As shown the above maps, Hågadalen is situated about 5.3 kilometres away from Uppsala city centre while Beijing Botanical Garden is situated roughly 28.1 kilometres away from Beijing city centre.

The initial tentative plan was to study the difference in major plants found in the two cities and draw conclusions based on the field trips, by picking 15 places in each nature reserve and make an inventory list on the plant species found within a transect area of 1m x 1m. These should be ideally of different geographic conditions e.g. meadow land, dry land, hill, "junk land", roadsides, and groves; however this method turned out to be rather unpractical and this sample size is too small to give a whole picture of the biota. Therefore an alternative method was used, which was to only pick one venue in each city, and simply record all the vascular plant species seen within the area, repeating for 5 times each, with not less than 1 hour each time, until no new species were observed. No transects were laid in this method. This method should not be treated as a fully representative image of the biodiversities in these cities. Both of the inventories were carried out between July and August, 2011.

If more time was available, there are much more complex and systematic inventory methods, for the purpose of doing an accurate and formal inventory of plant species, like those of the previously mentioned projects BIOME3 and Uppland's flora.

Identification keys and nomenclature for vascular plants follow He (1992) and Krok and Almquist (2001). They were then grouped into families in order to provide a clearer comparison between the two floras.

Minitab was used in order to test differences in distribution of genera and life forms of these two areas. Chi square tests were used in order to test the difference in the major species composition between the two biotas. Null hypothesis were proposed and tested.

3. Results

3.1 Patterns of Distribution

The vascular plant species in the two locations were grouped into families, shown in Appendix 1. The detailed lists obtained from the field trip in the Beijing Botanical Garden (114 species in total, grouped in families in descending order) and from Hågadalen (199 species in total, grouped into families in descending order) are listed in Appendix 2 and 3.

In addition, the collected species lists were divided into groups of life forms, consisting of ferns, graminoids, herbs, hydrophytes, parasites, woody plants, and vines (Table 1; Appendix 1 and 2). It is noted that the biodiversity is more abundant in Hågadalen comparing with that of Beijing Botanical Garden, both from the perspective of families as well from the aspect of varied life forms.

Table 1. Number of vascular plant species in the two locations by life forms

Life forms	Hågadalen, Uppsala	Beijing Botanical Garden
Fern	3	0
Graminoid	32	2
Herb	120	27
Hydrophyte	4	0
Parasite	1	0

Woody plant	39	83
Vine	0	1

As the complete species lists from the two locations (Appendix 2 and 3) contain several small values and are from many non-overlapping families, it is impossible and impractical to compare the total plant species in one area with another; we need to figure out a convenient method as first to convert the species into some comparable data. Hence they were grouped into families as well as life forms. The 12 most common families shared by both locations (criteria is that the sum of species in the same family in two locations is larger than 5) were chosen to be shown individually in the pie chart, and the rest families containing small number of species were grouped into category called “others”, for better visualisation. The data used for grouping into life forms were however the complete data set. The illustrated results are shown in pie charts demonstrated in Figures 5-6.

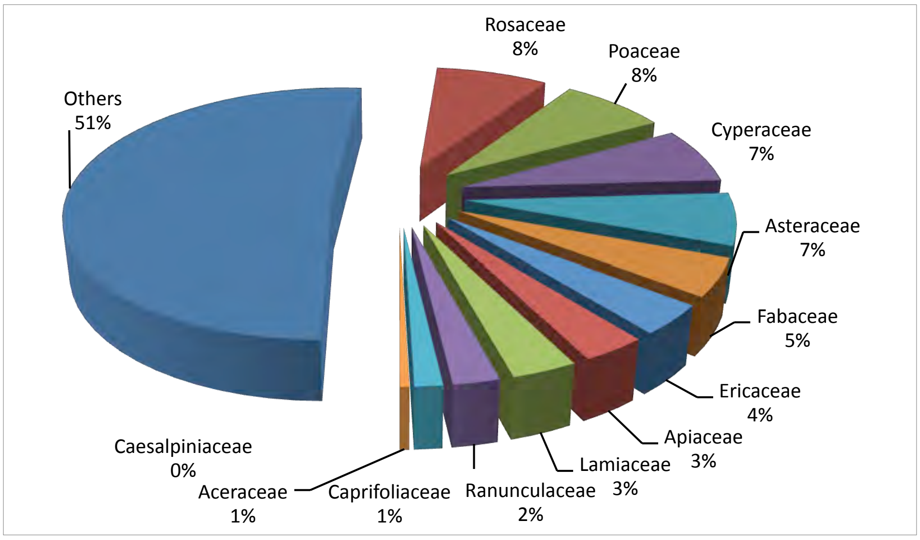

Figure 5a. Composition of flora in Hågadalen by families

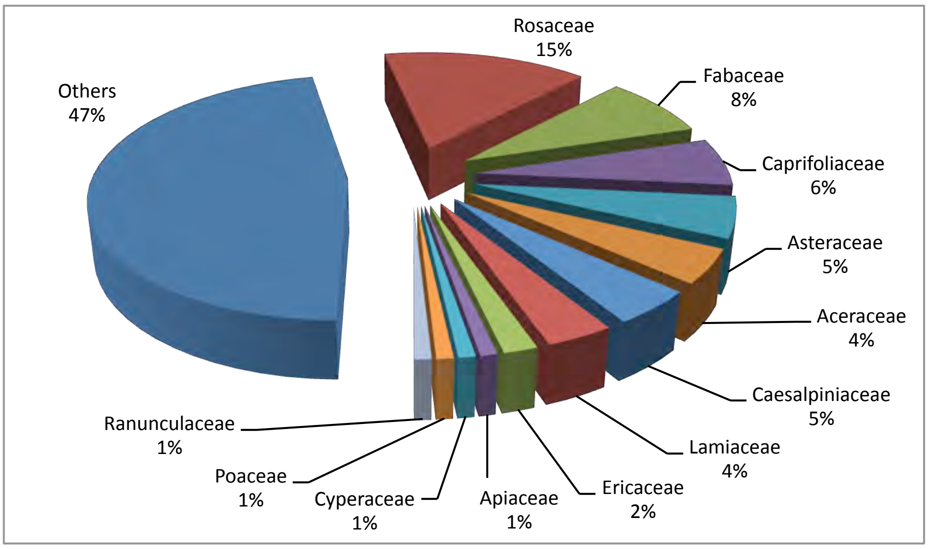

Figure 5b. Composition of flora in Beijing Botanical Garden by families

In Figure 5, the 12 most common families in both locations are Rosaceae, Poaceae, Cyperaceae, Asteraceae, Fabaceae, Ericaceae, Apiaceae, Lamiaceae, Ranunculaceae, Caprifoliaceae, Aceraceae, and Caesalpiniaceae. Their respective percentage distributions vary, with Rosaceae being the most common family observed (8% and 15% respectively), followed by Asteraceae (7% and 5% respectively) and Fabaceae (5% and 8% respectively).

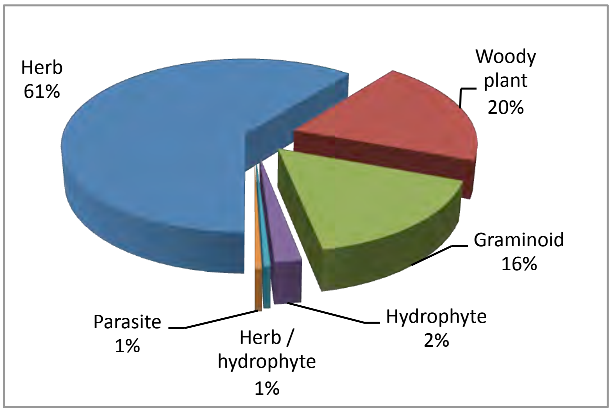

Figure 6a. Composition of flora in Hågadalen by life forms

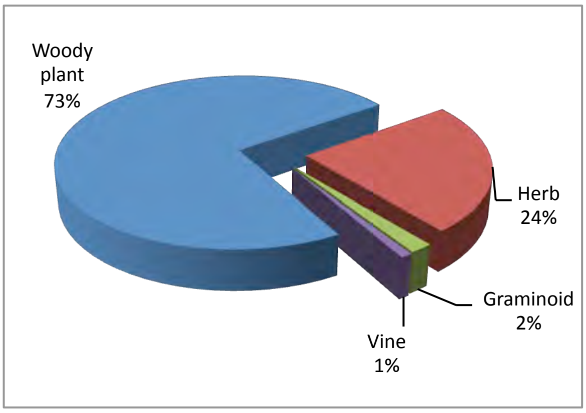

Figure 6b. Composition of flora in Beijing Botanical Garden by life forms

In Fig. 6, we see that the composition of flora in Uppsala Hågadalen (6 life forms) is more varied than that of Beijing Botanical Garden (4 life forms).

3.2 Statistical Analysis

The following two groups of data were tested using the chi-square test, results cited as follows:

(1) Chi-Square Test, grouped as families: Uppsala Hågadalen, Beijing Botanical Garden. Data from Appendix 1 gave invalid results in Minitab due to large number of small values. Thus only the most common families shared by both locations (criteria is that the sum of species in the same family in two locations is larger than 5) were chosen to be shown in Table 2. This set of data corresponds with the data used in the pie charts illustrated in Fig. 5a and 5b. 103 species in Hågadalen and 89 species in Beijing Botanical Garden fulfilled this criterion and are shown in Table 2.

Table 2. Number of vascular plant species in the two locations by families

Families	Hågadalen, Uppsala	Beijing Botanical Garden
Rosaceae	17	17
Poaceae	16	1
Cyperaceae	15	1
Asteraceae	14	6
Fabaceae	10	9
Ericaceae	8	2
Apiaceae	7	1
Lamiaceae	7	4
Ranunculaceae	5	1

Caprifoliaceae	3	37
Aceraceae	1	5
Caesalpiniaceae	0	5

Chi-Square contributions generated by data in Table 2 are shown in Appendix 4.

Chi-Sq = 40.637, DF = 11, P-Value = 0.000

The p-value is smaller than 0.05, assuming 95% confidence level. This rejects the null hypothesis that the flora compositions by families between the two locations are identical. Conclusion can be drawn that the dominating families in these two locations differ to a great extent. This may also be visually observed in Figures 5a and 5b.

(2) Chi-Square Test, grouped as life forms: Uppsala Hågadalen, Beijing Botanical Garden. Data from Table 1 gave invalid results in Minitab due to some results containing small values. Thus the less interesting data were grouped into category “others”, and only life forms of graminoid, herb and woody plant were kept, as shown in Table 3.

Table 3. Life forms of vascular plants in the two locations (simplified)

Life forms	Hågadalen, Uppsala	Beijing Botanical Garden
Graminoid	32	2
Herb	120	27
Woody plant	39	83
Others	8	1

Chi-Square contributions generated by data in Table 3 are shown in Table 4.

Table 4. Chi square test results between locations by life forms. The first line gives the observed values, the second the expected, and the third the contribution to Chi-square.

	Uppsala	Beijing	Total
Graminoid	32	2	34
	21.69	12.31	
	4.906	8.639	
Herb	120	27	147
	93.76	53.24	
	7.344	12.933	
Woody plant	39	83	122
	77.81	44.19	
	19.361	34.095	
Others	8	1	9
	5.74	3.26	
	0.889	1.566	
Total	199	113	312

Chi-Sq = 89.733, DF = 3, P-Value = 0.000

The p-value is smaller than 0.05, assuming 95% significance level. This rejects that null hypothesis that the flora compositions by life forms between the two locations are identical. Conclusion can be drawn that the main life forms in these two locations differ to a great extent. This may also be visually observed in Figures 6a and 6b.

4. Discussion

4.1 Resemblance and Disparity

As a detailed overview of the Uppland's flora is missing, no general comparison could be made between flora of Beijing and Uppsala. However, a rather integral picture of Beijing's flora is currently provided by scholars such as He *et al*. (1992). The largest families by order are ranked as follows: Asteraceae, Poaceae, Fabaceae, Rosaceae, Liliaceae, Cyperaceae, Caryophyllaceae, Polygonaceae, Scruphylariaceae, Apiaceae, Brassicaceae and Lamiaceae.

It is observed that the composition of families differs from that of the Beijing Botanical Garden, however have somewhat more similarities with that from the Hågadalen nature reserve. This indicates further that two randomly picked locations from two biomes cannot fully be represented as the while picture of the local biodiversity.

Focusing on the life forms in both locations (Fig. 6), in Hågadalen the dominating life forms are herbs (61%), woody plants (20%) and graminoids (16%); on the other hand, in Beijing Botanical Garden the distributions of herbs, woody plants and graminoids are 24%, 73% and 2%, respectively. The former consists of abundant herbaceous plants whilst the latter consists of impressive diversity of woody species.

In Figure 5, the Rosaceae species are abundant in both locations. In Hågadalen, there are large proportions of Poaceae and Cyperaceae, and Beijing Botanical Garden instead consists of large proportions of Fabaceae and Caprifoliaceae. These major families such as Asteraceae, Poaceae, Fabaceae, *etc.*, the resemblance is that they are successful almost worldwide. For instance, one of the dominant species in both locations, Asteraceae, is the 4th largest family worldwide. This mainly accounts on their high adaptive fitness. Taking one of the five families as the example, which is also the largest family in the world, The Asteraceae, are found as high as above elevation of 5000 meters on the Himalayas, and as dry as in the deserts. Another unique feature, its capitulum arrangement, is considered the most derived and dense form of inflorescence. Hence it is possible that this form of inflorescence helps attract greater amount of insects for pollination. Its connate anthers can protect pollen and prolonged style brings out the pollen. The small seeds can transfer for a long distance. Asteraceae is also known to be efficient spreading their seeds. The seeds, or rather the fruit called achenes, have typically adjuncts that facilitates the spread of seeds, for instance the tails of the *Taraxacum* ssp. seeds, and the barbs of *Bidens pilosa* can attach to people's clothes and animals' fur and have their seeds carried efficiently in this way (Raven *et al.*, 2004).

Apart from the similarities of the major families between Uppsala and Beijing, there are a number of disparities in the composition of species, both biotic and abiotic, including the different environmental conditions of the biomes they are located in, the evolutionary and cultural causes, *etc.*. The statistical tests have rejected the null hypotheses that the compositions of flora in these two locations are identical. In other words, the composition flora in Beijing Botanical Garden and Hågadalen in Uppsala are very different. This corresponds with our initial hypothesis.

4.2 Factors Affecting the Difference in Flora

Many biotic and abiotic factors may decide whether or not a species is suitable to live in an environment, such as biomes, temperature gradients, and so on. *Corynephorus canescens*, for instance, is a grass of more open sands found in Europe, with its northern border almost halfway across Great Britain as well as Scandinavia (Fig. 10). Marshall (1967) has researched the factors which can be responsible for maintaining its northern boundary line, and he found that both flowering and germination were affected by low temperature. When the temperature is below 15^{o}C, the germination process is slowed down, and the seeds inseminated after October has a low survival rate. This explains why the northern border of this grass corresponds with the isotherm of 15^{o}C in July. Hence, the vegetation in Uppsala and Beijing with different temperature zones differ. Many studies have shown to support this theory. A study on biodiversity in Africa showed that climate accounts for 77.8% of the variation in species richness (O'Brien, 1993).

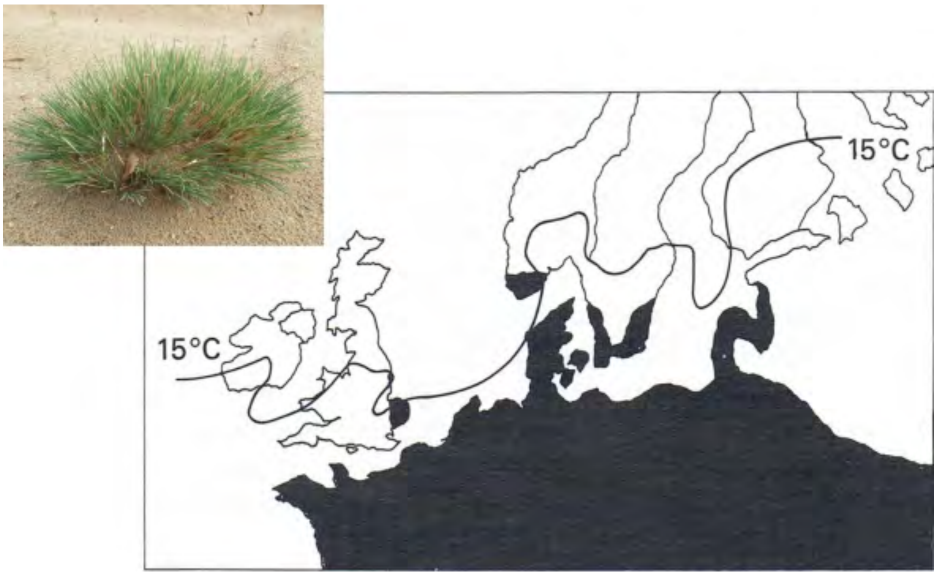

Figure 8. Distribution map and photo of *Corynephorus canescens*(Marshall, 1967)

Geographically, the native vegetation of Beijing should be pine-oak mixed broad-leaved deciduous forest, especially in the lower mountains around the Beijing area. However, long-term large-scale human activities—deforestation, farmland clearing, and urbanization—have altered the original vegetation as well as its character. Within the city and in outlying suburban areas, farmland, orchards, and villages have long since replaced the native forest (He *et al.*, 1992). Although forests have been well preserved in majority lands of Sweden, the flora of Uppsala has also changed somewhat in the last century, the 451 taxa include species that were considered less common to rare in the early 1900s, while excluding the commonest as well as the rarest species. Complex changes in land use (sharp decline in traditional management and the area of semi-natural grasslands, intensified agriculture and forestry, drainage and exploitation), regulation of natural water level fluctuations in water courses, and eutrophication seem to be the main drivers of the observed changes in the vascular plant flora of the province of Uppland during the 20th century.

Some factors that may cause differences in the biota composition in the two areas include human activities, water and oxygen in the air, annual precipitation, altitude, soil acidification and fauna in the area, *etc.*. All these factors may affect and interact with each other, for instance the close interaction between fauna and flora. Grazing should be taking into account which may interfere with the local plant species while it is not relevant for Beijing, as according to the *Beijing Agricultural Policies [2001]-57* and *[2005]-1*, grazing is gradually minimised and eventually forbidden. Grazing can affect the species pools. Grazed sites generally have high proportions of legumes, therophytes, species with basal position of leaves and with regeneration by means of a persistent seed bank. Abandonment of grazing favour monocots, geophytes, species with vegetative regeneration and (partly) leafy canopy structure. Some differences between grazed and abandoned sites were confined to either the smallest or largest plot sizes, indicating different responses of matrix and interstitial species. (Dupré & Diekmann, 2001)

5. Conclusions

Inventories of plant species were done in two nature reserves in two countries, located in different biomes. They were then compared with each other. Patterns of distribution are analysed through statistical software Minitab and patterns were shown. With statistical analysis, the floral compositions of the two locations differ both by families and life forms.

The reason for filtering out the smaller values in the original datasets is due to avoidance ofinvalidity of the tests performed. In future studies, inorder to obtain a valid and more credible statistical result, a much larger and more complete list should be provided. In this case, the sample sizes are too small. However combining with the data of Beijing Flora, it is found that the families of Rosaceae (the rose family), Poaceae (the grass family), Asteraceae (the daisy family), Fabaceae (the legume family), and Cyperaceae (the sedge family) are in great extent overlapped. While other components of plant species vary, depending on various factors such as climate, human impacts, grazing, historical reasons, precipitation, moisture in the air, evolution, etc.

Due to limitations of time and resources, this project still leaves great space for improvement and correction. The initial objective of this paper is to practice inventory skills, as well as to explore a field which has been less paid attention to. Proper inventory field work can be carried out in detail in order to obtain the reliable and up-to-date data suitable for comparison. Although no or little previous analytic studies have been done comparing species pools in two areas, this topic helps future cultivation and promotion of regional vegetation planning, introduction of new plant species into other areas, etc. More inventory work can be done in order to provide a less arbitrary and ambiguous species list, and consequently generates a more statistically significant report.

References

Beijing Agricultural Policies [2001]-57 and [2005]-1, Sayre 194.

Chen LZ, Ma KP. 2011. Science of Biodiversity (Theory and Practice), 2011. Scientific & Technical Publishers, Shanghai.

Dupré C, Diekmann M. 2001. Differences in species richness and life-history traits between grazed and abandoned grasslands in southern Sweden. Ecography 24: 275–286. doi: 10.1034/j.1600-0587.2001.240305.x

Haxeltine A, Prentice IC. 1996. BIOME3: An equilibrium terrestrial biosphere model based on ecophysiological constraints, resource availability and competition among plant functional types. Global Biogeochemical Cycles 10: 693–709.

He SY. 1992. Flora of Beijing. 2nd ed. Beijing Press, Beijing.

Hou XY, Sun SZ, Zhang JW, He MG, Wang YF, Kong DZ, Wang SQ. 1982. Vegetation Map of the People's Republic of China. China Map Publisher, Beijing.

Jonsell L (ed.). 2010. Upplands flora, SBF Publishing House, Uppsala.

Krok T, Almquist S. 2001. Svensk flora. Fanerogamer och ormbunkväxter. 28th ed. Liber AB Publisher, Stockholm.

Map of Beijing Botanical Garden, retrieved on Aug 19, 2011 from website www.maps.google.com

Map of Hågadalen, retrieved on Aug 19, 2011 from website www.maps.google.com

Marshall JK. 1967. *Corynephorus canescens* (L.) Beauv. Journal of Ecology, 55: 207-220.

O'Brien EM. 1993. Climatic gradients in woody plant species richness: towards an explanation based on an analysis of southern Africa's woody flora. Journal of Biogeography, 20:181-198.

Raven PH, Evert RF, Eichhorn SE. 2004. Biology of Plants. 7th ed. New York. W.H. Freeman.

Sjörs H. 1999. The background: Geology, climate and zonation. Acta Phytogeographica Suecica, 84: 5-14.

Whittaker, RH. 1978. Classification of Plant Communities. Junk Publishers, The Hague, Boston, pp408.

Appendix

Appendix 1. Vascular plant species in the two locations grouped into families

Families	Uppsala	Beijing
Aceraceae	1	5
Alangiaceae	0	1
Alliaceae	2	0
Amaranthaceae	0	1
Anacardiaceae	0	3
Apiaceae	7	1
Aspleniaceae	1	0
Asteraceae	14	6
Balsaminaceae	0	1
Begoniaceae	0	1
Berberidaceae	0	1
Betulaceae	1	0
Boraginaceae	3	1
Brassicaceae	3	0
Caesalpiniaceae	0	5
Campanulaceae	1	0
Caprifoliaceae	3	7
Caryophyllaceae	3	1
Cephalotaxaceae	0	1
Cistaceae	1	0
Cladoniaceae	1	0
Cladoniaceae	1	0
Cladoniaceae	1	0
Clusiaceae	1	0
Commelinaceae	0	1
Convallariaceae	2	0
Convolvulaceae	2	0
Cornaceae	0	2
Corylaceae	1	0
Crassulaceae	3	0
Cupressaceae	1	1
Cyperaceae	15	1
Dennstaedtiaceae	1	0
Dicranaceae	1	0
Droseraceae	2	0
Dryopteridaceae	1	0

Elaeagnaceae	1	1
Empetraceae	1	0
Equisetaceae	4	0
Ericaceae	8	2
Eucommiaceae	0	1
Fabaceae	10	9
Fagaceae	1	0
Geraniaceae	3	0
Ginkgoaceae	0	1
Grossulariaceae	1	0
Hydrangeaceae	0	2
Hylocomiaceae	1	0
Hylocomiaceae	1	0
Hylocomiaceae	1	0
Hypnaceae	1	0
Iridaceae	1	2
Juglandaceae	0	1
Juncaceae	3	0
Lamiaceae	0	4
Lamiaceae	7	0
Lauraceae	0	1
Lemnaceae	2	0
Lentibulariaceae	2	0
Liliaceae	0	3
Linaceae	0	1
Linaceae	0	1
Lycopodiaceae	1	0
Magnoliaceae	0	2
Melanthiaceae	1	0
Menyanthaceae	1	0
Mimosaceae	0	1
Moraceae	0	2
Myricaceae	1	0
Nyctaginaceae	0	1
Nymphaeaceae	2	0
Oleaceae	1	2
Onagraceae	1	0
Orchidaceae	4	0
Oxalidaceae	1	0
Papaveraceae	1	0
Parmeliaceae	1	0
Parmeliaceae	1	0
Parmeliaceae	1	0
Pinaceae	1	0

Plantaginaceae	2	0
Plumbaginaceae	1	0
Poaceae	16	1
Polygalaceae	1	0
Polygonaceae	4	3
Polypodiaceae	1	0
Polytrichaceae	1	0
Primulaceae	2	0
Ranunculaceae	5	1
Rhamnaceae	1	2
Rosaceae	17	17
Rubiaceae	3	0
Rutaceae	0	3
Salicaceae	4	0
Sapindaceae	0	1
Scheuchzeriaceae	1	0
Scrophulariaceae	4	0
Simaroubaceae	0	1
Solanaceae	1	0
Taxaceae	0	1
Teloschistaceae	1	0
Thelypteridaceae	1	0
Tiliaceae	1	0
Ulmaceae	1	1
Urticaceae	1	0
Valerianaceae	1	0
Verbenaceae	0	2
Violaceae	1	0
Vitaceae	0	1
Woodsiaceae	2	0

Appendix 2. Detailed list of vascular plant species in Hågadalen, Uppsala

Family	Species	Life form	Number of species with this life form
Thelypteridaceae	*Phegopteris connectilis*	Fern	3
Woodsiaceae	*Athyrium filix-femina*	Fern	
Woodsiaceae	*Woodsia ilvensis*	Fern	
Cyperaceae	*Carex canescens*	Graminoid	32
Cyperaceae	*Carex flacca*	Graminoid	
Cyperaceae	*Carex hirta*	Graminoid	
Cyperaceae	*Carex limosa*	Graminoid	
Cyperaceae	*Carex pallescens*	Graminoid	

Cyperaceae	*Carex vesicaria*	Graminoid	
Cyperaceae	*Carex acuta*	Graminoid	
Cyperaceae	*Carex echinata*	Graminoid	
Cyperaceae	*Carex lasiocarpa*	Graminoid	
Cyperaceae	*Carex nigra*	Graminoid	
Cyperaceae	*Carex ovalis/leporine*	Graminoid	
Cyperaceae	*Carex panacea*	Graminoid	
Juncaceae	*Juncus conglomeratus*	Graminoid	
Juncaceae	*Luzula multiflora*	Graminoid	
Juncaceae	*Luzula pilosa*	Graminoid	
Poaceae	*Alopecurus pratensis*	Graminoid	
Poaceae	*Anthoxanthum odoratum*	Graminoid	
Poaceae	*Arrhenatherum elatius*	Graminoid	
Poaceae	*Briza media*	Graminoid	
Poaceae	*Calamagrostis arundinacea*	Graminoid	
Poaceae	*Dactylis glomerata*	Graminoid	
Poaceae	*Deschampsia flexuosa*	Graminoid	
Poaceae	*Elytrigia repens*	Graminoid	
Poaceae	*Helictotrichon pretense*	Graminoid	
Poaceae	*Lolium perenne*	Graminoid	
Poaceae	*Melica nutans*	Graminoid	
Poaceae	*Milium effusum*	Graminoid	
Poaceae	*Phleum pretense*	Graminoid	
Poaceae	*Phragmites australis*	Graminoid	
Poaceae	*Poa nemoralis*	Graminoid	
Poaceae	*Poa pratensis*	Graminoid	
Scrophulariaceae	*Rhinanthus sp.*	Graminoid	
Alliaceae	*Allium oleraceum*	Herb	120
Alliaceae	*Allium schoenoprasum*	Herb	
Apiaceae	*Aegepodium podagraria*	Herb	
Apiaceae	*Anthriscus sylvestris*	Herb	
Apiaceae	*Carum carvi*	Herb	
Apiaceae	*Laserpitium latifolium*	Herb	
Apiaceae	*Cicuta virosa*	Herb	
Apiaceae	*Pimpinella saxifrage*	Herb	
Apiaceae	*Sium latifolium*	Herb	
Aspleniaceae	*Asplenium trichomanes*	Herb	
Asteraceae	*Achillea millefolium*	Herb	
Asteraceae	*Antennaria dioica*	Herb	
Asteraceae	*Arctium tomentosum*	Herb	
Asteraceae	*Artemisia vulgaris*	Herb	
Asteraceae	*Chamomilla suaveolens*	Herb	
Asteraceae	*Cirsium arvense*	Herb	
Asteraceae	*Cirsium helenioides*	Herb	

Asteraceae	*Cirsium vulgare*	Herb
Asteraceae	*Hieracium sect. Hieracium*	Herb
Asteraceae	*Hypochoeris maculate*	Herb
Asteraceae	*Matricaria perforate*	Herb
Asteraceae	*Pilosella officinarum*	Herb
Asteraceae	*Tragopogon pratensis*	Herb
Asteraceae	*Hieracium sect. Vulgata*	Herb
Boraginaceae	*Anchusa officinalis*	Herb
Boraginaceae	*Myosotis sp.*	Herb
Boraginaceae	*Symphytum x uplandicum*	Herb
Brassicaceae	*Bunias orientalis*	Herb
Brassicaceae	*Capsella bursa-pastoris*	Herb
Brassicaceae	*Thlaspi caerulescens*	Herb
Campanulaceae	*Campanula rotundifolia*	Herb
Caryophyllaceae	*Herniaria glabra*	Herb
Caryophyllaceae	*Lychnis viscaria*	Herb
Caryophyllaceae	*Stellaria graminea*	Herb
Clusiaceae	*Hypericum perforatum*	Herb
Convallariaceae	*Convallaria majalis*	Herb
Convallariaceae	*Polygonatum odoratum*	Herb
Convolvulaceae	*Convolvulus arvensis*	Herb
Crassulaceae	*Sedum acre*	Herb
Crassulaceae	*Sedum album*	Herb
Crassulaceae	*Sedum telephium*	Herb
Cyperaceae	*Eriophorum angustifolium*	Herb
Cyperaceae	*Schoenoplectus lacustris*	Herb
Cyperaceae	*Eleocharis palustris*	Herb
Dennstaedtiaceae	*Pteridium aquilinium*	Herb
Droseraceae	*Drosera rotundifolia*	Herb
Droseraceae	*Drosera anglica*	Herb
Dryopteridaceae	*Dryopteris filix-mas*	Herb
Equisetaceae	*Equisetum arvense*	Herb
Equisetaceae	*Equisetum fluviatile*	Herb
Equisetaceae	*Equisetum hyemale*	Herb
Equisetaceae	*Equisetum sylvaticum*	Herb
Fabaceae	*Lathyrus pratensis*	Herb
Fabaceae	*Lotus corniculatus*	Herb
Fabaceae	*Trifolium medium*	Herb
Fabaceae	*Trifolium montanum*	Herb
Fabaceae	*Trifolium pretense*	Herb
Fabaceae	*Trifolium repens*	Herb
Fabaceae	*Vicia cracca*	Herb
Fabaceae	*Vicia sepium*	Herb
Fabaceae	*Lathyrus linifolius*	Herb

Fabaceae	*Trifolium hybridum*	Herb
Geraniaceae	*Geranium robertianum*	Herb
Geraniaceae	*Geranium sanguineum*	Herb
Geraniaceae	*Geranium sylvaticum*	Herb
Iridaceae	*Iris pseudacorus*	Herb
Lamiaceae	*Lamium album*	Herb
Lamiaceae	*Mentha aquatica*	Herb
Lamiaceae	*Origanum vulgare*	Herb
Lamiaceae	*Prunella vulgaris*	Herb
Lamiaceae	*Scutellaria galericulata*	Herb
Lamiaceae	*Thymus serpyllum*	Herb
Lentibulariaceae	*Pinguicula vulgaris*	Herb
Lycopodiaceae	*Lycopodium clavatum*	Herb
Melanthiaceae	*Paris quadrifolia*	Herb
Menyanthaceae	*Menyanthes trifoliate*	Herb
Onagraceae	*Epilobium angustifolium*	Herb
Orchidaceae	*Dactylorhiza maculate*	Herb
Orchidaceae	*Listera ovata*	Herb
Orchidaceae	*Ophrys insectifera*	Herb
Orchidaceae	*Platanthera bifolia*	Herb
Oxalidaceae	*Oxalis acetosella*	Herb
Papaveraceae	*Chelidonium majus*	Herb
Plantaginaceae	*Plantago major*	Herb
Plantaginaceae	*Plantago media*	Herb
Plumbaginaceae	*Armeria maritime*	Herb
Polygalaceae	*Polygala vulgaris*	Herb
Polygonaceae	*Bistorta vivipara*	Herb
Polygonaceae	*Rumex acetosa*	Herb
Polygonaceae	*Rumex acetosella*	Herb
Polygonaceae	*Rumex crispus*	Herb
Polypodiaceae	*Polypodium vulgare*	Herb
Primulaceae	*Lysimachia thyrsiflora*	Herb
Primulaceae	*Primula veris*	Herb
Ranunculaceae	*Actaea spicata*	Herb
Ranunculaceae	*Anemone hepatica*	Herb
Ranunculaceae	*Anemone nemorosa*	Herb
Ranunculaceae	*Ranunculus acris*	Herb
Ranunculaceae	*Ranunculus repens*	Herb
Rosaceae	*Alchemilla vulgaris*	Herb
Rosaceae	*Filipendula ulmaria*	Herb
Rosaceae	*Filipendula vulgaris*	Herb
Rosaceae	*Fragaria vesca*	Herb
Rosaceae	*Geum rivale*	Herb
Rosaceae	*Geum urbanum*	Herb

Rosaceae	*Potentilla argentea*	Herb	
Rosaceae	*Potentilla erecta*	Herb	
Rosaceae	*Rubus chamaemorus*	Herb	
Rubiaceae	*Galium album*	Herb	
Rubiaceae	*Galium boreale*	Herb	
Rubiaceae	*Galium verum*	Herb	
Scheuchzeriaceae	*Scheuchzeria palustris*	Herb	
Scrophulariaceae	*Lathraea squamaria*	Herb	
Scrophulariaceae	*Melampyrum nemorosum*	Herb	
Scrophulariaceae	*Veronica chamaedrys*	Herb	
Solanaceae	*Solanum dulcamara*	Herb	
Urticaceae	*Urtica dioica*	Herb	
Valerianaceae	*Valeriana sp.*	Herb	
Violaceae	*Viola mirabilis*	Herb	
Lentibulariaceae	*Utricularia sp.*	Herb/hydrophyte	
Lemnaceae	*Lemna minor*	Hydrophyte	4
Nymphaeaceae	*Nuphar lutea*	Hydrophyte	
Nymphaeaceae	*Nymphaea alba*	Hydrophyte	
Lemnaceae	*Spirodela polyrrhiza*	Hydrophyte	
Convolvulaceae	*Cuscuta europaea*	Parasite	1
Aceraceae	*Acer platanoides*	Woody plant	39
Betulaceae	*Alnus glutinosa*	Woody plant	
Caprifoliaceae	*Lonicera xylosteum*	Woody plant	
Caprifoliaceae	*Sambucus racemosa*	Woody plant	
Caprifoliaceae	*Linnaea borealis*	Woody plant	
Cistaceae	*Helianthemum nummularium*	Woody plant	
Corylaceae	*Corylus avellana*	Woody plant	
Cupressaceae	*Juniperus communis*	Woody plant	
Elaeagnaceae	*Hippophaë rhamnoides*	Woody plant	
Empetraceae	*Empetrum nigrum*	Woody plant	
Ericaceae	*Andromeda polifolia*	Woody plant	
Ericaceae	*Calluna vulgaris*	Woody plant	
Ericaceae	*Rhododendron tomentosum*	Woody plant	
Ericaceae	*Vaccinium myrtillus*	Woody plant	
Ericaceae	*Vaccinium oxycoccos*	Woody plant	
Ericaceae	*Vaccinium uliginosum*	Woody plant	
Ericaceae	*Vaccinium vitis-idaea*	Woody plant	
Ericaceae	*Arctostaphylos uva-ursi*	Woody plant	
Grossulariaceae	*Ribes alpinum*	Woody plant	
Lamiaceae	*Stachys sylvatica*	Woody plant	
Myricaceae	*Myrica gale*	Woody plant	
Oleaceae	*Fraxinus excelsior*	Woody plant	
Pinaceae	*Pinus sylvestris*	Woody plant	
Rhamnaceae	*Frangula alnus*	Woody plant	

Rosaceae	*Comarum palustre*	Woody plant
Rosaceae	*Crataegus sp.*	Woody plant
Rosaceae	*Prunus padus*	Woody plant
Rosaceae	*Rosa dumalis*	Woody plant
Rosaceae	*Rosa rugosa*	Woody plant
Rosaceae	*Rubus idaeus*	Woody plant
Rosaceae	*Sorbus aucuparia*	Woody plant
Rosaceae	*Rosa villosa*	Woody plant
Salicaceae	*Populus tremula*	Woody plant
Salicaceae	*Salix caprea*	Woody plant
Salicaceae	*Salix cinerea*	Woody plant
Salicaceae	*Salix pentandra*	Woody plant
Tiliaceae	*Tilia cordata*	Woody plant
Ulmaceae	*Ulmus glabra*	Woody plant
Fagaceae	*Quercus robur*	Woody plant

Appendix 3. Detailed list of vascular plant species in Beijing Botanical Garden

Family	Species	Life form	Number of species with this life form
Asteraceae	*Conyza canadensis*	Graminoid	2
Poaceae	*Oplismenus undulatifolius*	Graminoid	
Alangiaceae	*Alangium chinense*	Herb	27
Amaranthaceae	*Amaranthus tricolor*	Herb	
Apiaceae	*Sium suave*	Herb	
Balsaminaceae	*Impatiens balsamina*	Herb	
Boraginaceae	*Trigonotis peduncularis*	Herb	
Caesalpiniaceae	*Gleditsia sinensis*	Herb	
Caryophyllaceae	*Cerastium arvense*	Herb	
Commelinaceae	*Commelina benghalensis*	Herb	
Compositae	*Dendranthema indicum*	Herb	
Compositae	*Galinsoga parviflora*	Herb	
Compositae	*Inula helenium*	Herb	
Compositae	*Hemistepta lyrata*	Herb	
Cornaceae	*Cornus officinalis*	Herb	
Cyperaceae	*Scirpus validus*	Herb	
Fabaceae	*Gueldenstaedtia multiflora*	Herb	
Fabaceae	*Lespedeza cuneata*	Herb	
Iridaceae	*Iris ensata*	Herb	
Iridaceae	*Iris pseudacorus*	Herb	
Lamiaceae	*Lagopsis marrubiactrum*	Herb	
Lamiaceae	*Leonurus artemisia*	Herb	
Lauraceae	*Lindera angustifolia*	Herb	

Liliaceae	*Liriope spicata*	Herb	
Liliaceae	*Asparagus officinalis*	Herb	
Liliaceae	*Aspargus setacens*	Herb	
Linaceae	*Linum perenne*	Herb	
Lythraceae	*Lythrum salicaria*	Herb	
Polygonaceae	*Rumex patientia*	Herb	
Polygonaceae	*Polygonum auberti*	Vine	1
Aceraceae	*Acer ginnala*	Woody plant	83
Aceraceae	*Acer griseum*	Woody plant	
Aceraceae	*Acer negundo*	Woody plant	
Aceraceae	*Acer tataricum*	Woody plant	
Aceraceae	*Acer truncatum*	Woody plant	
Anacardiaceae	*Rhus chinensis*	Woody plant	
Anacardiaceae	*Rhus potaninii*	Woody plant	
Anacardiaceae	*Rhus typhina*	Woody plant	
Begoniaceae	*Begonia sinensis*	Woody plant	
Berberidaceae	*Berberis koreana*	Woody plant	
Caesalpiniaceae	*Cercis yunnanensis*	Woody plant	
Caesalpiniaceae	*Cercis canadensis*	Woody plant	
Caesalpiniaceae	*Gleditsia japonica*	Woody plant	
Caesalpiniaceae	*Gymnocladus dioicus*	Woody plant	
Caprifoliaceae	*Kolkwitzia amabilis*	Woody plant	
Caprifoliaceae	*Lonicera ferdinandii*	Woody plant	
Caprifoliaceae	*Lonicera maackii*	Woody plant	
Caprifoliaceae	*Lonicera tatarica*	Woody plant	
Caprifoliaceae	*Symphoricarpos orbiculatus*	Woody plant	
Caprifoliaceae	*Viburnum sargentii*	Woody plant	
Caprifoliaceae	*Weigela coraeensis*	Woody plant	
Cephalotaxaceae	*Cephalotaxus sinensis*	Woody plant	
Compositae	*Myripnois dioica*	Woody plant	
Cornaceae	*Cornus alba*	Woody plant	
Cupressaceae	*Platycladus orientalis*	Woody plant	
Elaeagnaceae	*Elaeagrus umbellate*	Woody plant	
Ericaceae	*Rhododendron mucronulatum*	Woody plant	
Ericaceae	*Rhododendron micranthum*	Woody plant	
Eucommiaceae	*Eucommia ulmoides*	Woody plant	
Fabaceae	*Amorpha fruticosa*	Woody plant	
Fabaceae	*Colutea arborescens*	Woody plant	
Fabaceae	*Lespedeza bicolor*	Woody plant	
Fabaceae	*Lespedeza floribunda*	Woody plant	
Fabaceae	*Lespedeza thunbergii*	Woody plant	
Fabaceae	*Piptanthus concolor*	Woody plant	
Fabaceae	*Sophora viciifolia*	Woody plant	
Ginkgoaceae	*Ginkgo blob*	Woody plant	

Hydrangeaceae	*Deutzia parviflora*	Woody plant
Hydrangeaceae	*Philadelphus pekinensis*	Woody plant
Juglandaceae	*Pterocarya stenoptera*	Woody plant
Lamiaceae	*Elsholtzia stauntonii*	Woody plant
Labiatae	*Salvia plebeian*	Woody plant
Lythraceae	*Lagerstroemia chekiangensis*	Woody plant
Lythraceae	*Lagerstroemia indica*	Woody plant
Magnoliaceae	*Magnolia biondii*	Woody plant
Magnoliaceae	*Magnolia denudata*	Woody plant
Mimosaceae	*Albizia julibrissin*	Woody plant
Moraceae	*Broussonetia papyrifera*	Woody plant
Moraceae	*Morus alba*	Woody plant
Nyctaginaceae	*Mirabilis jalapa*	Woody plant
Oleaceae	*Ligustrum obtusifolium*	Woody plant
Oleaceae	*Fontanesia fortunei*	Woody plant
Polygonaceae	*Polygonum orientale*	Woody plant
Ranunculaceae	*Clematis heracleifolia*	Woody plant
Rhamnaceae	*Zizyphus jujuba*	Woody plant
Rhamnaceae	*Rhamnus parvifolia*	Woody plant
Rosaceae	*Chaenomeles japonica*	Woody plant
Rosaceae	*Cotoneaster horizontalis*	Woody plant
Rosaceae	*Cotoneaster multiforus*	Woody plant
Rosaceae	*Cotoneaster divaricatus*	Woody plant
Rosaceae	*Cotoneaster sternianus*	Woody plant
Rosaceae	*Crataegus cuneata*	Woody plant
Rosaceae	*Crataegus kansuensis*	Woody plant
Rosaceae	*Exochorda racemosa*	Woody plant
Rosaceae	*Prinsepia sinensis*	Woody plant
Rosaceae	*Prunus japonica*	Woody plant
Rosaceae	*Prunus tomentosa*	Woody plant
Rosaceae	*Sorbaria kirilowii*	Woody plant
Rosaceae	*Rosa hugonis*	Woody plant
Rosaceae	*Rosa primula*	Woody plant
Rosaceae	*Rosa roxburghii*	Woody plant
Rosaceae	*Rosa xanthina*	Woody plant
Rosaceae	*Rhodotypos scandens*	Woody plant
Rutaceae	*Evodia daniellii*	Woody plant
Rutaceae	*Ptelea trifoliate*	Woody plant
Rutaceae	*Zanthoxylum bungeanum*	Woody plant
Sapindaceae	*Xanthoceras sorbifolia*	Woody plant
Simaroubaceae	*Ailanthus altissima*	Woody plant
Taxaceae	*Taxus cuspidata*	Woody plant
Ulmaceae	*Celtis koraiensis*	Woody plant
Verbenaceae	*Callicarpa dichotoma*	Woody plant

Verbenaceae	*Vitex negundo*	Woody plant
Vitaceae	*Parthenocissus tricuspidata*	Woody plant

Appendix 4. Chi square test results between locations by families. The first line gives the observed values, the second the expected, and the third the contribution to Chi-square.

	Uppsala	Beijing	Total
Rosaceae	17	17	34
	21.62	12.38	
	0.986	1.722	
Poaceae	16	1	17
	10.81	6.19	
	2.493	4.353	
Cyperaceae	15	1	16
	10.17	5.83	
	2.291	3.999	
Asteraceae	14	6	20
	12.72	7.28	
	0.130	0.226	
Fabaceae	10	9	19
	12.08	6.92	
	0.358	0.625	
Ericaceae	8	2	10
	6.36	3.64	
	0.424	0.740	
Apiaceae	7	1	8
	5.09	2.91	
	0.720	1.257	
Lamiaceae	7	4	11
	6.99	4.01	
	0.000	0.000	
Ranunculaceae	5	1	6
	3.81	2.19	
	0.368	0.643	
Caprifoliaceae	3	7	10
	6.36	3.64	
	1.774	3.096	
Aceraceae	1	5	6
	3.81	2.19	
	2.077	3.626	
Caesalpiniaceae	0	5	5
	3.18	1.82	
	3.179	5.550	
Total	103	59	162