Ecological and Evolutionary Consequences of Two Distinct Modes of Speciation in Plants

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Ecological and evolutionary consequences of two distinct modes of speciation in plants

A dissertation presented

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ECOLOGICAL AND EVOLUTIONARY CONSEQUENCES OF TWO DISTINCT MODES OF SPECIATION IN PLANTS

ABSTRACT

Speciation—the evolutionary process by which new species arise—can occur through genetic divergence maintaining the ploidy—the number of complete sets of chromosomes in the cells—of the descendant lineages relatively unchanged (i.e., homoploid speciation) or through drastic changes in ploidy associated with whole-genome duplications (i.e., polyploid speciation). In this thesis, I use the *Arabidopsis arenosa* species complex and the Angiosperm family Brassicaceae to explore different hypotheses about the ecological and evolutionary consequences of these two distinct modes of speciation in plants. The *A. arenosa* complex includes at least three highly divergent diploid lineages and one recently formed polyploid lineage. In chapter 1, I explore the potential consequences of human-induced global warming on one instance of homoploid speciation in *A. arenosa*. Here, I offer empirical evidence supporting the hypothesis that climate-induced range shifts may increase sympatry between two parapatric lineages and demonstrate that rising temperatures will undermine reproductive isolation by increasing the probability of introgressive hybridization. Next, in chapter 2, I evaluate the ecological consequences of the recent case of polyploid speciation in *A. arenosa*. Here, I find no evidence supporting the hypothesis that successful establishment of neopolyploids is contingent on climatic niche shifts from their diploid progenitors, but I show how this neopolyploid lineage has significantly expanded its niche instead. Finally, in chapter 3, I study the long-term evolutionary consequences of polyploidy in the family Brassicaceae which exhibits an extensive inter-specific variation in chromosome numbers and a high incidence of polyploid species. Here, I show macroevolutionary evidence supporting the hypothesis that polyploidy has significant effects on the long-term diversification of lineages, contradicting the traditional model that considers polyploidy as an evolutionary dead-end. Altogether, this dissertation contributes to our understanding of the short- and long-term ecological and evolutionary consequences of homoploid vs. polyploid modes of speciation.

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CONTRIBUTIONS

Introduction: Y. Franchesco Molina-Henao (YFMH) wrote the text.

Chapter 1: YFMH conceived the ideas, collected and analysed the data; YFMH and Robin Hopkins (RH) wrote and discussed the ideas on the text.

Chapter 2: YFMH conceived the ideas, collected and analysed the data; YFMH and RH wrote and discussed the ideas on the text. Chapter 2 has previously been published as the following paper:

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Chapter 3: YFMH and Cristian Román-Palacios (CRP) conceived the ideas, collected and analysed the data; YFMH, CRP and Mike Barker wrote and discussed the ideas on the text.

Conclusions and future directions: YFMH wrote the text.

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INTRODUCTION

A central goal in evolutionary biology is to explain the processes that generate and maintain biodiversity on our planet. Speciation is the evolutionary process by which lineages diverge to become reproductively isolated entities known as species (Coyne and Orr, 2004, Sobel et al., 2010). Pragmatically, here I distinguish two modes of speciation based on the ploidy—the number of complete sets of chromosomes in the cells—of the descendant lineages. Speciation can occur by maintaining the ploidy of the descendant lineages relatively unchanged (i.e., homoploid speciation). Alternatively, speciation can happen by drastic changes in ploidy associated with whole-genome duplications (i.e., polyploid speciation). I use the sand rock-cress or *Arabidopsis arenosa* species complex, and the mustard family or Brassicaceae to explore different hypotheses about the ecological and evolutionary consequences of these two distinct modes of speciation in plants.

The *A. arenosa* complex is an obligate outcrosser that includes diploid and polyploid populations. Diploid populations (2n = 2x = 16 chromosomes) are split into three highly divergent lineages (Kolář et al., 2016a, Monnahan et al., 2018) known as Carpathian, Dinaric, and Pannonian, according to their respective ecogeographical region. The Carpathian lineage is found in the mid-altitudes to high altitudes of the western Carpathians in Slovakia, and mid-altitudes of southern and eastern Carpathians in Romania and the southern Dinarides in Serbia. The Carpathian lineage also includes diploid populations found along the Baltic sea coast. The Dinaric lineage is found in the foothills of the Dinaric Alps and their surroundings in Slovenia, Croatia, and Bosnia and

Herzegovina. The Pannonian lineage is found in the Pannonian lowlands of Hungary and southern Slovakia. The Carpathian and Dinaric lineages diverged approximately 650,000 generations ago, whereas the Pannonian lineage diverged approximately 760,000 generations ago from the Carpathian-Dinaric ancestor (Kolář et al., 2016a). In chapter 1, I explore the potential consequences of human-induced global warming on the divergence between the Carpathian and Pannonian diploid lineages in *A. arenosa*—one instance of homoploid speciation.

Human-induced climate change may result in extraordinary increases in global temperature, which is predicted to have a significant effect on biodiversity loss during the twenty-first century (Sala et al., 2000). For instance, climate-induced range shifts could increase sympatry between previously isolated species which could increase introgressive hybridization and, consequently, weaken reproductive isolation (RI) (Becker et al., 2013, Garroway et al., 2010). Here, in chapter 1, I offer empirical evidence supporting the hypothesis that climate-induced range shifts may increase sympatry between the Carpathian and Pannonian lineages which currently exhibit parapatric distributions. Also, I demonstrate that increasing temperatures undermine reproductive isolation by increasing the probability of introgressive hybridization from the Pannonian into the Carpathian genomes.

Polyploid *A. arenosa* populations (2n = 4x = 32 chromosomes) are broadly distributed through Central and Northern Europe. The widespread tetraploid is an autopolyploid lineage since it shows no evidence of chromosome pairing preference during meiotic segregation (Hollister et al., 2012, Arnold et al., 2015, Arnold et al., 2016) due to having four sets of chromosomes derived from the same ancestral lineage. The autotetraploids likely originated from a single ancestral population that arose approximately 11,000-30,000 generations ago in the Carpathian Mountains, where its closest living diploid relatives are still found (Monnahan et al., 2018, Arnold et al., 2015), and the two cytotypes broadly overlap (Schmickl et al., 2012, Kolář et al., 2016b). In chapter 2, I evaluate the ecological consequences of the recent transition from the Carpathian diploids to the widespread autotetraploids in *A. arenosa*—one case of polyploid speciation.

The success of a new polyploid lineage is thought to be mostly dependent on its ability to ecologically diverge from the progenitor lineage(s) to avoid competing with and mating with them (Fowler and Levin, 1984, Levin, 1983, Levin, 2002, Levin, 1975). Although this has been a long-standing hypothesis, recent advances in niche analyses provide novel insights into whether and how the successful establishment of polyploid lineages involves shifts in their niches (Parisod and Broennimann, 2016). In chapter 2, I find no evidence supporting the hypothesis that successful establishment of *A. arenosa* autotetraploids is contingent on climatic niche divergence from their Carpathian diploid progenitors. In contrast, I show a significant climatic niche expansion in the autotetraploids in a relatively short time.

The long-term evolutionary significance of polyploidy is still debated (Soltis et al., 2009, Van de Peer et al., 2009, Mayrose et al., 2011, Arrigo and Barker, 2012, Tank et al., 2015). Discussions on the evolutionary role of polyploidy in plant evolution date back to Stebbins (1970) and Wagner (1970) who considered polyploidy to have negligible effects on the long-term evolution of lineages which induced the idea of polyploidy as an evolutionary ‘dead-end.’ Recently, the ‘dead-end’ hypothesis has been reformulated to predict that polyploids undergo extinction more frequently than diploids (Mayrose et al., 2011, Arrigo and Barker, 2012, Wood et al., 2009, Mayrose et al., 2015, Estep et al., 2014). However, in chapter 3, colleagues and I show evidence to claim that polyploidy influence the long-term evolution of lineages regardless of whether polyploids are more likely to go extinct than diploids.

Here, we use the family Brassicaceae to examine the role of ploidy in driving macroevolution. The Brassicaceae is a speciose clade (c.a. 3500 species) that includes several major crop plants and numerous model genera in evolutionary research such as *Arabidopsis* itself (Al-Shehbaz et al., 2006, Beilstein et al., 2006, Hohmann et al., 2015). The Brassicaceae exhibits extensive inter-specific variation in chromosome numbers and high incidence of polyploid species (Wood et al., 2009, Rice et al., 2015, Lysak, 2018). In chapter 3, I used a compiled ploidy database, along with the Brassicaceae phylogeny, to show that polyploid lineages have experienced faster rates of speciation and extinction than diploids. Moreover, even though net diversification rates were faster in diploids, both polyploids and diploids diversify at positive rates. Importantly, we also found species turnover rates to be higher in polyploids and differences in species richness among genera to be positively influenced by polyploidy. Therefore, we conclude that polyploidy is a major source of evolutionary novelty within clades, that has significant implications in driving present-day diversity patterns in the Brassicaceae.

In summary, this dissertation contributes to our understanding of the short- and long-term ecological and evolutionary consequences of both homoploid and polyploid modes of speciation.

CHAPTER 1

Global warming could undermine reproductive isolation between parapatric lineages in *Arabidopsis arenosa*

1.1 Abstract

Human-induced climate change is predicted to cause a significant loss of biodiversity through a variety of proximate mechanisms. The homogenization of diversity through increased species hybridization is one of the more poorly understood mechanisms. Reproductive isolation (RI) between closely related species may decline as a result of increased sympatry due to climate-induced range shifts, and yet empirical evidence connecting aspects of climate change to ecogeographical changes and decreases in RI remain elusive. Here, we combine predictive distribution modeling with a large-scale manipulative experiment to evaluate if and how hybridization will increase due to decreased RI in response to climate change in the *Arabidopsis arenosa* complex. We find that climate-induced range shifts are predicted to significantly increase sympatry between two distinct *A. arenosa* lineages (Carpathian vs. Pannonian). Furthermore, key reproductive barriers to gene flow are highly sensitive to temperature and are predicted to decrease with warmer climates significantly. Surprisingly, the most temperature-dependent barriers are related to fertility, which is classically assumed to be insensitive to the environment. Our findings demonstrate that the invasion of the Pannonians into the Carpathian suitable habitats in a future global warming scenario will not only increase the probability of heterospecific crosses because increased sympatry but may also facilitate the invasion of the Pannonian genetic diversity into the Carpathian genomes through loss of environmentally-dependent RI barriers.

1.2 Introduction

Human-induced climate change, and specifically increases in temperature (Karl and Trenberth, 2003), will likely cause a significant loss of biodiversity in the twenty-first century (Parmesan, 2006). This predicted loss motivates the need to understand how elevated temperatures directly affect the evolutionary processes that generate and maintain biodiversity. Specifically, climate change can increase hybridization between species by expanding range overlap between closely related species and by interfering with traits that maintain reproductive isolation between species (Garroway et al., 2010, Becker et al., 2013, Muhlfeld et al., 2014, Vallejo-Marín and Hiscock, 2016). This increase in hybridization can have severe fitness consequences in populations (Muhlfeld et al., 2014), cause genomic instability (Allendorf et al., 2001), and decrease local species diversity through extinction or homogenization (Rhymer and Simberloff, 1996). It is important to understand if increases in hybridization are due merely to the increased opportunity for heterospecific matings from expanded sympatric zones, or if the environmental change will directly affect the traits that prohibit reproduction and gene flow between species.

The mechanisms that limit the opportunity or success of heterospecific matings are known as reproductive isolating (RI) barriers. These barriers can be either environmentally-dependent (i.e., intrinsic RI) or environmentally-dependent (i.e., extrinsic RI) (Coyne and Orr, 2004). Intrinsic isolation typically includes barriers such as hybrid inviability and sterility that are thought to be invariable to biotic and abiotic environmental context. Extrinsic isolation includes barriers such as ecological maladaptation and environmentally-dependent behavioral or life-history timing mismatches. Extrinsic RI barriers are susceptible to climate change induced variation that could cause significant increases in hybridization and gene flow between species. Evaluating the strength of barriers to reproduction under manipulated environmental conditions is a powerful method for predicting how climate changes will affect RI and thus the possibility for gene flow in a changing climate.

Climate is predicted to change in many ways across multiple axes, but an increase in temperature is one of the most anticipated results of this multidimensional phenomenon (Karl and Trenberth, 2003, Rosenzweig et al., 2008). Temperature is also one of the most relevant environmental cues for the biology of organisms as it regulates everything from metabolism to life-history timing to ecosystem functioning (Angilletta, 2009, Kingsolver, 2009). The predicted changes in temperature, the importance of temperature to relevant biological processes, and the feasibility of manipulating temperature in controlled experiments make this component of climate change ideal for manipulative experiments to identify extrinsic RI susceptible to climate-change variation.

Here we investigate the extent to which climate change (specifically temperature) will increase hybridization between divergent lineages in the *Arabidopsis arenosa* complex. We predict the extent to which range expansions and shifts will increase sympatry between the two lineages and determine how variation in temperature affects the strength of RI barriers. *A. arenosa* is an obligate outcrosser closely related to *A. lyrata* and the genetic model plant *A. thaliana* (Al-Shehbaz and O'Kane, 2002), which includes diploid and recently formed autotetraploid populations (Arnold et al., 2015). The two most divergent diploid lineages (which diverged approximately 760,000 generations ago (Kolář et al., 2016a)) are found in central Europe Carpathian Mountains and Pannonian Basin respectively. These lineages occupy parapatric ranges restricted by distinct climatic niches that differ along an altitudinal gradient (Kolář et al., 2016a). The Carpathian lineage inhabits in the mid- to high-altitudes of the western Carpathians in Slovakia, and mid-altitudes of southern and eastern Carpathians in Romania and the south Dinarides in Serbia. The Pannonian lineage inhabits the Pannonian lowlands of Hungary and south Slovakia. We modeled and compared the current and future distribution of suitable habitats for the Carpathian and Pannonian lineages to estimate the effects of climate on their geographic distributions. Then, we calculated the strength of RI barriers between these lineages across different temperatures to determine which extrinsic barriers will vary with temperature.

1.3 Results and discussion

We found that the environmental niches between the Carpathian and Pannonian lineages are significantly divergent along the temperature gradient. Moreover, we show that climate change scenarios predict dramatic shifts in their geographic ranges which would increase the probability of sympatry between these parapatric lineages considerably. Therefore, we determined the temperature sensitivity of reproductive isolation (RI) by experimentally measure RI between the Carpathian and Pannonian lineages in four different temperatures. Then, we offer empirical evidence supporting the hypothesis that climate-induced range shifts may increase sympatry between two parapatric lineages and demonstrate that rising temperatures further undermine reproductive isolation by increasing the probability of introgressive hybridization, specifically from the Pannonian into de Carpathian genomes.

Environmental niche modeling — The two divergent Carpathian and Pannonian *A. arenosa* lineages currently occupy distinct niche space with a mere 0.2% overlap (Schoener's $D = 0.002$). Tests of niche divergence based on Schoener's D demonstrate that the two niches are neither equivalent ($P < 0.001$) nor similar (Carpathian compared to background: $P = 0.703$ and Pannonian compared to background: $P = 0.733$). The climatic space inhabited by the two lineages varies extensively with the first two axes of our principal components' analysis (PCA-env) explaining 69.18% of the total variance observed in the climatic dataset. PC1 corresponds to a precipitation axis and describes 38.22% of the variance with BIO12 (annual precipitation) and BIO17 (precipitation of driest quarter) having the most significant contributions. PC2 corresponds to a temperature axis and describes 30.96%

of the variance with BIO1 (annual mean temperature) and BIO10 (mean temperature of the warmest quarter) having the most significant contributions (Fig. 1.1; Table S1.2).

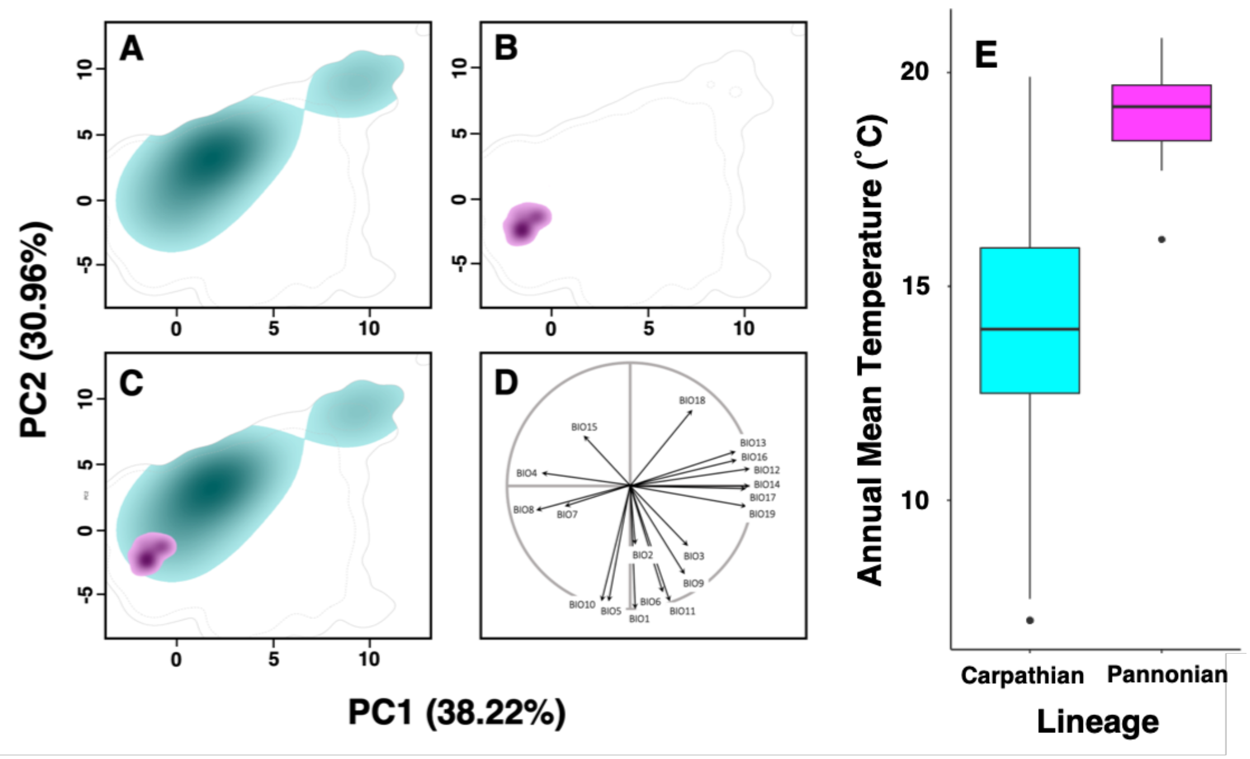

Figure 1.1 Comparison of environmental niche models between Carpathian (N = 103) and Pannonian (N = 27) *Arabidopsis arenosa* lineages in Central Europe. **A.** Carpathian niche model. **B.** Pannonian niche model. **C.** Overlap between Carpathian and Pannonian models. Continuous gray line delimits the full environmental space available within the background area; dashed gray line delimits the percentile 75 of the environmental space available within the background area. Darker shading indicates a higher density of presence data. **D.** Correlation circle of WorldClim variables used in the PCA-env (Complete list of climatic variables and respective contributions at table S1.2). **E.** Comparison of distributions of BIO1 variable (Annual Mean Temperature) between Carpathian and Pannonian lineages. BIO1 is the variable with the greatest contribution to PC2 or temperature axis**.**

Predictive habitat distribution modeling**—**We performed predictive habitat distribution modeling to determine if the sympatry between the Carpathian and Pannonian lineages may increase under future scenarios of climate change. Specifically, we compared the current and two future (2050 and 2070) distributions of suitable habitats for each lineage and quantified the overlapping between such distributions of suitability through time. We predict a significant increase in suitable habitat for the Pannonian lineage in both 2050 and 2070, with a corresponding decrease in suitable habitat for the Carpathian lineage. These range shifts increase the overlap of suitable habitats from ~6.60% in current conditions, to ~27.54% in 2050, and ~35.17% in 2070 (Fig. 1.2). Therefore, climate change is predicted to result in a substantial increase in potential sympatry between both lineages in the future.

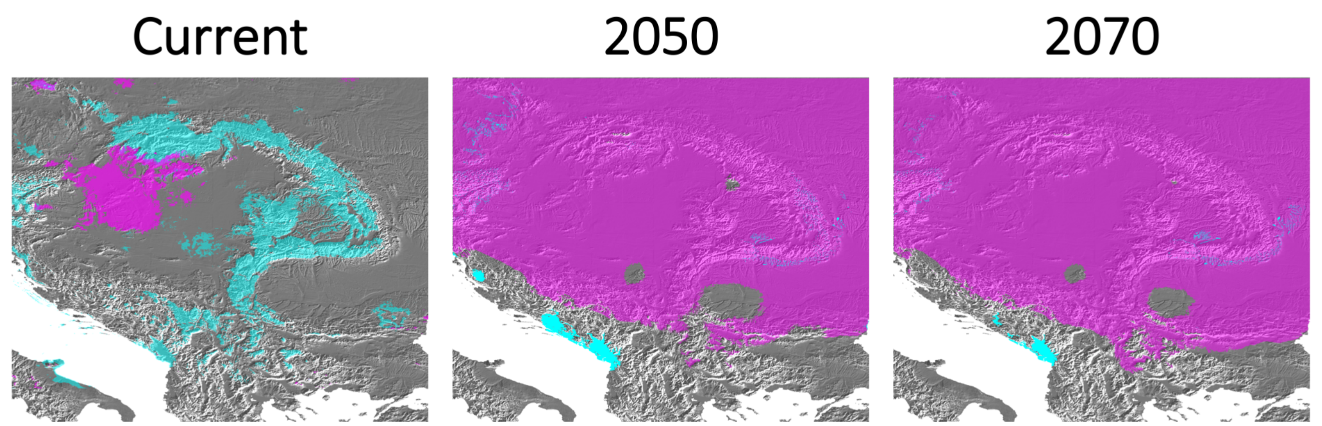

Figure 1.2 Overall predicted changes in climatically suitable habitats for each lineage of *A. arenosa*. Blue areas indicate suitable habitat for the Carpathian lineage, pink areas indicate suitable habitat for the Pannonian lineage.

Experimental measurements of RI **—**To determine if changes in climate are predicted to increase hybridization by decreasing extrinsic RI barriers, we experimentally quantified key barriers to gene flow between the Carpathian and Pannonian lineage across four different temperatures. We generated experimental half-sib seeds families from four “cross-types” (maternal region X paternal region) including two parental types - Carpathian X Carpathian (CXC) and Pannonian X Pannonian (PXP), and two hybrid types - Carpathian X Pannonian (CXP) and Pannonian X Carpathian (PXC). We divided each half-sib family between four temperature treatments (9°C, 14°C, 19°C, and 24°C) and measured a suite of phenotypes related to plant viability and fertility (including germination, survival to flowering, flowering, flowering time, pollen viability, and seed set from controlled crosses). We determined how these traits varied due to cross-type and temperature and calculated the strength of RI from these traits at each temperature.

We used Generalized Linear Mixed Models (GLMMs) to test if cross-type (CXC, PXP, CXP, and PXC), temperature, and the interaction of these two main effects explained variation in the measured traits. We tested for significant barriers to gene flow by comparing parent phenotypes to each other and to hybrids (as indicated by a cross-type effect). We tested for a significant change in RI across environments by testing for a significant interaction between cross-type and temperature. We found variation in germination, flowering time, pollen viability, and seed set were significantly predicted by a cross-type by temperature interaction, while survival was significantly predicted by cross type. We found that whether individuals flowered depending only on temperature but not on either cross-type or an interaction of cross-type and temperature (Table 1.1).

This significant interaction between temperature and cross type in many of our models indicates that the different parental and hybrid cross-types vary in their phenotypic response to temperature (Table 1.1). For seed germination we found that individuals from the warmer Pannonian lineage (PXP) and hybrid cross-type with

Pannonian mothers and Carpathian fathers (PXC) had consistent germination rates across temperatures but that Carpathian individuals (CXC) and the CXP hybrids had higher rates of germination in warmer temperatures (Fig. 1.3a, Table S1.3). Variation in survival until vernalization (termed early survival) showed a significant effect of cross-type, but each cross-type was consistent across temperature treatments (Table 1.1). All cross-types showed a similar increase in the proportion of flowering plants with increasing temperature (Fig. 1.3c, Table S1.3). Since we found no effect of either cross-type nor an interaction of cross-type and temperature, we excluded flowering from the calculations of reproductive isolation (Table 1.1). We did find the interaction between temperature and cross-type explained that variation in flowering time. In general, all cross-types flower faster at higher temperatures. However, the relative timing of each cross-type varied across temperature (Fig. 1.3g, Table S1.3). We also found a significant interaction between cross-type and temperature affecting pollen viability (Table 1.1). Consistent with local adaptation to a colder climatic niche, CXC pollen viability was substantially lower in warmer temperatures than in colder temperatures. The other cross-types had consistently high pollen viability across all temperatures (Fig. 1.3d, Table S1.3). Similar to results with pollen viability, CXC cross-type had lower seed set at warmer temperatures, with the rest of the cross-types having a general positive correlation between seed set and temperature (Figs. 1.3e and 1.3f, Table S1.3). (Fig. 1.3f, Table S1.3).

Table 1.1 Generalized Linear Mixed Models (GLMM) for the seven phenotypes evaluated. Significant effects (P-value < 0.05) are indicated in bold fonts.

RESPONSE VARIABLE	**FIXED EFFECTS** **Wald X^2 (df)** ***P-value***					**RANDOM EFFECTS** **Variance**		**R^2 (95% CI)**
	Temperature	**Cross**	**Temperature x Cross**	**Mother Population**	**Father Population**	**Mother ID**	**Father ID**	
Germination	**77.425 (1)** ***< 0.001***	**115.371 (3)** ***< 0.001***	**67.880 (3)** ***< 0.001***	**8.191 (2)** ***0.017***	**7.604 (2)** ***0.022***	0.499	0.971	0.144 (0.128-0.164)
Survival	0.383 (1) *0.536*	**17.261 (3)** ***< 0.001***	4.025 (3) *0.259*	0.365 (2) *0.833*	0.195 (2) *0.907*	< 0.001	< 0.001	0.014 (0.009-0.027)
Flowering	**83.638 (1)** ***< 0.001***	5.882 (3) *0.117*	2.563 (3) *0.464*	**16.220 (2)** ***< 0.001***	4.052 (2) *0.132*	< 0.001	< 0.001	0.054 (0.041-0.080)
Flowering Time	**547.270 (1)** ***< 0.001***	3.840 (3) *0.323*	**19.460 (3)** ***< 0.001***	**20.770 (3)** ***< 0.001***	-5.140 (3) *> 0.999*	< 0.001	NA	NA
Pollen Viability	**16.644 (1)** ***< 0.001***	**105.401 (3)** ***< 0.001***	**68.118 (3)** ***< 0.001***	3.859 (2) *0.145*	3.318 (2) *0.190*	< 0.001	< 0.001	0.286 (0.243-0.343)
Seed Set	**172.173 (1)** ***< 0.001***	**990.907 (7)** ***< 0.001***	**792.529 (7)** ***< 0.001***	0.820 (2) *0.664*	0.382 (2) *0.826*	7.227	< 0.001	0.842 (0.827-0.858)

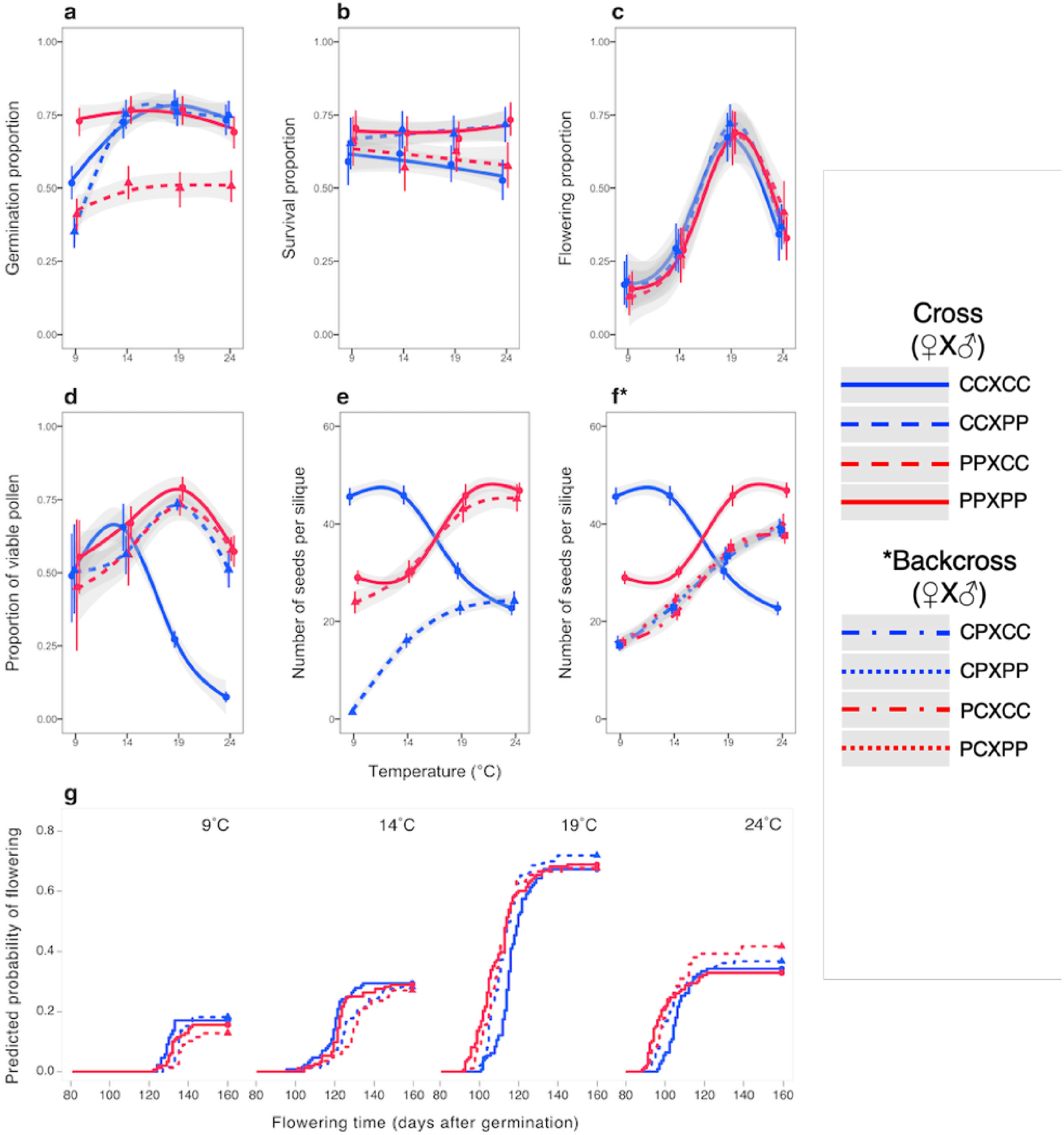

Figure 1.3 Phenotypes responses to temperature. a. Germination proportion**. b.** Survival proportion**. c.** Flowering proportion. **d.** Pollen viability**. e-f.** Seed set**. g.** Flowering time.

***Quantifying reproductive barriers*—** We calculated how traits contributed to reproductive isolation through reduction in gene flow from the Carpathians into the Pannonia ($RI_{Car \rightarrow Pan}$) lineages and gene flow from the Pannonia into the Carpathians ($RI_{Pan \rightarrow Car}$) lineages (Table S1.4).

Premating isolation—We calculated premating RI as differences in seed germination, early survival and pollen viability between conspecific cross-types (i.e., PXP vs. CXC) across temperatures. The strength of premating RI between Carpathian and Pannonian lineages was highly dependent on temperature. Specifically, we found that lower germination of CXC than PXP seeds resulted in significant RI at 9°C. For early survival (to reproduction), we found the Pannonians have a 16.9% advantage over the Carpathians at the warmest temperature (24°C) (Fig. 1.4 and Table 1.2). We found variation in flowering time caused significant RI, but surprisingly, this was the only pre-mating barrier that did not vary across temperatures. Also, counter to most findings, we found a very strong environmental dependency of RI due to pollen sterility. The Pannonian lineage has a 48.6% and 76.8% of advantage over the Carpathian lineage in pollen viability at 19°C and 24°C respectively (Fig. 1.4 and Table 1.2).

Postmating isolation—We measured postmating RI by comparing seed set from within parental-type crosses to between-parental-type crosses to between hybrid and parental-type crosses. We also compared hybrid and parental cross-type germination, survival, flowering time, pollen viability. Again, we found significant temperature-dependent RI barriers from these traits. Specifically, we found that lower seed set in (PXP)XC than in PXP resulted in significant RI only at 9°C, while lower seed set in (CXC)XP than in CXC resulted in significant RI at 9°C, 14°C, and 19°C. Both heterospecific cross-types (CXP and PXC) had lower germination then both the parental cross-types resulting in similarly weak RI across temperatures. We found that hybrids survived better then CXC parental types at 19°C and 24°C indicating slight heterosis and negative RI. The hybrid cross-types flowered significantly earlier than the PXP parents resulting in significant RI across all temperatures. These hybrids flowered later then CXC at cold temperatures (9°C and 14°C) but flowered earlier at warmer temperatures (19°C and 24°C) resulting in significant RI across all temperatures but variable strengths (Fig. 1.4 and Table 1.2). We found very weak or no RI comparing hybrid pollen inviability to Pannonian plants. We found that hybrids showed strong heterosis for pollen viability compared to Carpathian plants in warm temperatures. Finally, we found that lower seed set in heterospecific cross-types ((CXP)XP and (PXC)XP) than in PXP resulted in significant RI across all temperatures. Once again we found temperature sensitive RI between hybrids and Carpathian plants such that hybrids had lower seed set at 9°C and 14°C but higher at 19°C and 24°C (Fig. 1.4 and Table 1.2).

Table 1.2 Summary of individual contributions of the different isolating barriers to reproductive isolation between the Carpathian and Pannonian lineages of *Arabidopsis arenosa*.

GENE FLOW SOURCE	**RI Pan→Car (95% CI)**				**RI Car→Pan (95% CI)**			
	9°C	**14°C**	**19°C**	**24°C**	**9°C**	**14°C**	**19°C**	**24°C**
PREMATING								
Germination	***-0.169*** ***(-0.233, -0.106)***	-0.028 (-0.076, 0.019)	0.014 (-0.030, 0.058)	0.029 (-0.022, 0.081)	**0.169** **(0.106, 0.233)**	0.028 (-0.019, 0.076)	-0.014 (-0.058, 0.030)	-0.029 (-0.081, 0.022)
Survival	-0.088 (-0.190, 0.015)	-0.055 (-0.156, 0.046)	-0.073 (-0.180, 0.035)	***-0.169*** ***(-0.276, -0.062)***	0.088 (-0.015, 0.190)	0.055 (-0.046, 0.155)	0.073 (-0.035, 0.180)	**0.169** **(0.062, 0.276)**
Flowering Time	**0.417** **(0.224, 0.610)**	**0.339** **(0.182, 0.495)**	**0.410** **(0.311, 0.509)**	**0.492** **(0.344, 0.640)**	**0.417** **(0.224, 0.610)**	**0.339** **(0.182, 0.495)**	**0.410** **(0.311, 0.509)**	**0.492** **(0.344, 0.640)**
Pollen Viability	-0.061 (-0.143, 0.022)	-0.012 (-0.062, 0.037)	***-0.486*** ***(-0.529, -0.443)***	***-0.768*** ***(-0.804, -0.732)***	0.061 (-0.022, 0.143)	0.012 (-0.037, 0.061)	**0.486** **(0.443, 0.529)**	**0.768** **(0.732, 0.804)**
POSTMATING								
Seed Set	**0.950** **(0.926, 0.974)**	**0.483** **(0.440, 0.526)**	**0.139** **(0.096, 0.182)**	-0.036 (-0.086, 0.014)	**0.102** **(0.048, 0.155)**	-0.005 (-0.050, 0.040)	0.035 (-0.006, 0.076)	0.021 (-0.015, 0.058)
Hybrid Germination	**0.152** **(0.077, 0.227)**	**0.066** **(0.020, 0.113)**	**0.112** **(0.070, 0.153)**	**0.076** **(0.030, 0.122)**	**0.314** **(0.257, 0.371)**	**0.094** **(0.051, 0.137)**	**0.098** **(0.055, 0.141)**	0.047 (-0.001, 0.095)
Hybrid Survival	-0.056 (-0.151, 0.039)	-0.018 (-0.111, 0.074)	***-0.099*** ***(-0.162, -0.035)***	***-0.109*** ***(-0.214, -0.004)***	0.033 (-0.049, 0.114)	0.034 (-0.052, 0.120)	0.008 (-0.078, 0.095)	0.060 (-0.018, 0.139)
Hybrid Flowering Time	**0.696** **(0.517, 0.876)**	**0.431** **(0.271, 0.591)**	**0.337** **(0.237, 0.437)**	**0.354** **(0.226, 0.483)**	**0.494** **(0.242, 0.746)**	**0.439** **(0.276, 0.601)**	**0.225** **(0.143, 0.307)**	**0.280** **(0.161, 0.399)**
Hybrid Pollen Viability	0.010 (-0.067, 0.086)	**0.075** **(0.025, 0.124)**	***-0.459*** ***(-0.500, -0.419)***	***-0.758*** ***(-0.794, -0.722)***	0.070 (-0.003, 0.142)	**0.087** **(0.046, 0.128)**	**0.034** **(0.005, 0.063)**	0.024 (-0.018, 0.067)
Hybrid Seed Set	**0.572** **(0.537, 0.607)**	**0.327** **(0.292, 0.362)**	***-0.041*** ***(-0.077, -0.005)***	***-0.214*** ***(-0.252, -0.176)***	**0.400** **(0.355, 0.444)**	**0.130** **(0.093, 0.166)**	**0.166** **(0.132, 0.200)**	**0.152** **(0.123, 0.181)**

able 1.3 Summary of absolute contributions of the different isolating barriers to reproductive isolation and estimation of total eproductive isolation between the Carpathian and Pannonian lineages of *Arabidopsis arenosa*.

GENE FLOW SOURCE	**RI Pan→Car (95% CI)**				**RI Car→Pan (95% CI)**			
	9◦C	**14◦C**	**19◦C**	**24◦C**	**9◦C**	**14◦C**	**19◦C**	**24◦C**
PREMATING								
Germination	***-0.169*** ***(-0.233, -0.106)***	-0.028 (-0.076, 0.019)	0.014 (-0.030, 0.058)	0.029 (-0.022, 0.081)	**0.169** **(0.106, 0.233)**	0.028 (-0.019, 0.076)	-0.014 (-0.058, 0.030)	-0.029 (-0.081, 0.022)
Survival	-0.103 (-0.223, 0.017)	-0.056 (-0.158, 0.047)	-0.071 (-0.177, 0.034)	***-0.166*** ***(-0.271, -0.062)***	0.074 (-0.012, 0.160)	0.053 (-0.045, 0.152)	0.074 (-0.034, 0.182)	**0.175** **(0.065, 0.285)**
Flowering Time	**0.534** **(0.284, 0.784)**	**0.370** **(0.197, 0.543)**	**0.435** **(0.318, 0.551)**	**0.564** **(0.386, 0.742)**	**0.321** **(0.167, 0.476)**	**0.318** **(0.168, 0.468)**	**0.388** **(0.280, 0.497)**	**0.431** **(0.292, 0.570)**
Pollen Viability	-0.051 (-0.118, 0.016)	-0.009 (-0.049, 0.026)	***-0.304*** ***(-0.390, -0.219)***	***-0.441*** ***(-0.607, -0.275)***	0.031 (-0.009, 0.071)	0.008 (-0.022, 0.037)	**0.273** **(0.191, 0.354)**	**0.329** **(0.183, 0.475)**
POSTMATING								
Seed Set	**0.752** **(0.471, 1.000)**	**0.348** **(0.242, 0.454)**	**0.132** **(0.084, 0.181)**	-0.038 (-0.091, 0.014)	**0.046** **(0.015, 0.076)**	-0.003 (-0.030, 0.024)	0.012 (-0.002, 0.026)	0.004 (-0.004, 0.012)
Hybrid Germination	0.007 (-0.059, 0.074)	**0.028** **(0.005, 0.052)**	**0.091** **(0.051, 0.131)**	**0.084** **(0.032, 0.135)**	**0.120** **(0.055, 0.185)**	**0.059** **(0.028, 0.091)**	**0.029** **(0.008, 0.050)**	0.007 (-0.007, 0.021)
Hybrid Survival	-0.003 (-0.036, 0.030)	-0.008 (-0.043, 0.028)	-0.048 (-0.120, 0.024)	***-0.111*** ***(-0.217, -0.004)***	0.011 (-0.014, 0.036)	0.021 (-0.028, 0.070)	0.003 (-0.021, 0.026)	0.009 (-0.011, 0.029)
Hybrid Flowering Time	0.021 (-0.268, 0.310)	**0.164** **(0.046, 0,282)**	**0.260** **(0.158, 0.362)**	**0.394** **(0.222, 0.567)**	**0.135** **(0.014, 0.257)**	**0.241** **(0.117, 0.365)**	**0.059** **(0.012, 0.105)**	0.027 (-0.040, 0.094)
Hybrid Pollen Viability	0.000 (-0.023, 0.022)	0.019 (-0.005, 0.042)	***-0.231*** ***(-0.340, -0.123)***	***-0.526*** ***(-0.789, -0.262)***	0.013 (-0.009, 0.035)	**0.028** **(0.004, 0.051)**	0.008 (-0.001, 0.017)	0.003 (-0.007, 0.013)
Hybrid Seed Set	0.001 (-0.293, 0.296)	0.060 (-0.028, 0.148)	***-0.032*** ***(-0.061, -0.004)***	***-0.265*** ***(-0.370, -0.160)***	0.044 (-0.054, 0.142)	**0.034** **(0.004, 0.064)**	0.031 (-0.002, 0.064)	0.010 (-0.028, 0.048)
TOTAL RI	**0.995** **(0.991, 0.999)**	**0.872** **(0.820, 0.924)**	**0.224** **(0.009, 0.440)**	-0.536 (-1.119, 0.046)	**0.921** **(0.873, 0.969)**	**0.759** **(0.663, 0.856)**	**0.843** **(0.800, 0.887)**	**0.944** **(0.922, 0.967)**

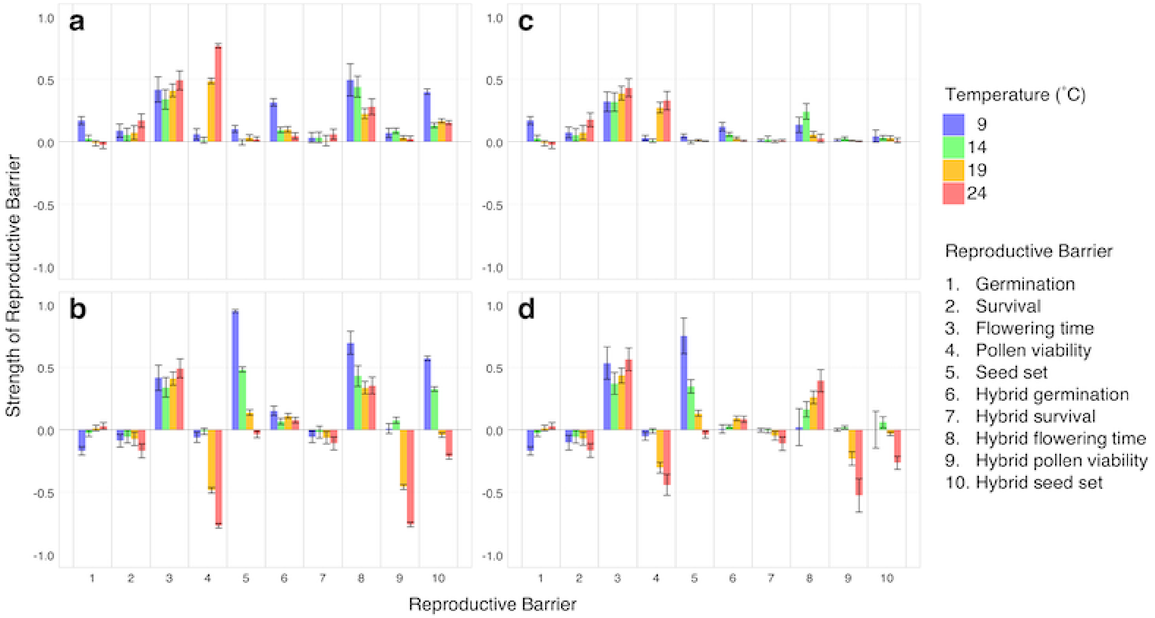

Figure 1.4 Strength of reproductive barriers across temperatures. a-b. Individual contribution: **a.** Reproductive isolation from the Carpathians into the Pannonians. **b.** Reproductive isolation from the Pannonians into the Carpathians. **c-d.** Absolute contribution: **c.** Reproductive isolation from the Carpathians into the Pannonians. **d.** Reproductive isolation from the Pannonians into the Carpathians

Total RI across temperatures— Total reproductive isolation between species reflects the accumulated effect of each pre- and post-zygotic barrier to gene flow. Carpathian and Pannonian lineages show highly temperature dependent total reproductive isolation. We find a nearly complete barrier to gene flow from the Carpathian lineages into the Pannonian lineages across all temperatures. Contrastingly, we found that reproductive isolation from the Pannonian lineage to the Carpathian lineage decreases from nearly complete to strongly negative as temperature increases. In other words, in cooler temperatures (9°C and 14°C) these two lineages can not generate viable and fertile hybrids, but as temperatures warm toward 24°C, the Carpathian individuals are predicted to mate more successfully with Pannonian and hybrid individuals than with other Carpathian individuals. This hybridization and differential mating success will lead to homogenization of genomic differentiation between these two lineages and swarming of the Carpathian genome.

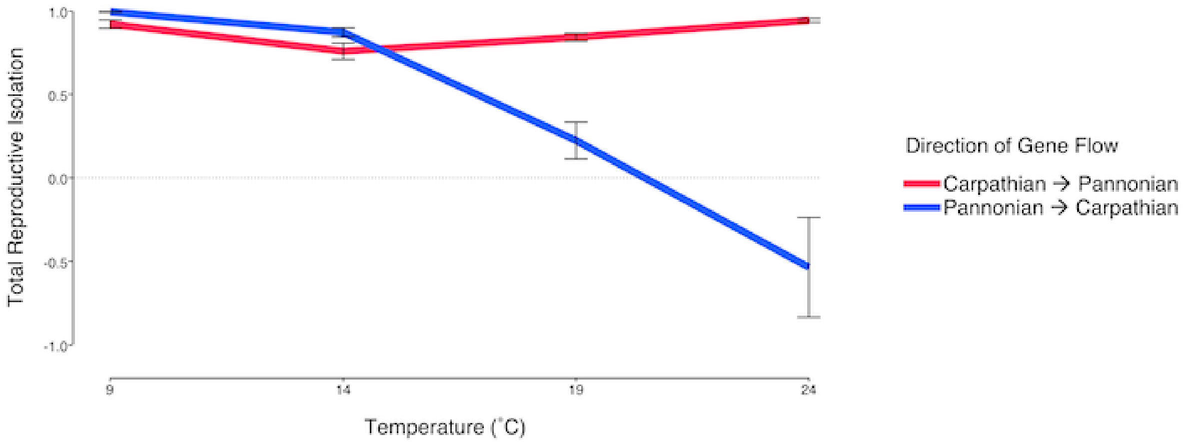

Figure 1.5 Total reproductive isolation across temperatures in both directions. Total isolation from the Carpathians into the Pannonians is stable across temperatures; however, total isolation from the Pannonians into the Carpathians is temperature sensitive reaching negative values at the highest temperature.

Climate change has long been hypothesized to cause significant loss of biodiversity. Here, we explore how the mechanisms that generate and maintain biodiversity are directly affected by an aspect of climate change – temperature. We demonstrate that range shifts due to predicted geographic changes in niche availability will drastically increase the co-habitation of currently isolated lineages. This increase in sympatry significantly increases the probability of mating between lineages. We also quantify how temperature variation, a major aspect of climate change, will directly affect the strength of reproductive isolating barriers between diverged lineages. We find that two lineages of *A. arenosa* have nearly complete barriers to reproduction at cold temperatures but with warming, these two lineages will be highly compatible and may actually be more successful mating disassortatively. Surprisingly, the temperature-dependent variation in RI results from variation in pollen viability and seed set. These are two traits traditionally thought to cause intrinsic RI that is independent of context. However, we find that one lineage significantly increases sterility with increasing temperature. This increase in sterility leads to a substantially higher reproductive success from between-lineages crosses than within lineage crosses. This significant reduction in RI associated with warming temperatures combined with increased sympatry will likely result in a complete loss of one lineage or homogenization of the two lineages

1.4 Methods

Locality and climate data collection**—**To characterize the climatic niches for both lineages (Carpathian and Pannonian) in *A. arenosa,* we retrieve climate data from specific locations where the lineages are known to grow. We collected a total of 130 presence data corresponding to 103 Carpathian populations and 27 Pannonian populations (Table S1.1). We modeled the environmental niches for each lineage based on the 19 WorldClim climatic variables (Hijmans et al., 2005). Bioclimatic variables (BIO1-BIO19) were obtained from WorldClim v2.0 at 30s spatial resolution at http://worldclim.org/version2. The WorldClim database is based on spatially interpolated data between weather stations and average values of climate variables from ~1970 to 2000. We included all available climate variables in our analyses (Table S1.2).

We estimated the ‘background region’ to extract climate data for the niche similarity analyses (see below). The background region is a set of data points in the vicinity of the presence data of both lineages that establishes the environmental domain available to the taxa given the geographic range. This area is much broader than the presence data, which include just the conditions under which a species is known to occur. To create the background region, we projected the geographic coordinates for each population in ArcGIS 9.3 (Environmental Systems Research Institute, Redlands, CA, USA) and drew a convex polygon around all projected data points to delineate the observed geographic range. We then randomly select points within this polygon to create a climate ‘background region’.

Niche-modeling analyses**—**Our Environmental Niche Modeling (ENM) analyses were divided into two parts. First, we estimated the niches for Carpathian and Pannonian lineages and calculated niche overlap. Second, we tested for ENM equivalency and similarity. We estimated the ENMs using the package ‘*ecospat’* (Di Cola et al., 2017, Broennimann et al., 2012) in R 2.13.2 (R Core Team 2012). Specifically, we used an ordination approach (Principal Component Analysis, PCA) to estimate the occurrence and climatic factor densities along environmental axes (PCA-env) and used these densities to calculate ENM overlap. ENM overlap was evaluated using the Schoener's *D* metric (Schoener, 1968) that varies from 0 (no overlap) to 1 (complete overlap). Furthermore, equivalency and similarity tests are complementary measures of ENM divergence, but they test slightly different hypotheses. The niche equivalency test evaluates if ENMs are statistically identical when compared directly with each other using a bootstrap resampling approach (Warren et al., 2008, Broennimann et al., 2012). For each ENM comparison, we generated a null distribution of divergence based on all the observed presence data points. Specifically, we pooled all the presence data points for both lineages in the comparison and resampled by randomly reassigning presence points to two sets. We then calculated *D* on these resampled sets. We resampled 1000 times to create a null distribution of *D*. If the observed *D* is less than the null distribution of *D*, then the hypothesis of niche equivalency is rejected, and ENMs are not equivalent. The ENM similarity test uses bootstrap resampling to evaluate if one ENM predicts the other better than a randomly generated ENM from the geographic range (Warren et al., 2008, Broennimann et al., 2012). We estimated a null distribution of ENM similarity by extracting climate variables from a randomly generated set of geographic localities within the 'background region' containing both lineages. The ENM based on these background points is our 'random' ENM. We compared this random ENM to the actual ENM of each lineage calculated by the presence data using the D statistic. For each comparison, we resample the background points 1000 times comparing actual Carpathian and Pannonian ENM to random background ENM. Observed *D*'s greater than the null distribution indicate that ENMs are more similar than expected given their geographic ranges, while values significantly less than the null distribution indicate ENMs divergence. A non-significant result from the similarity test indicates that there is low power to detect similarities or differences or the expected similarity between niches given the null hypothesis pulled from the geographic ranges is very high, and thus the actual niche differentiation merely is what is expected by chance.

Predictive habitat distribution modeling—To estimate the effects of climate change on the geographic distribution of the Carpathian and Pannonian lineages in *A. arenosa*, we modeled and compared the current and future distribution of suitable habitats for each lineage based on the 19 WorldClim climatic variables (Hijmans et al., 2005). Bioclimatic variables (BIO1-BIO19) were obtained from WorldClim v2.0 at 30s spatial resolution at http://worldclim.org/version2, corresponding to the period ~1970–2000 (hereafter 'Current'). First, we conducted two commonly applied species distribution modelling (SDM) methods implemented in R package biomod2 (Thuiller et al., 2016), generalized linear model (GLM) and maximum entropy (MAXENT). GLM is a linear regression model that allows for non-linearity and is based on an assumed relationship between the predictor variables and the response variable. MAXENT uses environmental data for known presence localities and a large set of background points (or pseudoabsences) in a machine learning methodology using the principle of maximum entropy to model species distributions. This method determines models with uniform/spread out distributions while considering the study region as a density estimation. Pseudoabsences were chosen from the defined background areas following the recommendations of Barbet-Massin et al. (2012), and the calibration was replicated ten times for each modeling method. For each model, we randomly chose testing data as 30% of the occurrences, and we assessed model performance using two indicators: the full area under the receiver operating characteristic curve (AUC) and the partial receiver operating characteristic (pROC) curve method. For the final ensemble of projections, we only considered models with significant pROC values (p-value ≤ 0.001) and AUC ≥ 0.7 (Gogol-Prokurat, 2011). Predicted habitat suitability for the retained models was transformed into binary data using the threshold that maximizes the true skills statistics (TSS) value (Liu et al., 2005).

We obtained the future climate layers from WorldClim at 30s spatial resolution from the Coupled Model Intercomparison Project Phase 5 projections (CMIP5) at http://worldclim.org/cmip5_30s, corresponding to two time periods: 2041–2060 (hereafter '2050') and 2061–2080 (hereafter '2070'). We considered two global climate models for each future period, the Community Climate System Model version 4 (CCSM4), and the NASA Goddard Institute for Space Studies E2-R Model (GISS-E2-R). Each global climate model was generated by the two most extreme Representative Concentration Pathway (RCP) greenhouse-gas scenarios (RCP 2.6 W/m^2 and RCP 8.5 W/m^2). In total, we estimated four climate model-scenario combinations for each future period. We trimmed the obtained future climate layers using the same background areas used for calibrating the models for each lineage. We projected the retained calibrated models to current and future climates. For each of the nine combinations of climate-model scenario per lineage (i.e., one for current and four for each of the two future periods), the ensemble projections produced habitat suitability matrices with each value denoting the proportion of the number of models predicting the corresponding cell as climatically suitable to the total number of models. Then, we transformed habitat suitability matrices to binary matrices using the average threshold that maximized the TSS value across all retained models and estimated the number of climatically suitable cells for each contemporary and future prediction. Next, we combined the resulting binary matrices for each future time period and lineage in order to geographically visualize the overall predicted changes in climatically suitable habitats for each lineage. The combined projections produced raster maps with each cell value denoting the number of scenarios under which the particular cell was predicted as suitable. Cells with a value greater than or equal to two (i.e., 50% of the estimated scenarios for each future period) were displayed as climatically suitable for the *A. arenosa* lineages. Finally, we estimated the proportion of overlapping of climatically suitable areas between the Carpathian and Pannonian lineages for each time period.

Seed collections and experimental set-up—We generated seeds for this experiment by performing controlled crosses between individuals grown from seeds collected in two different localities for each lineage (See experimental design section for more details). Seeds from the Carpathian lineage were collected from the Retezat Mountains at 850m.a.s.l. (*RZA*; 45.368°N, 22.751°E) in Romania and Strečno at 390m.a.s.l. (*SNO*; 49.167°N, 18.851°E) in Slovakia. Seeds from the Pannonian lineage were collected from Kesztölc at 330m.a.s.l. (*KZL*; 47.717°N, 18.768°E) and the Szigliget Castle at 130m.a.s.l. (*SZI*; 46.801°N, 17.433°E) both localities in Hungary (Figure 1.6).

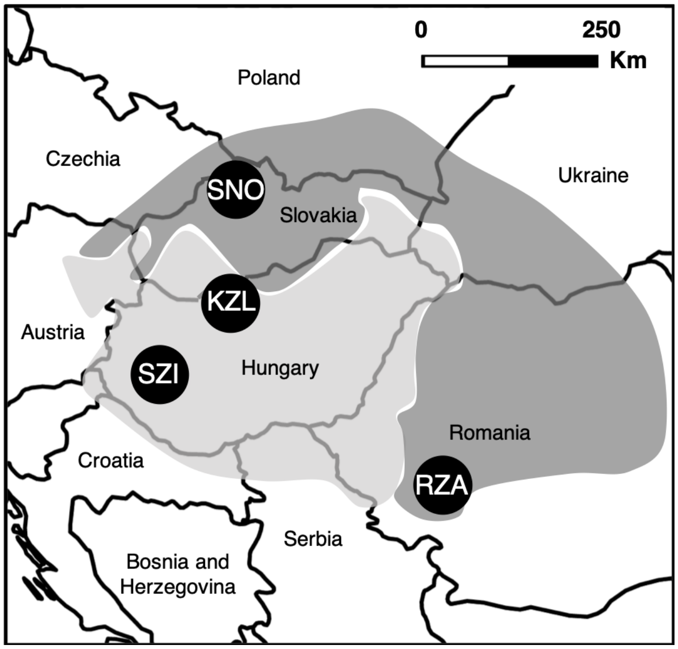

Figure 1.6 Ecogeographic regions and location of sampled populations. Carpathian Mountains range in dark gray: RZA: Retezat, Romania, and SNO: Strečno, Slovakia. Pannonian lowland in light gray: KZL: Kesztölc, Hungary, and SZI: Szigliget, Hungary**.**

We started our experiment with two half-sib plants from each of three maternal lines from our four populations (*RZA* and *SNO* from the Carpathian, and *KZL* and *SZI* from the Pannonian). For each of these 24 parental individuals, we generated seeds from four types of breeding: *(i).* Within a population, *(ii).* Between populations within a region, and *(iii & iv).* Between regions to each of the two populations. This strategy resulted in four cross-types (maternal region X paternal region): Carpathian X Carpathian (CXC), Pannonian X Pannonian (PXP), Carpathian X Pannonian (CXP), and Pannonian X Carpathian (PXC). We haphazardly selected pollen donors for these crosses ensuring that individuals were not used as pollen donors more than four times, in total, we performed 96 crosses. From each cross, we planted 12 seeds in each of four temperature treatments (a total of 48 seeds per each cross): *(i).* 9°C (16h day)–5°C (8h night), *(ii).* 14°C (16h day)–9°C (8h night), *(iii).* 19°C (16h day)–15°C (8h night), and *(iv).* 24°C (16h day)–20°C (8h night). We will refer to these treatments by their daytime temperature of 9°C, 14°C, 19°C, and 24°C respectively. We grew all plants in four Conviron MTPC-144 plant growth chambers with one chamber per temperature treatment. In total, we generated 4608 seeds, 1152 seeds per cross-type (CXC, PXP, CXP, and PXC), with 288 seeds of each cross-type in each temperature.

We sowed the seeds in soil (50% Sunshine Mix #4 / 50% fine vermiculite) and stratified them at 4°C for two weeks in complete darkness. We moved seeds into their assigned temperature treatments and we recorded seedling emergence (germination) and survival of seedlings for the next 60. Next, we vernalized the plants for 60 days at 4°C (8h day–16h night). After vernalization, we returned plants to their temperature treatments and recorded flowering, flowering time, pollen viability, and seed set from controlled crosses. We use these phenotypes to estimate pre- and post-mating reproductive isolation barriers in the four different temperature treatments.

Phenotyping and statistical analyses—We measured six phenotypes on each individual in our experiment: germination, survival, flowering, flowering time, pollen viability, and seed set from controlled crosses. Germination, survival, and flowering were recorded as a binary response where 0 = failure and 1 = success. We quantified flowering time as the number of days from germination until the first flower open minus 60 days of vernalization. We quantified pollen viability as the proportion of viable pollen grains for greater than 200 grains per sample. Viable pollen grains were evaluated with Alexander's staining method (Alexander, 1969).

For each of our experimental plants, we evaluated seed set success from crosses with pure Carpathian and pure Pannonian individuals. For this assay, we chose two CXC fathers and two PXP fathers each with 100% pollen viability for a total of four fully fertile fathers. From each temperature, we chose two mothers of every cross-type (CXC, PXP, CXP, and PXC) for a total of eight mothers per temperature and 32 mothers in total. Every mother was pollinated with pollen from the four fathers, pollen from each father was used to pollinated six flowers; in total, 24 flowers per mother were pollinated. From each cross we quantified the number of seeds developed per silique.

We tested whether variation in the measured phenotypes was explained by cross-type (CXC, PXP, CXP, and PXC), temperature treatment, or their interaction. For germination, survival, flowering, pollen viability, and seed set we fit generalized linear mixed effect models (GLMMs) with temperature treatment, cross-type, and their interaction, as well as mother and father population as fixed effects, and mother and father identities as random effects using the glmer function in R package *lme4* (Bates et al., 2015). For germination, survival, and flowering we assume a binomial distribution of error terms. For the number of viable pollen grains we use the total number of counted pollen grains as an offset and assume a Poisson distribution of error terms. For the number of seeds per silique, we assume a Poisson distribution of error terms. To analyze flowering time, we fit a survival model with temperature, cross-type, and their interaction, as well as mother and father population as covariates and mother identity as a random effect using the survfit and survreg functions in R package *survival* (Therneau and Grambsch, 2000, Therneau, 2015).

Calculating reproductive barriers strength—For any phenotype for which we found either significant cross-type effect or significant cross-type by temperature interaction effect, we calculated the strength of reproductive isolation associated with this trait. We use a method for calculating *RI* that allows a simple linear correlation between *RI* and the probability of gene flow between lineages (Sobel and Chen, 2014):

$$RI = 1 - 2\left(\frac{H}{H+C}\right) \qquad \textbf{(1)}$$

In equation (1), H and C represent either the number of heterospecific and conspecific matings or the amount of viable heterospecific and conspecific offspring. Using this equation, the *RI* values 1, 0, and –1 correspond to 0%, 50%, and 100% heterospecific outcomes, respectively. In order to investigate asymmetries in the strength of barriers, we calculated the strength of *RI* from the Carpathians into the Pannonia ($RI_{Car\rightarrow Pan}$) separately from the strength of *RI* that reduces gene flow from the Pannonia into the Carpathians ($RI_{Pan\rightarrow Car}$). Specific calculations for each trait for each species are found in Table S1.4.

We calculated flowering time *RI* based on temporal co-occurrence. The minimum value of *RI* is zero (total co-occurrence), so, we use an analogous equation for *RI* that ranges from 0 to 1 (Sobel and Chen, 2014):

$$RI = 1 - \left(\frac{S}{S+U}\right) \qquad \textbf{(2)}$$

In equation (2), S and U represent the shared and unshared portions of occurrence. Using this equation, the *RI* values 1, 0.5, and 0 correspond to 0%, 50%, and 100% shared occurrence, respectively. We estimated the proportion of temporal co-occurrence $\left(\frac{S}{S+U}\right)$ using the overlap function in R package *overlapping* (Pastore, 2017). Since temporal isolation is symmetrical, the strength of *RI* that reduces gene flow from the Carpathians into the Pannonia ($RI_{Car\rightarrow Pan}$) equals *RI* that reduces gene flow from the Pannonia into the Carpathians ($RI_{Pan\rightarrow Car}$).

For each barrier, we used 10,000 bootstrap resamples of our raw datasets to calculate 95% confidence intervals of individual contributions (Efron, 1987). To calculate total *RI*, we assume that reproductive barriers act sequentially and estimate their absolute contributions (Sobel and Chen, 2014). Finally, we resampled from the distributions of each separate barrier strength 10,000 times during total *RI* calculation to estimate 95% confidence intervals.

CHAPTER 2

Autopolyploid lineage shows climatic niche expansion but not divergence in *Arabidopsis arenosa*

2.1 Abstract

Successful establishment of neopolyploids, and therefore polyploid speciation, is thought to be contingent on environmental niche shifts from their progenitors. We explore this niche shift hypothesis in the obligate outcrosser *Arabidopsis arenosa* complex, which includes diploid and recently formed autotetraploid populations. To characterize the climatic niches for both cytotypes in *A. arenosa,* we first gathered climatic data from localities with known ploidy types. We then estimated the climatic niches for diploids and autotetraploids and calculated niche overlap. Using this niche overlap statistic, we tested for niche equivalency and similarity. We explored differences in niches by estimating and comparing niche optimum and breadth and calculated indices of niche expansion and unfilling. We found that climatic niche overlap between diploids and autotetraploids is substantial. Although the two niche models are not significantly divergent, they are not identical as they differ in both optimum and breadth along two environmental gradients. Autotetraploids fill nearly the entire niche space of diploids and have expanded into novel environments. In conclusion, we find climatic niche expansion but not divergence, together with a moderate change in the niche optimum, in the autotetraploid lineage of *A. arenosa*. These results indicate that the climatic niche shift hypothesis alone cannot explain the coexistence of tetraploid and diploid cytotypes.

2.2 Introduction

Speciation initiated by whole-genome duplication, or polyploidy, is widespread throughout plant evolution (Grant, 1981, Wood et al., 2009, Soltis et al., 2007). Despite the high incidence of polyploidization, the success of a new polyploid lineage is thought to be largely dependent on its ability to ecologically diverge from the progenitor lineage(s). It has been hypothesized that neopolyploid lineages will be successful only if they establish a new ecological niche or spread to a new geographic location and therefore avoid competing with and mating with parental lineages (Fowler and Levin, 1984, Levin, 1983, Levin, 2002, Levin, 1975). Although this has been a long-standing hypothesis (Anderson, 1971, Borrill and Lindner, 1971, Cavanah and Alexander, 1963, Hagberg and Ellerström, 1959, Lewis, 1967a, Lewis, 1967b), recent advances in niche analyses can provide novel insights into if and how successful establishment of polyploid lineages involves shifts in their niches (Parisod and Broennimann, 2016).

In general, new species face two challenges – they must evolve reproductive isolation to prevent gene flow with closely related species and establish a unique niche, either through ecological divergence or successfully outcompeting other species (Coyne and Orr, 2004, Via, 2009, Barton, 2010). Because crosses between plants of different ploidy levels frequently result in reduced hybrid fertility (Pegoraro et al., 2016, Roccaforte et al., 2015, Borges et al., 2012, Greiner and Oberprieler, 2012, Husband and Schemske, 2000, Husband and Sabara, 2004, Gross and Schiestl, 2015, Sweigart et al., 2008, however see Lafon-Placette et al., 2017), it has been suggested that polyploidization causes instantaneous speciation (Schluter, 2001, Schluter, 2000, Rundle and Nosil, 2005). However, for a new polyploid lineage to become a new species, it must also overcome the challenge of establishing a self-sustaining population. In this way, ecological adaptation can play a significant role in the process of polyploid speciation.

A central challenge faced by neopolyploids is avoiding costly hybridization with parental lineages. Levin (1975) described this selection against newly formed polyploids as the “minority cytotype disadvantage” (MCD). When initially formed neopolyploids are rare relative to their progenitor lineages, they will often mate with the more frequent diploid lineages. These cross-cytotype matings often fail or result in sterile hybrids and therefore significantly impede successful propagation and establishment of a stable polyploid population (Husband, 2000). Hence, the MCD represents a significant challenge for polyploid establishment and speciation.

One primary mechanism by which the MCD can be overcome is through habitat segregation by niche divergence or what is known as the "niche shift hypothesis" (NSH) (Husband, 2000, Levin, 2004). The study of niche divergence has experienced recent advances due to the availability of global climate data and the development of novel analytical approaches (Wiens and Graham, 2005, Warren et al., 2008, Broennimann et al., 2012). These advanced methods and data availability combined with taxon distribution data have allowed for the development of refined environmental niche models (ENMs) that characterize species niches and allow assessment of how niches vary between species (Guisan et al., 2014). Niche divergence is characterized by the extent of niche overlap, which is evaluated using tests for niche equivalency and niche similarity (Warren et al., 2008).

Niche equivalency is a conservative test that determines if two observed niches are identical. Rejecting this null hypothesis indicates that the two niches are not statistically equivalent (Fig. 2.1). The niche similarity test determines if niches are more similar than expected by chance, testing if the ENM of one taxon predicts the ENM of another taxon better than a null model (Fig. 2.1). The null model in the niche similarity test controls for the geographic distribution of the species to determine if the two niches are more similar than would be expected given the niches available across the geographic range of the species (Warren et al., 2008). The niche similarity test is less stringent than the niche equivalency test but is often underpowered to detect significant similarity or differences between niches. If ENMs are not conserved, as indicated by the niche equivalency and the niche similarity test, they can differ in niche optimum, niche breadth, or both. Differences in niche optimum are caused by differences in the occupied environmental conditions (i.e. differences in the “mean” niche), while differences in niche breadth are caused by the expansion of a niche or the “unfilling” of taxa’s ecological tolerances (Guisan et al., 2014, Petitpierre et al., 2012, Di Cola et al., 2017).

Previous empirical analyses of niche divergence between diploids and polyploids have produced inconsistent results across species leading to ambiguous patterns. Most of the reported examples about ecological consequences of polyploidization, which use niche-modeling approaches, come from studies focused on allopolyploids. Although several studies show niche divergence between allopolyploids and at least one of their progenitors (Glennon et al., 2012, Theodoridis et al., 2013, Glennon et al., 2014, Harbert et al., 2014, Han et al., 2015, Lopez-Alvarez et al., 2015, Marchant et al., 2016), other studies show allopolyploid lineages have intermediate or non-divergent ecological niches (Oberprieler et al., 2012, Glennon et al., 2014, Harbert et al., 2014, Marchant et al., 2016, Boucher et al., 2016, Casazza et al., 2017). For autopolyploids, some studies have found significant ecological segregation between polyploids and their ancestors (Visger et al., 2016, Mandak et al., 2016, Lazaroff et al., 2016, Zozomova-Lihova et al., 2015, Thompson et al., 2014, Mered'a et al., 2016, Stahlberg, 2009, Schonswetter et al., 2007, Sonnleitner et al., 2016, Hulber et al., 2015), and yet other studies find no ecological divergence between cytotypes (Hanzl et al., 2014, Godsoe et al., 2013). Most of the reported studies are limited to evaluating if niches are conserved but do not investigate how the niches of the two cytotypes differ in aspects such as optima and breadths (but see Kirchheimer et al., 2016). Understanding if and how polyploids undergo ecological niche shifts remains a persistent challenge.

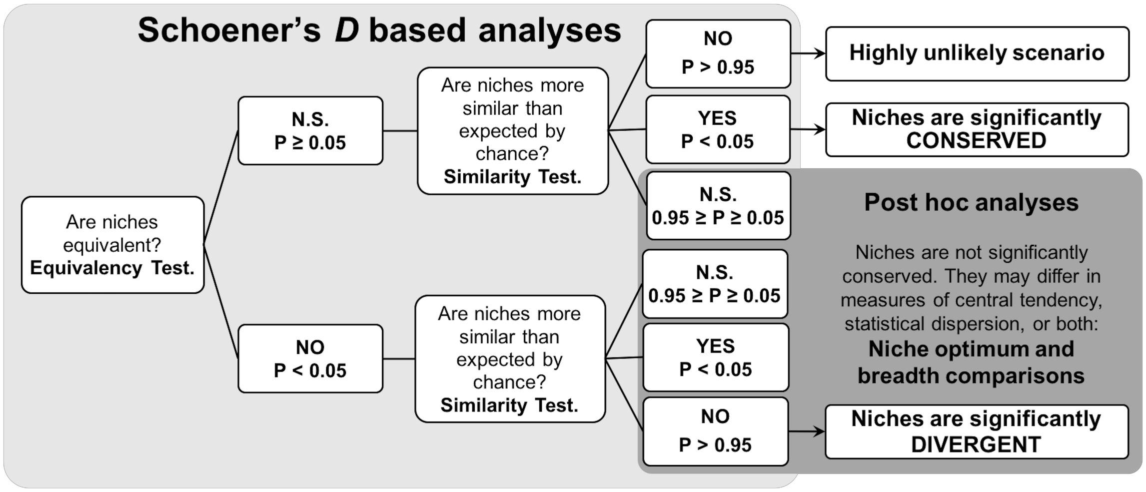

Figure 2.1 Workflow diagram describing the niche evolution analyses performed in this study, and the conclusions derived from the possible test results. N.S. represents a non-significant result.

We performed a thorough characterization of whether and how polyploid niches diverge from progenitor niches using the *Arabidopsis arenosa* (L.) (Sand rock-cress) complex (Brassicaceae). *A. arenosa* is an obligate outcrosser closely related to *A. lyrata* and the genetic model plant *A. thaliana* (Al-Shehbaz and O'Kane, 2002). Diploid (2n = 2x = 16) *A. arenosa* populations are found in Eastern Europe and the Balkans, and along the southern Baltic Coast in Poland, whereas polyploid (2n = 4x = 32) populations are broadly distributed through Central and Northern Europe. Recent genome-wide sequence analyses have resolved the phylogenetic relationships and demographic histories within the *A. arenosa* complex (Kolář et al., 2016a, Yant and Bomblies, 2017, Novikova et al., 2016, Monnahan et al., 2018). Although these phylogenetic results differ from the previously described taxonomy of the group based on morphology (Schmickl et al., 2012, e.g., Měsíček and Goliašová, 2002, Hohmann et al., 2014), we will use the demographic history inferred from the genome-wide analyses as the evolutionary framework for our study.

Diploid populations of *A. arenosa* are split into three highly divergent lineages (Kolář et al., 2016a, Monnahan et al., 2018): *(i)* The Carpathian lineage, found in the mid-altitudes to high altitudes of the western Carpathians in Slovakia, and mid-altitudes of southern and eastern Carpathians in Romania and the southern Dinarides in Serbia. The Carpathian lineage also includes diploid populations found along the Baltic sea coast. *(ii)* The Dinaric lineage, found in the foothills of the Dinaric Alps and their surroundings in Slovenia, Croatia, and Bosnia and Herzegovina. And *(iii)* the Pannonian lineage, found in the Pannonian lowlands of Hungary and southern Slovakia. The Carpathian and Dinaric lineages diverged approximately 650,000 generations ago, whereas the Pannonian lineage diverged approximately 760,000 generations ago from the Carpathian-Dinaric ancestor (Kolář et al., 2016a). The widespread *A. arenosa* tetraploid cytotype represents an autopolyploid lineage with chromosome segregation during meiosis showing no evidence of pairing preference (Hollister et al., 2012, Arnold et al., 2015, Arnold et al., 2016). The autotetraploids likely originated from a single ancestral population that arose approximately 11,000-30,000 generations ago in the Carpathian Mountains, where its closest living diploid relatives are still found (Monnahan et al., 2018, Arnold et al., 2015), and the two cytotypes broadly overlap (Schmickl et al., 2012, Kolář et al., 2016b). Although gene flow from both tetraploid *A. lyrata* and diploid *A. arenosa* into tetraploid *A. arenosa* has been reported (Jorgensen et al., 2011, Arnold et al., 2016, Baduel et al., 2018, Novikova et al., 2016, Monnahan et al., 2018), even the hybrid lineages show fully random chromosome pairing and trace back to a single origin with subsequent gene flow between geographically proximal taxa.

Here, we applied ENM to estimate the climatic niche spaces of autotetraploid lineage and the diploid progenitor lineage (the Carpathian lineage). We restrict our analyses of diploids to just the Carpathian lineage because the tetraploid lineage arose from the Carpathian lineage far more recently than the Carpathian lineage divergence from the other diploid lineages (a full analysis of all diploid *A. arenosa* is also reported in Fig. S3.2.) We used an ordination-based analysis of climate variables to assess shifts in environmental space between cytotypes. Then, we applied a resampling method to evaluate differences in ENM optimum and breadth between cytotypes. If climatic niche differentiation was important for autotetraploid *A. arenosa* establishment, we hypothesize that the niches of the two cytotypes are divergent. However, we find climatic niche expansion but not divergence, together with a moderate change in the niche optimum, in the autotetraploid lineage.

2.3 Results

We estimated a climatic niche overlap of 54.1% between the progenitor diploid and the tetraploid *A. arenosa* (Schoener's *D* = 0.541). Schoener's *D* based tests of equivalency and similarity show that diploid and autotetraploid niches are not equivalent (P = 0.002) but are more similar than expected by chance in both comparisons (2x → background: P = 0.042 and 4x → background: P = 0.045) (Fig. 2.2). We found qualitatively similar results when we compared the tetraploid linages to the all diploid lineages (Fig S2.2).

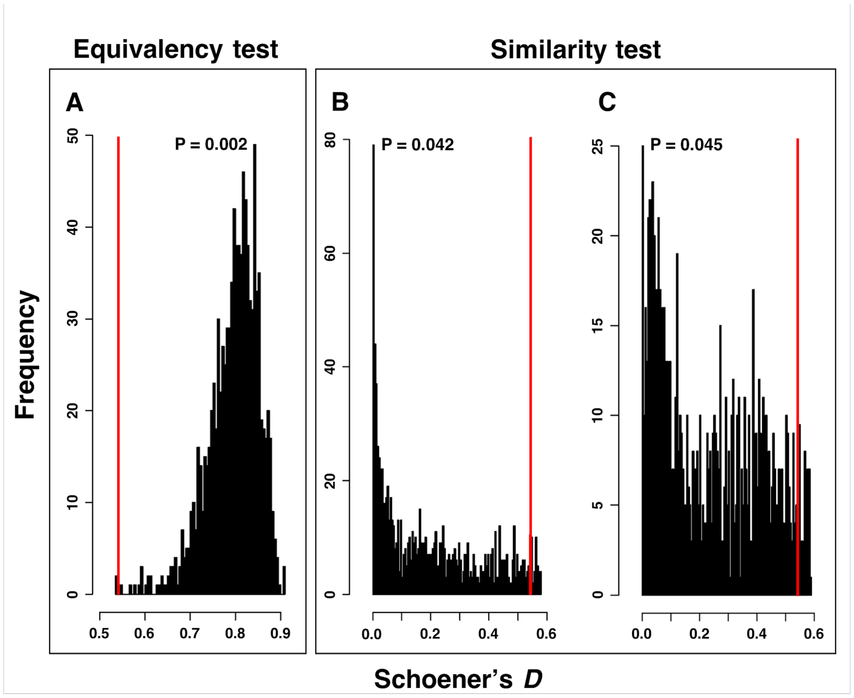

Figure 2.2 Histograms of Schoener's *D* based bootstrap tests with 1000 resamples. Black bars indicate resamples of estimated and red line represents observed *D* = 0.541. **A**. Equivalency test, which predicts no statistically significant differences between alternative niche models. **B.** Similarity test (2x → background), and **C.** Similarity test (4x → background).

The first two components of our principal components' analysis (PCA-env) explain 74.38% of the total variance observed in the climatic dataset. PC1 corresponds to a precipitation axis and describes 44.11% of the variance with BIO12 (annual precipitation), BIO17 (precipitation of driest quarter), and BIO19 (precipitation of coldest quarter) having the greatest contributions. PC2 corresponds to a temperature axis and describes 30.27% of the variance with BIO11 (mean temperature of coldest quarter), BIO6 (minimum temperature of coldest month), and BIO1 (annual mean temperature) having the greatest contributions (Fig. 2.3; Table S2.2).

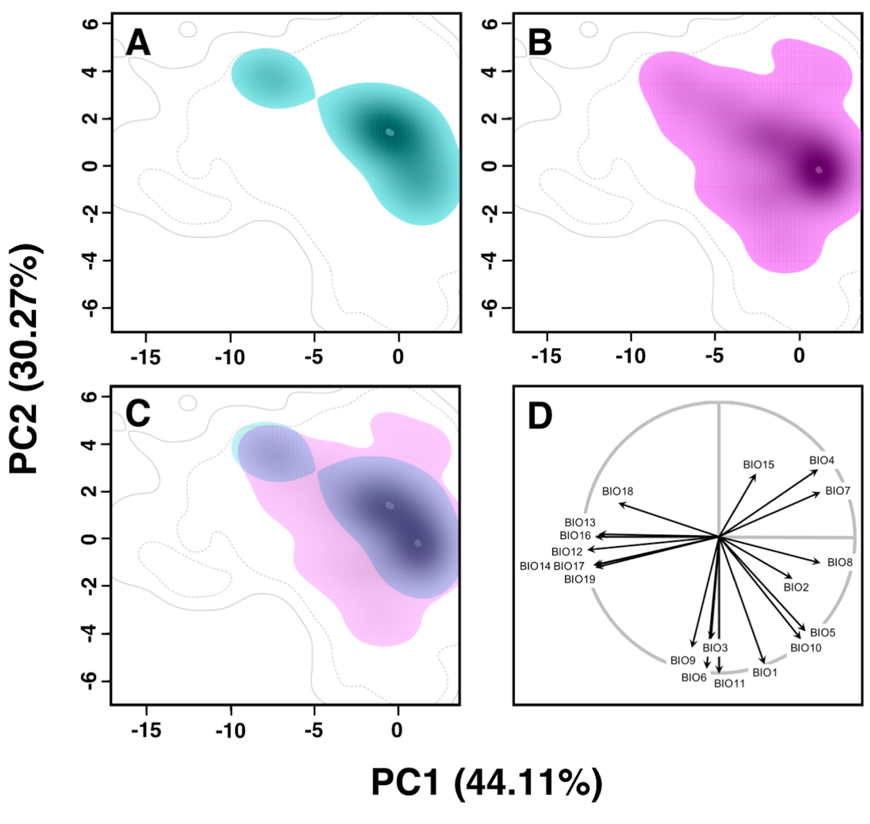

Figure 2.3 Niche dynamics observed comparing diploid (N = 103) and tetraploid (N = 208) *Arabidopsis arenosa* cytotypes in Central and Northern Europe. **A.** Diploid niche model. **B.** Tetraploid niche model. **C.** Overlap between diploid and tetraploid models. Continuous gray line delimits the full environmental space available within the background area; dashed gray line delimits the percentile 75 of the environmental space available within the background area. Darker shading indicates a higher density of presence data. Clearer dots represent niche centroids. **D.** Correlation circle of WorldClim variables used in the PCA-env (Complete list of climatic variables and respective contributions at table S2.2).

2.4).

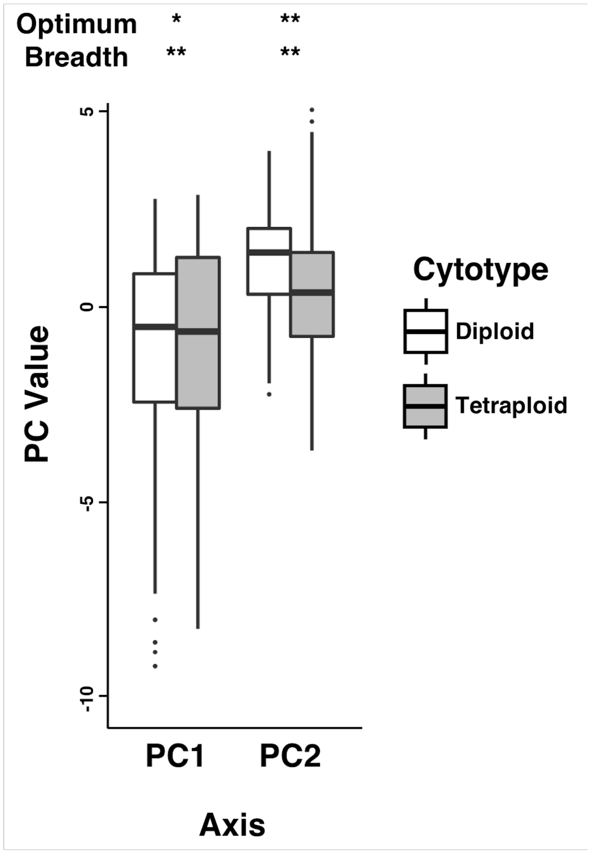

Figure 2.4 Values of principal components along the two environmental gradients (PCA-env axes). Comparisons are made between diploid (N = 103) and tetraploid (N = 208) cytotypes of *Arabidopsis arenosa* in Central and Northern Europe. Niche optimum and breadth correspond to the median and the length of the 95% inter-percentile interval along the two PCA-env axes respectively. * P < 0.01, ** P < 0.001.

Table 2.1 Comparisons of the niche optimum and breadth along the two environmental gradients (PCA-env axes).

AXIS	CYTOTYPE	OPTIMUM	BREADTH
	2X	-0.510	11.948
PC1	**4X**	-0.626	11.099
	DIFFERENCE	0.116	0.849
	2X	1.393	6.222
PC2	**4X**	0.370	8.711
	DIFFERENCE	1.023	2.489

Notes: comparisons are made between Carpathian diploid (N = 103) and tetraploid (N = 208) cytotypes of *Arabidopsis arenosa* in Central and Northern Europe. Niche optimum and breadth values correspond to the median and the length of the 95% inter-percentile interval along the two PCA-env axes respectively. Both optimum and breadth show significant differences along the two environmental axes (P < 0.01; Fig. 2.4).

2.4 Discussion

Polyploid lineages must persist in the face of competition and costly hybridization with its diploid progenitors. The niche shift hypothesis (NSH) proposes that the ecological niche of polyploid lineages must diverge for these lineages to successfully establish (Levin, 1975, Fowler and Levin, 1984). Some studies support the NSH. For instance, it has been reported that polyploids are generally found in drier (Hagerup, 1932, Watanabe, 1986, Maherali et al., 2009, Treier et al., 2009) and more exposed habitats than diploids (Rothera and Davy, 1986, Watanabe, 1986, Lumaret et al., 1987, Brammall and Semple, 1990). However, the extent to which polyploids are adapted to more extreme environments and therefore differentiated from diploids remains controversial (te Beest et al., 2012). Our work uses refined analyses of environmental niches to test the NSH in the autotetraploid lineage of *A. arenosa*. We found that the tetraploid niche has a significant degree of overlap with the diploid niche, and yet is not conserved. Niche differences result from an increase in tetraploid niche breadth and a small but significant change in optimum.

Recent advances in ecological niche modeling analyses provide new opportunities to understand whether and how neopolyploid lineages have altered their niches to allow successful establishment. We used Schoener's *D,* as a summary statistic for niche overlap, to test the hypothesis of niche conservatism versus niche divergence (Warren et al., 2008). Niches are conserved when two specific criteria are satisfied (Fig. 2.1): *(i)* niche equivalency hypothesis is not rejected (i.e., $0.025 \leq P \leq 0.975$) and *(ii)* niche similarity test is significant (i.e., $P < 0.05$). If niches are divergent, or not conserved, they can vary in their breadth, optimum, or both.

We determined if and how the *A. arenosa* tetraploid niche diverged from the diploid progenitor. In general, we found that the niche overlap between cytotypes was equal or higher for *A. arenosa* than has been observed in other diploid-autopolyploid species complexes (Glennon et al., 2012, Thompson et al., 2014, Kirchheimer et al., 2016, Visger et al., 2016). Despite a high degree of overlap, the autotetraploid niche is not identical to the diploid niche, as evaluated by the equivalency test, but when controlling for geographic range, the two niches are statistically “similar.” Although both equivalency and similarity tests assess niche conservatism, their approaches are slightly different, and therefore this type of inconsistency is common when comparing niches (e.g., Glennon et al., 2014).

The test for niche equivalency is conservative as it directly compares two niches and asks if they are identical. The test for niche similarity controls for the geographic range of the taxa by asking if, given the possible niches available in their ranges, two species maintain similar niches or shift and expand into new niches. The ability to detect significant similarity is therefore highly dependent on the geographic ranges of the two species. This difference between the tests likely explains the seemingly contradictory results in the *A. arenosa* species complex. The autotetraploid lineage experienced a geographic range expansion since formation from the diploid ancestors (Arnold et al., 2015). Relative to the diploid niche, the possible niche divergence across this range expansion is considerable. Thus, there is a high null expectation of how much the autotetraploid and diploid niches could diverge. Compared to this null expectation, the two niches remained more similar than expected even though they are not identical. This climatic niche stability between diploid and autotetraploid cytotypes in *A. arenosa* is consistent with the notion that autopolyploid lineages exhibit lower rates of niche evolution than allopolyploids. For instance, a previous study conducted in the *Alyssum montanum* species complex showed that allopolyploids expand into different climatic conditions than those of their diploid congeners, but autopolyploids occupy ecological niches similar to their ancestors and are limited to peripheral and less competitive geographic areas (Arrigo et al., 2016).

Our exploration of the divergence between the autotetraploid and diploid niches revealed significant differences in both breadth and optimum. The autotetraploid niche expanded to encompass broader temperature tolerances and underwent a slight change in the niche optimum such that more populations inhabit climates with a greater variability throughout the year. Therefore, our finding of expansion in the autotetraploid niche shows weak support for the hypothesis that polyploid lineages are more tolerant than their diploid progenitors of extreme environmental conditions. It is possible that our ENMs did not incorporate an important axis of ecological variation and thus we missed key aspects of divergence. For example, we could not evaluate microclimate, soil, phenology, or biotic interactions. Tetraploid lineages may have diverged in other ways besides climatic niche to better compete or coexist with the diploid ancestors. For example, the tetraploids may have shifted their life-history timing to not reproduce simultaneously with the diploids.

Furthermore, tetraploid *A. arenosa* exhibits a tetrasomic inheritance (Hollister et al., 2012, Arnold et al., 2015, Arnold et al., 2016) which is a crucial autopolyploid feature that consists in the random pairing of the two sets of homologous chromosomes such that the four alleles at a given locus pair and segregate at random. All tetraploid *A.*

arenosa populations that have been tested are in Hardy-Weinberg equilibrium assuming a random pairing tetraploid model, even those from hybrid regions (Hollister et al., 2012, Arnold et al., 2015, Arnold et al., 2016). Autotetraploids may be able to compete with diploids as a result of having twice as much genetic material per individual. Consequently, autotetraploid populations are distinguished by high heterozygosity and by nearly doubled effective population size as compared to diploids (Ronfort, 1999, Ronfort et al., 1998, Arnold et al., 2012). These features may result in selection being more efficient within tetraploid populations than diploid populations allowing for more rapid adaptation. However, the efficiency of selection and the long-term adaptive potential of autopolyploids remain mostly unexplored (Parisod et al., 2010). The potential advantages of tetrasomic inheritance may have allowed for autotetraploid lineages of *A. arenosa* to more rapidly establish in disturbed landscapes following the last deglaciation period.

In fact, Monnahan et al. (2018) found a higher proportion of nonsynonymous polymorphisms fixed by positive selection in tetraploid compare to diploid *A. arenosa*, which implies that autotetraploid populations may respond faster to directional selection (Selmecki et al., 2015). Indeed, tetraploid *A. arenosa* has extended its range beyond their diploid ancestor range, including new human-made habitats and postglacial environments (Kolář et al., 2016a), suggesting an improved capability to establish in novel environments. In general, it has been suggested that in extreme or regularly glaciated environments, the increased available genetic diversity in polyploid individuals relative to diploids can allow for more rapid colonization (Comai, 2005, Brochmann et al., 2004, Novikova et al., 2018).

Additionally, polyploidy might decrease the negative consequences of interspecific hybridization and introgression (Alix et al., 2017). Indeed, hybridization is broadly recognized as a source of variation for adaptation to new environments (e.g., Lewontin and Birch, 1966, Seehausen, 2004, Rieseberg et al., 1999). Interploidal gene flow from diploid into tetraploid *A. arenosa* and gene flow from tetraploid *A. lyrata* into tetraploid *A. arenosa* have been previously reported (Jorgensen et al., 2011, Arnold et al., 2015, Baduel et al., 2018, Arnold et al., 2016, Monnahan et al., 2018). Multiple events of introgression into tetraploid *A. arenosa* may offer an additional substrate for local adaptation. Specifically, population genomics analyses have suggested that migrant alleles from tetraploid *A. lyrata* may have facilitated adaptation of tetraploid *A. arenosa* to the challenging serpentine habitat in the Austrian Alps (Arnold et al., 2016); in the same sense, adaptive introgression from Baltic diploid populations may have facilitated the evolution of early flowering in tetraploid *A. arenosa* adapted to a railway environment in Berchtesgaden in the Bavarian Alps (Baduel et al., 2018). These findings suggest that hybridization and introgression could have played a role in the observed niche expansion in the diploid to autotetraploid transition in *A. arenosa*.

In conclusion, expansion of niche breadth, together with a slight change in the niche optimum, but not a significant ecological niche shift, occurred during (or after) the *A. arenosa* autotetraploids moved out of the Carpathian Mountains. Whether climatic niche differences between the diploid and autotetraploid were an immediate consequence of polyploidy (i.e. tetrasomic inheritance), a result of subsequent evolution (i.e. gene flow) or a combination of both is beyond the scope of this study. Therefore, it is important to consider our findings as representing a combination of both autopolyploidy and subsequent evolution.

2.5 Methods

***Locality and climate data collection*—**To characterize the climatic niches for both cytotypes (diploid and autotetraploid) in *A. arenosa,* we retrieve climate data from specific locations where the species is known to grow. We only used locality information from occurrences for which ploidy was determined using flow cytometry (Schmickl et al., 2012, Yant et al., 2013, Kolář et al., 2016b, Kolář et al., 2016a, Schmickl and Koch, 2011, Wright et al., 2015, Novikova et al., 2016). To the best of our ability, we sampled every known population that fit our criteria at the time of our analysis. We collected a total of 311 presence data corresponding to 103 Carpathian diploid populations (the ancestral lineage for the tetraploids, including 10 presence data from the Baltic Sea coast) and 208 autotetraploid populations (Fig. 2.5, Table S2.1). These populations are from both the allopatric portion of the lineages' ranges as well as the sympatric region where there is some history of inter-ploidy hybridization (Monnahan et al., 2018). As reported in Fig. S3.2, we also performed our analyses on diploid populations from across the *A. arenosa* range by adding 47 populations from the Pannonian and Dinaric lineages to our data set (Table S2.1). We extracted climate data for each georeferenced location from the WorldClim database (Hijmans et al., 2005) at a ~1km^2 resolution, using '*raster'* package (Hijmans and van Etten, 2012) in R 2.13.2 (R Core Team 2012). The WorldClim database is based on spatially interpolated data between weather stations and average values of climate variables from 1950 to 2000. We included all available climate variables in our analyses (Table S2.2).

We estimated the 'background region' to extract climate data for the niche similarity analyses (see below). The background region is a set of data points in the vicinity of the presence data of both cytotypes that establishes the environmental domain available to the taxa given the geographic range. This area is much broader than the presence data, which include just the conditions under which a species is known to occur. To create the background region, we projected the geographic coordinates for each population in ArcGIS 9.3 (Environmental Systems Research Institute, Redlands, CA, USA) and drew a convex polygon around all projected data points to delineate the observed geographic range. We then randomly select points within this polygon to create a climate 'background region'.

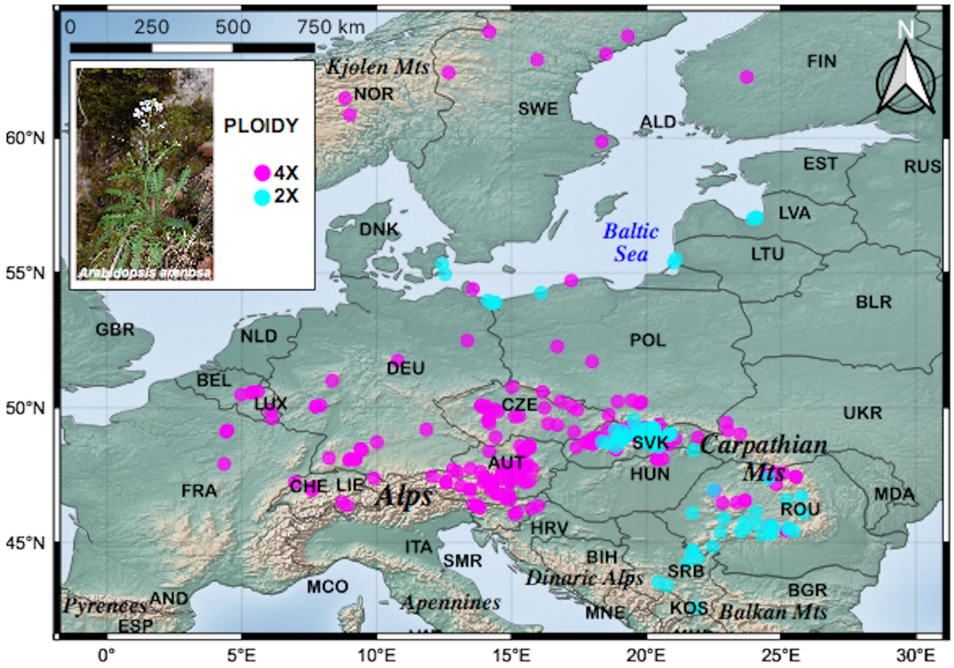

Figure 2.5 Map of *Arabidopsis arenosa* populations used for niche modeling analyses (N = 311) in Central and Northern Europe with ploidy verified by flow cytometry. Magenta circles represent autotetraploid (4X, N = 208), and cyan circles represent Carpathian diploid (2X, N = 103) populations. Photo of *A. arenosa* courtesy of K. Bomblies.

Niche-modeling analyses**—**Our ENM analyses were divided into four parts. First, we estimated the niches for diploids and tetraploids and calculated niche overlap. Second, we tested for ENM equivalency and similarity. Third, we estimated and compared ENM optima and breadths. Finally, we calculated ENM expansion-unfilling indices.

Niche overlap estimates—We estimated the ENMs using the package '*ecospat'* (Di Cola et al., 2017, Broennimann et al., 2012) in R 2.13.2 (R Core Team 2012). Specifically, we used an ordination approach (Principal Component Analysis, PCA) to estimate the occurrence and climatic factor densities along environmental axes (PCA-env) and used these densities to calculate ENM overlap. ENM overlap was evaluated using the Schoener's *D* metric (Schoener, 1968) that varies from 0 (no overlap) to 1 (complete overlap).

Niche equivalency and similarity tests—Equivalency and similarity tests are complementary measures of ENM divergence, but they test slightly different hypotheses. The niche equivalency test evaluates if ENMs are statistically identical when compared directly with each other using a bootstrap resampling approach (Warren et al., 2008, Broennimann et al., 2012). For each ENM comparison, we generated a null distribution of divergence based on all the observed presence data points. Specifically, we pooled all the presence data points for both cytotypes in the comparison and resampled by randomly reassigning presence points to two sets. We then calculated *D* on these resampled sets. We resampled 1000 times to create a null distribution of *D*. If the observed *D* is less than the null distribution of *D*, then the hypothesis of niche equivalency is rejected, and ENMs are not equivalent. If niches were not equivalent, we evaluated differences in niche optimum and breadth to determine why (Fig. 2.1). The ENM similarity test uses bootstrap resampling to evaluate if one ENM predicts the other better than a randomly generated ENM from the geographic range (Warren et al., 2008, Broennimann et al., 2012). We estimated a null distribution of ENM similarity by extracting climate variables from a randomly generated set of geographic localities within the 'background region' containing both cytotypes. The ENM based on these background points is our 'random' ENM. We compared this random ENM to the actual ENM of each lineage calculated by the presence data using the D statistic. For each comparison, we resample the background points 1000 times comparing actual diploid and tetraploid ENM to random background ENM. Observed *D*'s greater than the null distribution indicate that ENMs are more similar than expected given their geographic ranges, while values significantly less than the null distribution indicate ENMs divergence. A non-significant result from the similarity test indicates that there is low power to detect similarities or differences or the expected similarity between niches given the null hypothesis pulled from the geographic ranges is very high, and thus the actual niche differentiation merely is what is expected by chance. If niches were not similar, we proceeded to test differences in niche optimum and breadth (Fig. 2.1).

Niche optimum and breadth estimates—Schoener's *D* offers an estimate of niche conservatism versus divergence; however, it carries limited information regarding how the niches of the two cytotypes vary. Specifically, Schoener's *D,* and therefore our tests of equivalency and similarity, do not discriminate between differences in niche optima and breadths (Glennon et al., 2014). If compared niches were not significantly equivalent, we calculated the ENM optimum and the ENM breadth, respectively, as the median and the length of the 95% inter-percentile interval along the first two PCA-env axes (Broennimann et al., 2012). We evaluated if diploid and autotetraploid differed in ENM optimum and breadth using a bootstrap resampling approach. For each comparison, we generated a null distribution of differences in the ENM optima and the ENM breadths based on all the observed presence data points. Specifically, we pooled all the presence data points for both cytotypes and resampled by randomly reassigning presence points to two sets. Then, we calculated the median and the length of the 95% inter-percentile interval on these two resampled sets and estimated their differences. We resampled 1000 times to create a null distribution of differences in the ENM optima and the ENM breadths. If the observed difference in the median is higher than the null distribution of median differences, then the hypothesis of similar ENM optima is rejected. If the observed difference in 95% inter-percentile interval is higher than the null distribution, then the autotetraploid ENM has expanded with respect to the diploid ENM.

To calculate the observed differences in breadth, we subtract diploid from autotetraploid estimates.

Niche dynamic indices of expansion and unfilling—Niche overlap between cytotypes can be characterized by niche unfilling and niche expansion. To calculate the degree of unfilling and expansion of autotetraploids we used the package '*ecospat'* (Di Cola et al., 2017) in R 2.13.2 (R Core Team 2012). Unfilling is the proportion of the diploid ENM density located outside the tetraploid ENM. Expansion is the proportion of the autotetraploid ENM density located outside the diploid ENM density. This classification provides additional information about the drivers of the niche dynamic between diploid and autotetraploid lineages (Guisan et al., 2014, Petitpierre et al., 2012, Di Cola et al., 2017).

CHAPTER 3

Polyploidy is not an evolutionary ‘dead-end’ in the Brassicaceae

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3.1 Abstract

Although polyploidy, or whole-genome duplication, is widespread across the Plant Tree of Life, its long-term evolutionary significance is still poorly understood. Here we examine the effects of polyploidy in driving macroevolutionary patterns within the angiosperm family Brassicaceae, a speciose clade exhibiting extensive inter-specific variation in chromosome numbers. We inferred ploidy levels from haploid chromosome numbers for 80% of species in the most comprehensive species-level chronogram for the Brassicaceae published to date. Here we show that ploidy drives diversification rates across the Brassicaceae, with polyploids experiencing faster rates of speciation and extinction, but slower rates of diversification. Nevertheless, diversification rates are, on average, positive for both polyploidy and diploidy. We also show that despite diversifying significantly slower than diploids, polyploids have played a significant role in driving present-day differences in species richness among clades within the Brassicaceae. Overall, although most polyploids go extinct before sustainable populations are established, rare successful polyploids persist to significantly contribute to the long-term evolution of lineages. Our findings, suggesting that polyploidy has played a major role in shaping the long-term evolution within the Brassicaceae, highlight the importance of polyploidy in driving diversity patterns across the Plant Tree of Life.

3.2 Introduction

Although polyploidy—the heritable condition of carrying more than two complete sets of chromosomes—is widespread across the plant phylogeny, its evolutionary significance is still debated (Soltis et al., 2009, Van de Peer et al., 2009, Mayrose et al., 2011, Arrigo and Barker, 2012, Tank et al., 2015). Discussions on the evolutionary role of polyploidy in plant evolution date back to Stebbins (1950, 1970) and Wagner (1970) who considered polyploidy to have negligible effects on the long-term evolution of lineages. This idea, later known as the 'dead-end' hypothesis in polyploidy, was recently restated such as polyploids are predicted to undergo extinction more frequently than diploids (Mayrose et al., 2011, Arrigo and Barker, 2012, Wood et al., 2009, Mayrose et al., 2015, Estep et al., 2014).

We note that polyploidy can influence the long-term evolution of lineages (Paterson et al., 2004, De Bodt et al., 2005, Jaillon et al., 2007, Fawcett et al., 2009, Jiao et al., 2011) regardless of whether polyploids are more likely to go extinct than diploids (Mayrose et al., 2011, Arrigo and Barker, 2012, Wood et al., 2009, Mayrose et al., 2015, Estep et al., 2014). Both interpretations of the 'dead-end' hypothesis are thus not equivalent to each other. Specifically, while the original hypothesis is focused on the evolutionary role of polyploidy as a process (Stebbins, 1950, Stebbins, 1970, Wagner, 1970), the modern perspective compares macroevolutionary rates between polyploids and diploids (Mayrose et al., 2011, Arrigo and Barker, 2012, Wood et al., 2009, Mayrose et al., 2015, Estep et al., 2014). Discussions around the role of polyploidy (or polyploids) in the evolution of plant lineages have, therefore, been obscured by the fact that different interpretations of the 'dead-end' hypothesis are identically named.

Here we examine the long-term evolutionary significance of polyploidy in the evolution of plants (Stebbins, 1950, Stebbins, 1970, Wagner, 1970). Specifically, we test if polyploids have significantly contributed to the long-term evolution of plants, despite being more likely to experience extinction than diploids (Mayrose et al., 2011, Arrigo and Barker, 2012, Wood et al., 2009, Mayrose et al., 2015, Estep et al., 2014). We predict that if rare successful polyploids have significantly contributed to present-day diversity patterns (Arrigo and Barker, 2012), polyploidy (as a process) is not an evolutionary dead-end. Here, we first use state-of-art methods to test the relationship between diversification rates and ploidy. We then examine the role of polyploidy in driving the long-term evolution across clades.

Our analyses are based on the Angiosperm family Brassicaceae, an ideal lineage for studying the short- and long-term significance of polyploidy in the evolution of flowering plants. The systematics and evolutionary history of this angiosperm family have been studied extensively (Al-Shehbaz et al., 2006, Beilstein et al., 2006, Hohmann et al., 2015). Furthermore, a comprehensive species-level phylogeny for the family including ~48% of the extant species (1,667 out of ~3,500 species; The Plant List, 2013, Smith and Brown, 2018) was recently published. Haploid chromosome counts, which are here used in to infer species ploidy, are available for ~55% of extant species within the family (The Plant List, 2013, Rice et al., 2015, Lysak, 2018). Ploidy levels were inferred using a model-based (Mayrose et al., 2010, Glick and Mayrose, 2014) for a total of 1,336 species, representing more than 80% of the species in the tree and almost 40% of the total family richness. We then used the compiled ploidy database, along with the Brassicaceae phylogeny, to examine the role of ploidy in driving macroevolutionary rates within the family.

First, we analyzed the fit of different trait-dependent and trait-independent models of diversification that accounted for the potential effects of unassessed traits (i.e., hidden states; Hidden State Speciation and Extinction models; HiSSE; Beaulieu and O'Meara, 2016b) or not (Binary State Speciation and Extinction models; BiSSE; Maddison et al., 2007, FitzJohn et al., 2009). We found that polyploid lineages have experienced faster rates of speciation and extinction. However, net diversification rates were faster in diploids, with both polyploids and diploids diversifying, on average, at positive rates. Next, we test whether polyploid-generated diversity has significantly contributed to the present-day differences in species richness among clades. We used phylogenetic path regression models (Gonzalez-Voyer and Von Hardenberg, 2014), based on 65% of the total genera in the family (243 out of 372), to test for the indirect contribution of polyploidy richness on differences in species among clades in the Brassicaceae. We compared models that assumed clade richness to be affected only by diversification rates and clade age, or polyploid and diploid richness influencing clade richness through net rates of diversification.

Overall, we found polyploidy to influence differences in species richness among genera positively. We, therefore, suggest that although polyploids are more likely to experience extinction than diploids, rare successful polyploids diversify and significantly influence the long-term evolution of particular lineages within the Brassicaceae. Our analyses show that polyploidy is not an ‘evolutionary dead-end’ (Stebbins, 1950, Stebbins, 1970, Wagner, 1970), but, instead, an important source of evolutionary novelty within clades, that has major implications in driving present-day diversity patterns in plants.

3.3 Results

We collected haploid chromosome counts for 816 Brassicaceae species representing 49% of taxa sampled in the phylogeny (Smith and Brown, 2018) and 24% of the total family richness (The Plant List, 2013; Table S3.1). We used this database to infer species ploidy levels for 1,333 in the tree (80% of the species in the tree, and 38% of the total family richness; Fig. 3.1; Table S3.2) using on the likelihood-based approach implemented in ChromEvol Perl package (Mayrose et al., 2010, Glick and Mayrose, 2014). Overall, we found that nearly a half of the analyzed Brassicaceae species were polyploids (n=654) and that these lineages were phylogenetically clustered in particular branches of Brassicaceae phylogeny (Pagel's lambda=0.816, P<0.001; D-statistic=0.006, P<0.001; Fig. 3.1).

We then explored the association between diversification rates and changes in ploidy across the Brassicaceae phylogeny. For this, we compared the fit of ten different hypotheses of trait-dependent diversification models that accounted for the potential effects of unassessed traits (n=6; hidden states; Hidden State Speciation and Extinction models, HiSSE; (Beaulieu and O'Meara, 2016b); Table S3.3) or not (n=4; Binary State Speciation and Extinction models, BiSSE; (Maddison et al., 2007, FitzJohn et al., 2009); Table S3.3). The fit of each of these ten alternative models was then compared against two null models that assumed diversification rates to be independent of ploidy changes. Overall, we found that changes in ploidy were important drivers of diversification rates across the Brassicaceae (Fig. 3.1; Table S3.3). The favored hypothesis, a HiSSE model assuming trait-dependent diversification (next model ΔAICc=385.589; Table S3.3), suggested that, in addition to unassessed traits (i.e., hidden states), ploidy has played a significant role in driving diversification rates across the phylogeny (Table S3.3).

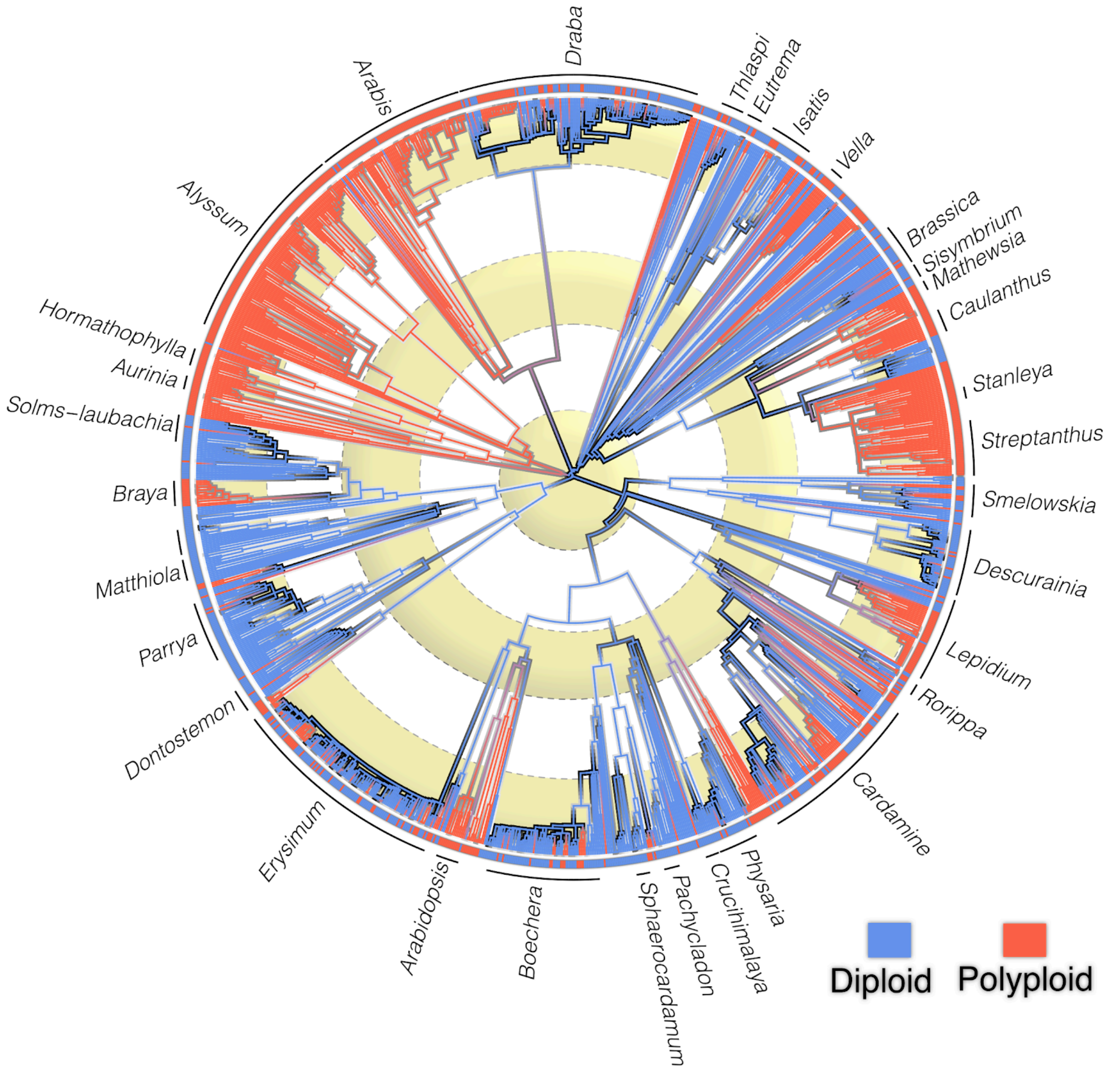

Figure 3.1 Phylogeny depicting the temporal evolution of ploidy across 1,366 Brassicaceae species (nearly 40% of the total family richness). Species are here coded as diploid or polyploid based on the evolution of haploid chromosome numbers across the tree. Ploidy levels were inferred using the Ploidy Inference Pipeline implemented in ChromEvol. We also show the ancestral state reconstruction of ploidy based on the best-fitting Hidden State Speciation and Extinction (HiSSE) model. Specifically, the favored HiSSE model assumed ploidy changes to influence diversification rates across the tree significantly. We depict also depict variation in net diversification rates across branches of the phylogeny – fast-evolving branches are marginally highlighted in black. Ancestral state reconstructions shown here are for visualization of diversification rates, and not used to ploidy changes across the tree. Instead, the ancestral state reconstruction for chromosomal numbers across the Brassicaceae is based on ChromEvol subtrees. Rings in the background are placed each ~5 My.

Our analyses indicate that polyploids, on average, speciate 48.7% faster (mean speciation rate polyploids=1.063 events My^{-1}, diploids=0.715 events My^{-1}; Fig. 3.2; Table S3.4), and experience extinction 73.3% faster relative to diploids (mean extinction rate polyploids=0.863 events My^{-1}, diploids=0.498 events My^{-1}; Fig. 3.2; Table S3.4). Congruently, we found that while diploids diversify 8.5% faster (mean diversification rate polyploids=0.199 events My^{-1}, diploids=0.216 events My^{-1}; Fig. 3.2; Table S3.4), the evolutionary turnover in polyploids is 58.8% faster (mean turnover rate polyploids=1.926 events My^{-1}, diploids=1.213 events My^{-1}; Fig. 3.2; Table S3.4). In sum, our analyses suggest that despite polyploids diversify slower than diploids, their net rates of diversification are, on average, positive.

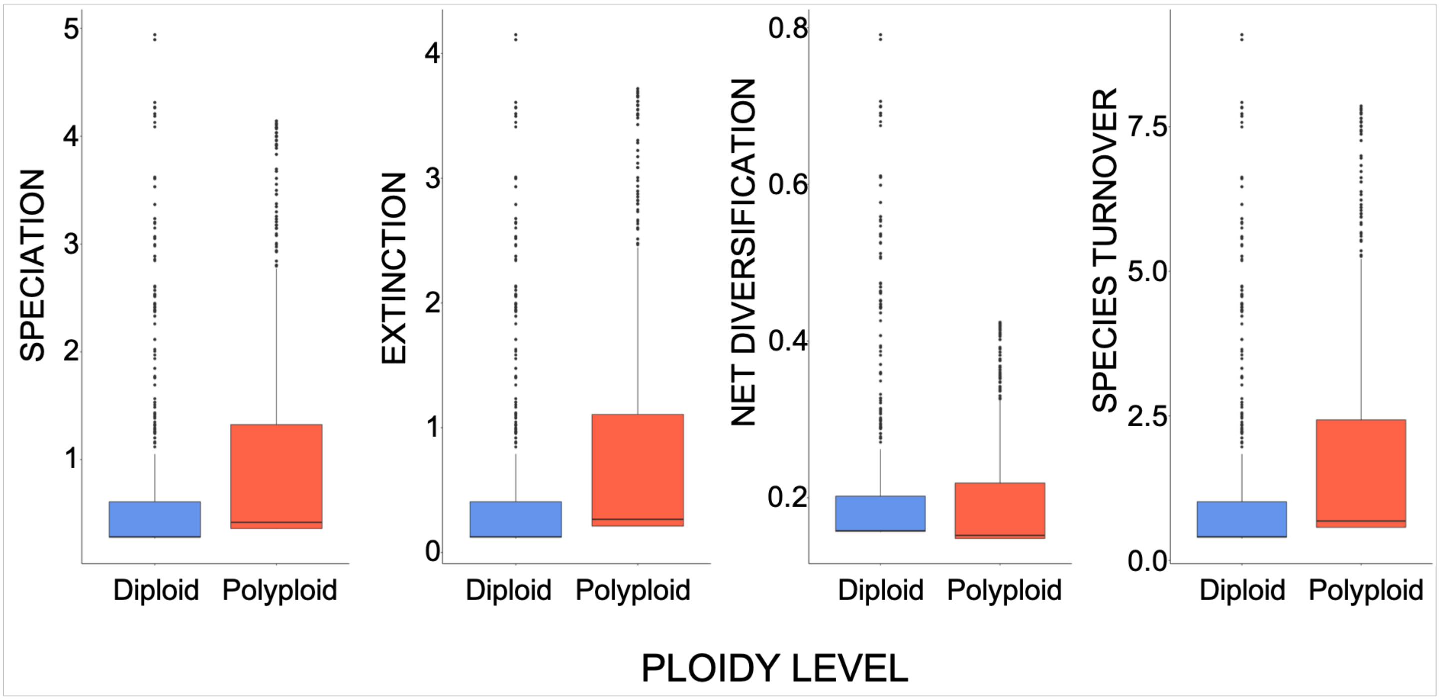

Figure 3.2 Comparison of observed macroevolutionary rates between diploid and polyploids in the Brassicaceae. Rates units in events My^{-1}.

It is still unclear, however, whether polyploidy-generated diversity has significantly contributed to present-day differences in species richness across clades in the Brassicaceae. Here, we based our analyses on 97% of genera in the tree and 65% of the total generic richness within the family (Table S3.5). First, we used phylogenetic generalized least squares (PGLS) models to test whether polyploid richness influences species richness through diversification rates. Strikingly, we found that 16–30% of the variance in net diversification rates is explained by polyploid richness (log-transformed polyploid richness versus net diversification rates; PGLS slope=0.085–0.444, r^2=0.166–0.304, P<0.001; Table S3.6). Second, we used 14 phylogenetic path regression models to test whether polyploid richness has indirectly shaped present-day patterns of species richness among clades through diversification rates (Table S3.7; Fig. 3.3). We found, based on the best-fitting model, that polyploidy is an indirect driver of differences in species richness among clades across the Brassicaceae (next model ΔCICc=21.021; Fig. 3.3; Table S3.7). Specifically, we show that despite diploids contribute four times more than polyploids to net diversification rates, polyploidy-generated diversity has significantly influenced species richness through its effect on net diversification rates.

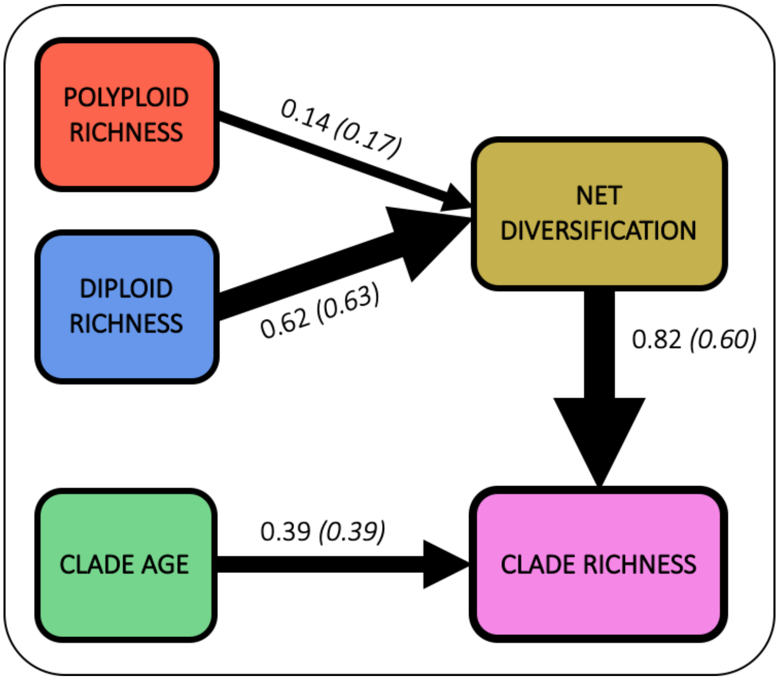

Figure 3.3 Path analysis showing the preferred drivers of species richness differences across clades in the Brassicaceae. Results are based on 65% of the total generic richness within the family. We show results for the best-fitting phylogenetic path model. This model included the indirect effects of polyploid and diploid richness on species richness. We also note that the selected model assumed clade richness to directly influenced by clade age and net rates of diversification. Here, polyploid richness is simply the number of polyploid species within each clade (based on ChromEvol analyses). We note that, contrary to the frequency of polyploidy, polyploid raw richness was a significant predictor of diversification rates explaining 16–30% of the variance. We present results for both stem-based MS and DR rates. We acknowledge that DR rates are usually referred to as related to speciation, but results are congruent to those based on MS. Path coefficient for MS estimator are indicated below each arrow outside of parentheses. DR-related coefficients are indicated next to MS-related coefficients but in parentheses. Finally, the clade age is always based on stem groups.

3.4 Discussion

We investigated the long-term evolutionary significance of polyploidy in the Brassicaceae. To our knowledge, our study based on 80% of the taxa in the largest species-level phylogeny for the Brassicaceae, representing 38% of the total species diversity, and 65% of genera, is by far the most comprehensive study ever conducted examining the role of polyploidy in shaping the present-day diversity within a single plant lineage. Our analyses highlight three main aspects of the role of polyploidy in influencing the evolution within the Brassicaceae. First, polyploidy is not rare in the family with nearly 50% of species inferred as polyploids. Second, because species turnover is relatively higher in polyploids, we recover the creative role of polyploidy in the evolution of the Brassicaceae. Third, we found that polyploidy has significantly shaped present-day differences in species richness among clades in the Brassicaceae. Below, we discuss the implications of our findings in the family and contextualize their implications in the understanding of diversity patterns across the Plant Tree of Life.

How does polyploidy influence macroevolutionary rates? —Polyploidy is associated with increased speciation, extinction, and turnover rates in the Brassicaceae. Even though net diversification rates are positive in polyploids, these rates are higher in diploids relative to those in polyploids. We acknowledge that previous studies have discussed the evolutionary trade-offs associated with polyploidy (Comai, 2005, Otto, 2007, Sémon and Wolfe, 2007, Madlung, 2013, Van De Peer et al., 2017). Thus, we first focus on explaining why polyploidy increases both speciation and extinction rates. Then, we explore the creative role of polyploidy in the evolution of Brassicaceae, and finally, we discuss the long-term consequences of polyploidy in driving present-day differences in species richness.

Speciation rates are predicted to be higher in polyploids relative to diploids. Specifically, polyploids are more likely to colonize and successfully establish in habitats that are potentially unsuitable for diploids (Theodoridis et al., 2013, Harbert et al., 2014, Thompson et al., 2014, Hulber et al., 2015, Lopez-Alvarez et al., 2015, Zozomova-Lihova et al., 2015, Marchant et al., 2016, Visger et al., 2016, Molina-Henao and Hopkins, 2019). From a genomic perspective, the increased speciation rate found in polyploids could potentially be explained by their ability to mask deleterious mutations, increased number of gene copies that can potentially harbor new beneficial mutations or changes in gene regulation that favor genome plasticity (Comai, 2005, Otto, 2007, Sémon and Wolfe, 2007, Madlung, 2013, Van De Peer et al., 2017). Nevertheless, we note that both ecological/physiological and genomic hypotheses should be considered when explaining why does polyploidy trigger speciation rates in the Brassicaceae.

The role of extinction in shaping the evolution of polyploids has been widely discussed before. In agreement with previous studies, our results suggest that polyploids are more likely to go extinct than diploids. The specific triggers of extinction in polyploidy has been a matter of recent discussion; for instance, polyploidy may (i) increase asexual reproduction and self-compatibility which generally decrease effective population sizes (Soltis et al., 2010, Otto and Whitton, 2000), (ii) exhibit (specially autopolyploids) increased rates of segregation errors during meiosis (Parisod et al., 2010), (iii) increase the accumulation of deleterious mutations and ultimately cause fitness reductions (Otto and Whitton, 2000), (iv) may generate species that are poorly suited for available niches due to genomic shock following hybridization which undergo higher extinction risk (Arrigo and Barker, 2012). Nevertheless, coupled with the creative role of polyploidy in plant evolution (see below), most polyploids are expected to be unsuccessful evolutionary ‘experiments’ that are quickly wiped out from clades.

Finally, we note that the relative importance of polyploids in shaping plant evolution should not exclusively be inferred from extinction or speciation rates alone (Arrigo and Barker, 2012). A comprehensive approach for examining the evolutionary role of polyploidy should also account for differences in net diversification and species turnover among lineages. Here, we found that Brassicaceae polyploids (i) experience species turnover much faster than diploid relatives, and (ii) diversify slower than diploids, but at positive rates. Our results on species turnover and net diversification rates combined suggest that polyploidy is a creative process in the evolution of the Brassicaceae by enabling lineages to ‘explore’ novel genotypic and phenotypic combinations that, in some particular cases, are successful (i.e., able to establish and diversify). Our results show that when polyploid lineages are successful, these lineages diversify and significantly contribute to clade richness. However, we highlight that although it is more likely for polyploids to undergo extinction than to be successful, polyploidy is still an important process driving differences in species richness among clades.

How does polyploidy influences species richness? —Different descriptors of lineage macroevolution are central to the alternative definitions of ‘dead-end’ hypothesis in polyploidy (e.g., speciation, extinction, diversification, turnover, clade richness). For instance, if a ‘dead-end’ is defined based on the long-term evolutionary contribution among lineages, one would have to focus on estimating the contribution of polyploidy in ultimately driving differences in species richness among clades. Conversely, if a ‘dead-end’ is defined based on the relationship between extinction and net diversification rates between polyploids and diploids, one should focus on comparing extinction and net diversification rates between polyploids and diploids. We note again that the latter definition of the ‘dead-end’ (exclusively based on macroevolutionary rates) provides an alternative and non-equivalent interpretation of the original definition based on the long-term evolutionary consequence of polyploidy. Here we found using the Brassicaceae, that polyploidy positively influences differences in species richness among clades.

However, despite the fact that the contribution of polyploids to clade richness is significant, diploids contribute significantly more that polyploids. We, therefore, highlight that under the classic definition of the dead-ends hypothesis, polyploidy is not an 'evolutionary dead-end' but a central driver of evolutionary diversification (Soltis et al., 2009, Freeling, 2009, Huminiecki and Conant, 2012, Garsmeur et al., 2013, Mayfield-Jones et al., 2013).

Overall, we note that a positive association between polyploid richness and species richness has been demonstrated both theoretically and using real-world data (Otto and Whitton, 2000, Vamosi and Dickinson, 2006). Based on this perspective, the positive association between clade richness and polyploid numbers found in our study could either be just a simple artifact of the analyses we utilized, or the consequence of diploidization rates being significantly low ('ratchet' model of polyploidy (Meyers and Levin, 2006, Scarpino et al., 2014). Nevertheless, we note three main aspects that suggest our results are not affected by the "inertia" in polyploid richness. First, previous analyses on the relationship between species richness and polyploid richness assumed clades to be independent of each other. However, because lineages share an evolutionary history, the phylogenetic relationships between them can potentially influence the association between polyploid richness and clade richness. Second, we account for the effect of clade age in the association between polyploid richness and clade richness. Specifically, if polyploidization rates outnumber diploidization, more polyploids are expected to be accumulated not only in richer clades but also in the older ones. This temporal scaling (Scholl and Wiens, 2016, Henao-Diaz et al., 2019) was not accounted for by previous studies on the association between polyploidy and clade richness. Third, we note that polyploid richness does not directly influence clade richness. In particular, our analyses suggest that ploidy affects diversification rates before influencing clade richness.

Finally, we note that the association between clade richness and polyploid richness could be driven by the differential contribution of allo- and autopolyploids to the overall polyploid richness. Specifically, one would expect allopolyploid richness to be positively associated with clade richness given that allopolyploids lineages are potentially more likely to be formed in species-rich clades. Nevertheless, it is also known that successful allopolyploids are more likely to be formed by distantly related diploids than closely related ones (Buggs et al., 2008, Soltis and Soltis, 2009). Autopolyploidy, on the other hand, is potentially unrelated to clade richness. Our analyses based on chromosomal counts cannot differentiate between allo- and autopolyploids. However, we found that models assuming polyploid richness to be dependent on clade richness fitted worse than other models. Thus, it is unlikely that the association between polyploid richness and clade richness is an artifact of the predicted diversity-dependence richness in allopolyploids. We acknowledge, however, that this question remains to be explored in further studies.

Are polyploids 'evolutionary dead-ends'? —The traditional perspective on polyploids as 'evolutionary dead-ends' dates back to Stebbins (Stebbins, 1950, Stebbins, 1970) and Wagner (Wagner, 1970). These authors suggested that polyploidy does not contribute significantly to long-term evolution. However, recent studies (Mayrose et al., 2011, Arrigo and Barker, 2012) have used this concept to mean that polyploids are more likely to go extinct than diploids are. We suggest that despite extinction rates are ultimately related to the long-term significance of polyploidy, their contribution in driving present-day diversity patterns can also be affected by other aspects such as diversification and turnover rates.

Nonetheless, the long-term contribution of polyploidy should not only be measured in terms of the macroevolutionary parameters but also, on whether polyploidy contributes to species richness differences among clades. Finally, we think that it is important to distinguish between polyploids (i.e., lineages) as being ‘dead-ends’ and polyploidy (i.e., trait or a process) as a ‘dead-end.’ We conclude polyploidy is not an ‘evolutionary dead-end’ given that although most polyploids arise but fail to persist, those that persist are important drivers of diversification.

Polyploidy and the Angiosperm Tree of Life**—**Our results recovering polyploidy as a major driver of diversification and species richness differences among clades shows that polyploidy is not an ‘evolutionary dead-end’ in the Brassicaceae. We suggest that our findings can be extended to other branches of the Plant Tree of Life. Specifically, our findings in the Brassicaceae (i.e., a high phylogenetic signal in polyploidy, and a high frequency across clades) are potentially an optimal indicator of polyploidy being an important driver of the macroevolution within other plant lineages. Nevertheless, we acknowledge that further quantitative studies are required to examine the specific relationship between diversification rates, clade richness, and ploidy across the Plant Tree of Life.

Here we compare our estimates of polyploidy frequency in the Brassicaceae, where nearly half of extant diversity is polyploid, to previous estimates of polyploid frequency in other lineages of the Angiosperm Tree of Life. Specifically, because polyploid frequency in lineages such as Asteraceae (47–64%; Góralski et al., 2014), Poaceae (62–67%; Paterson et al., 2004, Góralski et al., 2014, Blanc and Wolfe, 2004, Malcomber and Kellogg, 2005, Schlueter et al., 2004), Rosaceae (84%; Góralski et al., 2014), Higher monocots (46.58%; Wood et al., 2009), Solanaceae (Schlueter et al., 2004), Fabaceae (Lavin et al., 2005, Pfeil et al., 2005), and Cleomaceae (Schranz and Mitchell-Olds, 2006), are similar (or larger) than in the Brassicaceae, polyploidy has potentially been a major macroevolutionary driver in these other lineages. The influence of ploidy in the long-term evolution is potentially not only restricted to the Brassicaceae but likely to have a positive effect on diversity in other branches of the Plant Tree of Life.

Conclusions—We show that polyploidy is not 'evolutionary dead-ends' in the Brassicaceae. We demonstrate that polyploids are frequently 'dead-ends,' but those that are successful significantly contribute to the long-term evolution of the family. Our analyses show that polyploidy has played a significant role in driving macroevolutionary patterns within the Brassicaceae by influencing both speciation and extinction rates. We also show that polyploids have indirectly shaped the present-day differences in species richness among clades within the Brassicaceae, despite diversifying slower than diploids. We suggest that polyploidy in plants, instead of being an 'evolutionary dead-end,' is a major source of evolutionary innovation within particular clades of the Angiosperm Tree of Life. Furthermore, by demonstrating the significant role of polyploidy in shaping present-day diversity patterns within a single Angiosperm family, we also show that polyploids are an inevitable and substantial part in the origins of its plant diversity. Polyploidy has potential implications in explaining higher-level diversity patterns across the Angiosperm Tree of Life.

3.5 Methods

Brassicaceae phylogeny—The relationship between polyploidization and diversification rates is expected to be influenced, among others, by the phylogenetic relationships among species, and the evolutionary timing represented in branch lengths (Beaulieu and O'Meara, 2016b, Maddison et al., 2007, Soltis et al., 2014, Beaulieu and O'Meara, 2016a). Since the phylogeny and timing of evolution in the Brassicaceae has been extensively discussed before (Al-Shehbaz et al., 2006, Beilstein et al., 2006, Hohmann et al., 2015, Hall et al., 2002, Bailey et al., 2006, Beilstein et al., 2008, Franzke et al., 2016, Guo et al., 2017), we focused on analyzing the association between diversification rates and ploidy changes across the phylogeny. Our analyses are based on the Brassicaceae subtree extracted using the extract.clade function (ape R package version 5.2; Paradis et al., 2004) from the original GBMB Angiosperm phylogeny from Smith and Brown (Smith and Brown, 2018). The Brassicaceae subtree, including a total of 1,667 species (we pruned 100 tips corresponding to subspecies), is currently the largest-species level chronogram of the family. This phylogeny was constructed using PyPHLAWD based on GenBank release 218 (February 2017), with calibration points following Magallón et al. (2015). Additional methodological details are summarized in Smith and Brown (Smith and Brown, 2018) and https://github.com/FePhyFoFum/big_seed_plant_trees.

Ploidy inference—Chromosome number for each species in the tree were retrieved from the Chromosome Count Database (CCDB; Rice et al., 2015) using the chromer R package version 0.1 (Pennell, 2016). Raw haploid chromosome counts are provided in Table S3.1. Species ploidy levels were then inferred using a maximum likelihood approach using the Ploidy Inference Pipeline implemented in ChromEvol v.2.0 (Mayrose et al., 2010, Glick and Mayrose, 2014). Furthermore, we also used a more conservative approach for estimating ploidy levels from haploid chromosome counts. Results for this alternative non-model-based method were congruent to the ones based on ChromEvol and are presented in the supplement for this article.

Model-based ploidy inference analyses in ChromEvol failed to run on the full Brassicaceae phylogeny, consisting of 1,667 species, and with chromosome counts ranging between 4 and 156 (Table S3.1). We note that the inference of species ploidy under ChromEvol represents a challenge given the size of the tree and variation in chromosomal counts (among and within) species. Specifically, no study has used ChromEvol for analyzing chromosomal number evolution in phylogenies with more than 600 tips. Previous studies have analyzed trees containing between 18 and 588 species (Mayrose et al., 2011, Mota et al., 2016, Crowl et al., 2016, Glick et al., 2016, Schneider et al., 2017, Ogutcen and Vamosi, 2016, Pimentel et al., 2017, Pereira et al., 2018, Yang et al., 2017, Garcia et al., 2008, McCann et al., 2016, Escudero et al., 2018, De Oliveira et al., 2015, Moraes et al., 2017, Moraes et al., 2015, Campbell et al., 2016, Carnicero et al., 2017). Then, we developed an alternative approach to infer ploidy levels on our dataset (1,667 species). First, we estimated the median chromosome number across all the available counts for each species (Salman-Minkov et al., 2016). This approach reduces the computational time required to run ChromEvol while summarizing the overall trend in chromosomal counts within each species. Second, we extracted all possible subtrees from the Brassicaceae phylogeny using the subtrees function implemented in the ape R package (Paradis et al., 2004). Then, we selected subtrees with (i) size between 25 and 550 species, and (ii) a maximum of 70% of missing data (i.e., species lacking chromosome counts). We run the Ploidy Inference Pipeline (PIP) in the resulting 342 subtrees.

We used the default parameters for each Chromevol run. We allowed ChromEvol to optimize the base number for each subtree. The PIP first compares the fit (AICc; Hurvich and Tsai, 1989) among ten probabilistic models of chromosome count evolution along branches as a function of polyploidy and dysploidy (Mayrose et al., 2010). Confidence in ploidy assignment based on the best-fitting model is assessed from 100 simulations (Mota et al., 2016, Zhan et al., 2014). By last, PIP classifies each taxon as polyploid if the maximum likelihood estimate of polyploidization from the root to the tip is larger than 0.9 or assigns a diploid state otherwise. The PIP allowed us to infer ploidy levels for 517 species lacking chromosome counts. Unassigned species are those with assignment probability lower than 0.9. Finally, we note that some authors often refer to PIP-inferred polyploids as neopolyploids (Zhan et al., 2014, Zhan et al., 2016). However, we refer these lineages as polyploid given that the subtrees do not follow taxonomic limits (i.e., generic-level analyses as used in other studies).

Alternatively, we inferred species ploidy level relative to their generic base following Stebbins (Stebbins, 1938) and others (Wood et al., 2009, Klekowski Jr, 1973, Goldblatt, 1980). Precisely, we coded species as polyploid where sporophytic (2n) counts were greater than or equal to 3.5 times the lowest haploid (n) count of the corresponding genus (Table S3.2). However, main results are based on ChromEvol given that (i) chromosome evolution in the Brassicaceae is faster than the assumed using the Stebbins' fraction, (ii) Stebbins' fraction depends on taxonomic delimitation, and (iii) ploidy cannot be estimated for species with missing data under the Stebbins method. For the latter reason, species-level sampling decreases to a half of analyzed richness under the ChromEvol database (i.e. 642 fewer species and 104 fewer genera than the database constructed using ChromEvol).

***Testing for phylogenetic signal in ploidy*—**W analyzed the phylogenetic signal in ploidy across the Brassicaceae phylogeny using Pagel's Lambda (Pagel, 1999) and the *D*-statistics (Fritz and Purvis, 2010). The first index measures the fit of the data to a Brownian motion model in which trait evolution matches the phylogeny. Lambda values close to 1 suggest a high phylogenetic signal in the trait, and values close to zero indicates that trait to be randomly distributed across the phylogeny (Pagel, 1999). We used the phylosig function in Phytools version 0.6-60 (Revell, 2012), to estimate the Lambda value in ploidy across the tree. Statistical significance was approached on 1,000 simulations. Alternatively, the *D*-statistics measure the phylogenetic signal of binary traits (such as ploidy). We estimated the phylogenetic signal under the *D*-statistics using the phylo.d function in the Caper R package version 1.0.1 (Orme, 2013). Values of *D*-statistic close to 0 indicates the trait conservatism expected under Brownian motion, and a value of 1 indicates a random distribution of the trait across the tree (Fritz and Purvis, 2010). For both analyses, the ploidy database is provided in Table S3.2.

Species-level diversification analyses—We used both Binary State Speciation and Extinction models (BiSSE; Maddison et al., 2007, FitzJohn et al., 2009) and Hidden State Speciation and Extinction models (HiSSE; Beaulieu and O'Meara, 2016b) to examine the importance of ploidy changes on the Brassicaceae diversification. These models also allowed us to quantify rates of speciation and extinction associated with polyploid and diploid states. BiSSE models were fitted using the diversitree R package version 0.9-10 (FitzJohn, 2012). HiSSE models were fitted using the hisse R package version 1.8.9 (Beaulieu and O'Meara, 2016a, Beaulieu and O'Meara, 2016b). Species were coded as being either diploid (0) or polyploid (1) based on ChromEvol-inferred ploidy states. We specified the following sampling fraction in both BiSSE and HiSSE models based on the ploidy database generated using ChromEvol: diploid=0.499, polyploid=0.501 (Table S3.2).

We fitted a total of 12 different trait-dependent diversification models (both BiSSE and HiSSE; Table S3.3). Four of the analyzed models corresponded to a hypothesis of trait-dependent diversification under a BiSSE framework. Using hisse function in the hisse R package, we first fitted a model assuming turnover, extinction, and transition rates to be constrained between states (i.e., diploid and polyploid). A second model constrained only transition rates between states, with turnover and extinctions free between states. A third model constrained both turnover and extinction rates to be equal between states but allowed transition rates to vary between states. Finally, we fitted a model allowing all parameters to be free between states (turnover, extinction, and transition rates).

Next, we focused on fitting ten additional models under a HiSSE framework (Table S3.3). We first fitted two-character independent models (CID2, CID4) that assumed diversification rates to be exclusively driven by the hidden states (states A or B; not by the observed states 0 or 1). We fitted a 2-state character independent model using the hisse function in the hisse package. This null model has the same number of parameters as a BiSSE model (see above; Beaulieu and O'Meara, 2016b). We specified only two free parameters in the turnover.anc, and eps.anc arguments of the hisse function (one parameter for 0A and 1A, and another parameter for 0B and 1B). Alternatively, we fitted the 4-state character independent model under default parameters using the hisse.null4 in the hisse R package. This null model has the same complexity as a general HiSSE model. The remaining six HiSSE models correspond to alternative hypotheses of trait-dependent diversification. These models were fitted using the hisse function implemented in the hisse R package. Specifically, we first fitted a model with two hidden states being present, independent turnover and extinction parameters across the four states, and transition rates constrained to be equal. The second and third HiSSE models assumed only a single hidden state (hidden state present in either state 0 or 1), with turnover and extinction rates set to be free among states. Transition rates constrained to be equal between states. HiSSE models four and five that assumed only a single hidden state for each observed state (hidden state for either state 0, or 1). All the remaining parameters (turnover, epsilon, and transition rates) were set free between states. Finally, we fitted a full HiSSE. This model includes two hidden states, assumes independent diversification parameters across states, and allow for different transition rates among states.

We compared the fit among the analyzed 12 models using Akaike Information Criteria (Akaike, 1974) (AIC values: dAIC, and wAIC; Table S3.3). Akaike weights were estimated using the akaike.weights in the qpcR R package version 1.4-1 (Ahmed and Kim, 2018). We then focused on analyzing the outcome of the best fitting model(s). For this, we used the MarginRecon (hisse R package) to visualize the association between ploidy changes and diversification rates across the Brassicaceae phylogeny. We also estimated the confidence intervals for speciation and extinction rates associated with each state in the best fitting model(s) using the SupportRegion implemented in the hisse R package. Finally, we summarized rates of speciation, extinction, and net diversification at the tips of the tree by running the GetModelAveRates (hisse R package) on the marginal reconstruction object from the best-fitting model.

Clade-level diversification analyses—We analyzed the role of polyploid species in driving species richness among Brassicaceae genera using phylogenetic regressions (Martins and Hansen, 1997) and phylogenetic path analyses (Gonzalez-Voyer and Von Hardenberg, 2014). We first constructed an ordinal-level phylogeny for the family by pruning from each genus, all species except one. This step was conducted using the drop.tip function in the ape R package. We note that 97% of genera in the tree were monophyletic (243 out of the total 250). The remaining 3% non-monophyletic genera (n=7) were simply excluded from the phylogenetic path analyses. We also highlight that 51% of Brassicaceae genera were excluded from crown-based analyses. These lineages were represented by a single species in the tree (124 of 243). Stem-based analyses are, however, based on all the 243 analyzed genera.

We first constructed a database summarizing clade-level diversification rates (two different estimators; see below), species richness, clade age (stem and crown), and the proportion of polyploid species within clades. We retrieved species richness for each of the 243 analyzed genera from (The Plant List, 2013). We estimated rates of diversification within each genus using the Method-of-Moments estimator (MS hereafter; Magallon and Sanderson, 2001). Net diversification was estimated for the crown and stem groups after assuming three different relative extinction fractions (e=0, e=0.5, and e=0.9). MS rates were estimated using the bd.ms function implemented in the geiger R package version 2.0.6.1 (Harmon et al., 2008, Pennell et al., 2014). Note that stem-based rates are available for all 243 genera, but only 119 were included in crown-based analyses.

Alternatively, we estimated species-specific rates of diversification (potentially reflecting speciation rates; (Belmaker and Jetz, 2015, Quintero and Jetz, 2018) based on the DR statistic (Jetz et al., 2012, Steel and Mooers, 2010). We estimated species-specific rates based on the full species-level phylogeny of the Brassicaceae (1,667 species). Species-specific DR rates, summarized in Table S3.8, were then used to estimate the mean DR within genera (*n*=243).

We summarized the richness of polyploids within each clade using three different indexes. First, we simply obtained the absolute number of polyploid species within each genus (log-transformed). Second, we estimated the ratio between polyploid richness within each clade and the total number of species sampled in the tree for the same genus. Third, we estimated the ratio between polyploid richness and total clade richness. The analyzed database including clade age, richness, diversification rates, and proportion of polyploids is provided in Table S3.5. Then, we tested whether diversification rates among genera was influenced by polyploidy. We specifically tested the relationship between MS and DR rates against each of the three indexes of polyploid richness (see above). Phylogenetic regressions (Harvey and Pagel, 1991) were fitted using the Caper R package. We used the pgls function from the same package and allowed lambda to be estimated from the dataset.

Finally, phylogenetic path analyses were used to test the indirect effect of polyploidy in species richness among clades. The following procedure was repeated for each polyploidy index that was found to significantly predict diversification rates (see above PGLS). Models were fitted using the define_model_set function implemented in the R phylopath package version 1.0.2 (van der Bijl, 2018). Models were analyzed in phylopath package under a lambda model of evolution developed to analyze continuous traits. We fitted and compared a total of 30 phylogenetic path models (25 MS-based models, and five DR-based) that tested the indirect contribution of polyploidy in species richness among Brassicaceae genera. However, the main results are presented for stem-based rates of net diversification based on MS estimator (see below). Results were largely congruent to those based on DR rates because both approaches included all the 243 analyzed genera. Phylogenetic path regression models assumed different clade age (stem, crown), diversification rate estimates (MS based on crowns or stems, or DR), and variable influence of polyploid and diploid richness on net diversification rates. Our main results are, therefore, based on both stem-based MS and DR (all clades are included). Models were compared using a modified version of the Akaike Information Criteria (AIC; Akaike, 1974) that was developed for phylogenetic path analyses. This index is known as the C statistic Information Criterion (i.e., CIC statistic; Cardon et al., 2011) and is also calculated in the phylopath R package.

Finally, we highlight that missing data have a significant effect on the inferred effects of ploidy on species richness (through net diversification rates). Specifically, our results were congruent when DR and stem-based MS rates were analyzed for 243 of the genera, but crown-based results for MS estimator, where 119 clades were excluded, were remarkably different. Given the effect of missing data on the resulting patterns, we did not perform phylogenetic path analyses based on Stebbins dataset. Phylogenetic path analyses cannot account for missing data. Specifically, the Stebbins-based ploidy level dataset included only 138 genera, which represents 55% of the genera in the tree, and 37% of the total family diversity.

CONCLUSIONS AND FUTURE DIRECTIONS

Under certain circumstances homoploid speciation may be reversible; however, this may not be the case for polyploid speciation. Here, we show that the potential invasion of the Pannonian *Arabidopsis arenosa* lineage into the Carpathian suitable habitats, in a future global warming scenario, will not only increase the probability of heterospecific crosses because increased sympatry but also may facilitate the invasion of the Pannonians into the Carpathian genomes through a mechanism mediated by hybrids with higher fertility at warmer temperatures, which could cause the collapse of two independent lineages.

Additionally, we show that expansion of niche breadth, together with a slight change in the niche optimum, but not a significant ecological niche shift, occurred during (or after) the *A. arenosa* autotetraploids moved out of the Carpathian Mountains. Whether climatic niche differences between the diploid and autotetraploid were an immediate consequence of polyploidy (i.e. tetrasomic inheritance), a result of subsequent evolution (i.e. gene flow) or a combination of both is beyond the scope of this study. Therefore, it is important to consider our findings as representing a combination of both autopolyploidy and subsequent evolution.

Finally, we show that polyploidy is not an evolutionary dead-end. We demonstrate that successful polyploids significantly contribute to the long-term evolution of the Brassicaceae family. Our analyses show that polyploidy has played a significant role in driving macroevolutionary patterns within the Brassicaceae by influencing both speciation and extinction rates. We also show that polyploids have indirectly shaped the present-day differences in species richness among clades within the Brassicaceae, despite diversifying slower than diploids. We suggest that polyploidy in plants, instead of being an ‘evolutionary dead-end,’ is a major source of evolutionary innovation within particular clades of the Angiosperm Tree of Life. Furthermore, by demonstrating the significant role of polyploidy in shaping present-day diversity patterns within a single Angiosperm family, we also show that polyploids are an inevitable and substantial part in the origins of its plant diversity. Polyploidy has potential implications in explaining higher-level diversity patterns across the Angiosperm Tree of Life.

SUPPLEMENTARY MATERIAL FOR CHAPTER 1

SUPPLEMENTARY TABLES

Table S1.1. List of georeferenced localities for 130 (103 Carpathian and 27 Pannonian) populations of *Arabidopsis arenosa* and their respective bibliographic sources.

LINEAGE	LONGITUDE	LATITUDE	ALTITUDE (M.A.S.L.)	SOURCE
Carpathian	19.54°	49.57°	1508	Kolář et al. (2016a)
Carpathian	19.72°	49.26°	1589	Kolář et al. (2016b)
Carpathian	20.11°	49.26°	988	Kolář *et al.* (2016b)
Carpathian	20.21°	49.25°	1377	Kolář *et al.* (2016b)
Carpathian	20.23°	49.25°	1157	Kolář *et al.* (2016b)
Carpathian	20.22°	49.24°	1864	Kolář *et al.* (2016a)
Carpathian	20.20°	49.23°	1427	Schmickl and Koch (2011)
Carpathian	20.22°	49.23°	1779	Kolář *et al.* (2016b)
Carpathian	20.31°	49.23°	839	Kolář *et al.* (2016b)
Carpathian	20.22°	49.21°	1662	Kolář *et al.* (2016b)
Carpathian	20.03°	49.20°	1720	Schmickl et al. (2012)
Carpathian	20.12°	49.20°	1553	Schmickl *et al.* (2012)
Carpathian	20.21°	49.20°	1887	Kolář *et al.* (2016a)
Carpathian	20.28°	49.20°	1259	Kolář *et al.* (2016b)
Carpathian	20.03°	49.18°	1746	Schmickl *et al.* (2012)
Carpathian	20.06°	49.18°	1954	Kolář *et al.* (2016b)
Carpathian	20.09°	49.18°	2204	Kolář *et al.* (2016a)
Carpathian	20.15°	49.18°	2231	Kolář *et al.* (2016a)
Carpathian	18.86°	49.17°	358	Yant et al. (2013)
Carpathian	20.14°	49.17°	2165	Kolář *et al.* (2016a)
Carpathian	20.15°	49.16°	1916	Kolář *et al.* (2016b)
Carpathian	20.25°	49.16°	1118	Kolář *et al.* (2016b)
Carpathian	19.09°	49.15°	488	Kolář *et al.* (2016a)
Carpathian	20.05°	49.15°	1802	Kolář *et al.* (2016b)
Carpathian	20.16°	49.15°	1695	Kolář *et al.* (2016b)
Carpathian	19.87°	49.12°	869	Kolář *et al.* (2016a)
Carpathian	19.43°	49.11°	638	Kolář *et al.* (2016b)
Carpathian	20.93°	49.06°	716	Kolář *et al.* (2016a)
Carpathian	19.68°	49.04°	726	Kolář *et al.* (2016a)
Carpathian	19.70°	49.04°	773	Kolář *et al.* (2016b)
Carpathian	20.18°	49.04°	917	Kolář *et al.* (2016a)
Carpathian	19.79°	49.03°	655	Schmickl *et al.* (2012)
Carpathian	20.32°	49.03°	650	Kolář *et al.* (2016b)
Carpathian	19.81°	49.02°	667	Kolář *et al.* (2016b)
Carpathian	19.91°	49.02°	1150	Schmickl and Koch (2011)
Carpathian	20.85°	49.01°	582	Kolář *et al.* (2016b)
Carpathian	20.86°	49.00°	971	Kolář *et al.* (2016a)
Carpathian	19.76°	48.98°	835	Kolář *et al.* (2016b)
Carpathian	20.38°	48.96°	574	Kolář *et al.* (2016b)
Carpathian	19.27°	48.95°	718	Kolář *et al.* (2016b)
Carpathian	18.97°	48.94°	1189	Schmickl and Koch (2011)
Carpathian	20.27°	48.92°	802	Schmickl *et al.* (2012)
Carpathian	20.28°	48.90°	978	Kolář *et al.* (2016b)

Carpathian	20.24°	48.89°	946	Kolář *et al.* (2016b)
Carpathian	19.04°	48.88°	1309	Schmickl and Koch (2011)
Carpathian	20.25°	48.88°	973	Schmickl and Koch (2011)
Carpathian	20.53°	48.88°	814	Yant *et al.* (2013)
Carpathian	19.02°	48.82°	669	Schmickl and Koch (2011)
Carpathian	20.13°	48.82°	786	Kolář *et al.* (2016b)
Carpathian	19.10°	48.81°	513	Schmickl *et al.* (2012)
Carpathian	19.13°	48.81°	852	Kolář *et al.* (2016b)
Carpathian	19.98°	48.79°	1145	Kolář *et al.* (2016b)
Carpathian	20.08°	48.77°	997	Kolář *et al.* (2016b)
Carpathian	20.10°	48.77°	733	Kolář *et al.* (2016b)
Carpathian	20.02°	48.75°	783	Kolář *et al.* (2016b)
Carpathian	18.37°	48.74°	505	Kolář *et al.* (2016b)
Carpathian	20.14°	48.74°	610	Kolář *et al.* (2016b)
Carpathian	19.96°	48.71°	1071	Kolář *et al.* (2016b)
Carpathian	18.64°	48.69°	552	Kolář *et al.* (2016b)
Carpathian	20.27°	48.62°	526	Kolář *et al.* (2016b)
Carpathian	18.89°	48.58°	382	Schmickl *et al.* (2012)
Carpathian	20.47°	48.57°	391	Kolář *et al.* (2016b)
Carpathian	21.77°	48.43°	200	Kolář *et al.* (2016b)
Carpathian	24.55°	47.40°	557	Kolář *et al.* (2016a)
Carpathian	22.51°	46.96°	316	Schmickl *et al.* (2012)
Carpathian	25.78°	46.72°	1267	Kolář *et al.* (2016b)
Carpathian	25.23°	46.58°	853	Kolář *et al.* (2016b)
Carpathian	24.08°	46.14°	438	Schmickl *et al.* (2012)
Carpathian	21.72°	46.11°	189	Kolář *et al.* (2016b)
Carpathian	25.85°	46.11°	641	Kolář *et al.* (2016b)
Carpathian	22.90°	45.89°	241	Kolář *et al.* (2016b)
Carpathian	23.65°	45.78°	1010	Schmickl *et al.* (2012)
Carpathian	24.11°	45.70°	526	Kolář *et al.* (2016b)
Carpathian	24.61°	45.64°	1555	Kolář *et al.* (2016a)
Carpathian	24.70°	45.58°	1755	Kolář *et al.* (2016b)
Carpathian	24.70°	45.57°	1461	Kolář *et al.* (2016b)
Carpathian	23.70°	45.53°	1388	Kolář *et al.* (2016b)
Carpathian	25.28°	45.53°	1145	Kolář *et al.* (2016a)
Carpathian	25.29°	45.53°	948	Kolář *et al.* (2016a)
Carpathian	23.51°	45.41°	1305	Kolář *et al.* (2016b)
Carpathian	25.50°	45.41°	2075	Kolář *et al.* (2016b)
Carpathian	22.76°	45.38°	955	Wright et al. (2015)
Carpathian	24.64°	45.36°	1022	Kolář *et al.* (2016b)
Carpathian	24.64°	45.35°	779	Kolář *et al.* (2016b)
Carpathian	24.30°	45.29°	304	Kolář *et al.* (2016a)
Carpathian	22.48°	44.86°	729	Schmickl *et al.* (2012)
Carpathian	21.74°	44.71°	533	Kolář *et al.* (2016a)
Carpathian	21.71°	44.66°	265	Kolář *et al.* (2016b)
Carpathian	21.93°	44.42°	421	Kolář *et al.* (2016b)
Carpathian	21.54°	44.27°	282	Kolář *et al.* (2016b)
Carpathian	20.45°	43.52°	925	Kolář *et al.* (2016b)
Carpathian	20.79°	43.40°	997	Kolář *et al.* (2016b)
Carpathian	21.88°	42.59°	966	Kolář *et al.* (2016b)
Carpathian	14.13°	53.99°	17	Kolář *et al.* (2016a)
Carpathian	14.42°	53.92°	13	Kolář *et al.* (2016a)
Carpathian	21.03°	55.38°	2	Kolář *et al.* (2016a)
Carpathian	21.10°	55.53°	12	Kolář *et al.* (2016a)
Carpathian	24.10°	57.04°	3	Kolář *et al.* (2016a)
Carpathian	23.96°	57.02°	9	Kolář *et al.* (2016a)
Carpathian	12.55°	54.96°	49	Kolář *et al.* (2016a)

Carpathian	12.44°	55.34°	19	Kolář *et al.* (2016a)
Carpathian	14.29°	53.89°	3	Kolář *et al.* (2016a)
Carpathian	16.10°	54.27°	-2	Kolář *et al.* (2016a)
Pannonian	17.28°	46.98°	175	Kolář et al. (2016a)
Pannonian	17.45°	46.84°	142	Kolář et al. (2016a)
Pannonian	17.90°	47.10°	243	Kolář et al. (2016a)
Pannonian	18.23°	46.10°	340	Kolář et al. (2016a)
Pannonian	18.78°	47.82°	163	Kolář et al. (2016a)
Pannonian	18.92°	47.46°	267	Kolář et al. (2016a)
Pannonian	18.99°	47.67°	398	Kolář et al. (2016a)
Pannonian	19.00°	48.24°	329	Kolář et al. (2016a)
Pannonian	19.51°	48.25°	236	Kolář et al. (2016a)
Pannonian	19.86°	48.23°	299	Kolář et al. (2016a)
Pannonian	19.86°	48.17°	407	Kolář et al. (2016a)
Pannonian	20.03°	47.87°	703	Kolář et al. (2016a)
Pannonian	20.20°	47.94°	192	Kolář et al. (2016a)
Pannonian	20.33°	47.99°	337	Kolář et al. (2016a)
Pannonian	17.30°	46.99°	242	Kolář et al. (2016a)
Pannonian	17.43°	46.81°	112	Kolář et al. (2016a)
Pannonian	17.45°	46.83°	112	Kolář et al. (2016a)
Pannonian	17.88°	47.09°	243	Kolář et al. (2016a)
Pannonian	17.90°	47.35°	284	Kolář et al. (2016a)
Pannonian	17.93°	47.09°	244	Kolář et al. (2016a)
Pannonian	18.09°	48.35°	318	Kolář et al. (2016a)
Pannonian	18.21°	47.07°	179	Kolář et al. (2016a)
Pannonian	18.56°	48.34°	259	Kolář et al. (2016a)
Pannonian	18.93°	47.79°	195	Kolář et al. (2016a)
Pannonian	19.00°	48.28°	280	Kolář et al. (2016a)
Pannonian	19.00°	48.27°	280	Kolář et al. (2016a)
Pannonian	19.05°	47.49°	109	Kolář et al. (2016a)

Table S1.2. List of WorldClim variables used in the PCA-env analysis and their respective contributions on PC1 and PC2.

WORLDCLIM VARIABLE	DESCRIPTION	PC1	PC2
BIO1	Annual Mean Temperature	-0.010	**-0.977**
BIO2	Mean Diurnal Range (Mean of monthly (max temp - min temp))	0.035	-0.462
BIO3	Isothermality (BIO2/BIO7) (* 100)	0.462	-0.481
BIO4	Temperature Seasonality (Standard deviation *100)	-0.718	0.093
BIO5	Max Temperature of Warmest Month	-0.171	**-0.912**
BIO6	Min Temperature of Coldest Month	0.282	-0.847
BIO7	Temperature Annual Range (BIO5-BIO6)	-0.500	-0.159
BIO8	Mean Temperature of Wettest Quarter	-0.735	-0.203
BIO9	Mean Temperature of Driest Quarter	0.435	-0.695
BIO10	Mean Temperature of Warmest Quarter	-0.219	**-0.923**
BIO11	Mean Temperature of Coldest Quarter	0.284	**-0.913**
BIO12	Annual Precipitation	**0.951**	0.134
BIO13	Precipitation of Wettest Month	0.845	0.208
BIO14	Precipitation of Driest Month	**0.922**	-0.010
BIO15	Precipitation Seasonality (Coefficient of Variation)	-0.370	0.397
BIO16	Precipitation of Wettest Quarter	0.847	0.266
BIO17	Precipitation of Driest Quarter	**0.945**	-0.018
BIO18	Precipitation of Warmest Quarter	0.500	0.610
BIO19	Precipitation of Coldest Quarter	**0.921**	-0.165

Table S1.3 Summary of descriptive statistics (mean and standard error) for the seven phenotypes evaluated, per cross-type per temperature.

RESPONSE VARIABLE	**MEAN** ***(standard error)***															
	CXC				**PXP**				**CXP**				**PXC**			
	9°C	**14°C**	**19°C**	**24°C**	**9°C**	**14°C**	**19°C**	**24°C**	**9°C**	**14°C**	**19°C**	**24°C**	**9°C**	**14°C**	**19°C**	**24°C**
Germination	0.517 *(0.029)*	0.726 *(0.026)*	0.788 *(0.024)*	0.733 *(0.026)*	0.729 *(0.026)*	0.767 *(0.025)*	0.767 *(0.025)*	0.691 *(0.027)*	0.351 *(0.028)*	0.754 *(0.025)*	0.760 *(0.025)*	0.750 *(0.026)*	0.410 *(0.029)*	0.517 *(0.029)*	0.500 *(0.030)*	0.507 *(0.030)*
Survival	0.591 *(0.040)*	0.617 *(0.034)*	0.582 *(0.033)*	0.526 *(0.034)*	0.705 *(0.032)*	0.688 *(0.031)*	0.670 *(0.032)*	0.734 *(0.031)*	0.654 *(0.048)*	0.701 *(0.031)*	0.685 *(0.031)*	0.718 *(0.031)*	0.661 *(0.044)*	0.571 *(0.041)*	0.625 *(0.040)*	0.575 *(0.041)*
Flowering	0.171 *(0.040)*	0.295 *(0.040)*	0.674 *(0.041)*	0.342 *(0.045)*	0.155 *(0.030)*	0.290 *(0.037)*	0.689 *(0.038)*	0.329 *(0.039)*	0.182 *(0.048)*	0.283 *(0.037)*	0.720 *(0.037)*	0.368 *(0.039)*	0.128 *(0.038)*	0.271 *(0.048)*	0.678 *(0.050)*	0.417 *(0.054)*
Flowering Time	129.1 *(0.792)*	119.4 *(1.343)*	116.1 *(0.755)*	107.0 *(0.975)*	132.4 *(1.094)*	122.9 *(1.396)*	109.2 *(1.065)*	100.0 *(1.271)*	135.2 *(1.127)*	127.8 *(1.626)*	112.4 *(0.797)*	104.8 *(1.303)*	136.2 *(2.112)*	129.2 *(2.479)*	109.9 *(1.083)*	104.7 *(1.943)*
Pollen Viability	0.490 *(0.080)*	0.656 *(0.044)*	0.272 *(0.015)*	0.075 *(0.010)*	0.554 *(0.066)*	0.671 *(0.030)*	0.791 *(0.021)*	0.573 *(0.029)*	0.509 *(0.081)*	0.563 *(0.034)*	0.735 *(0.011)*	0.511 *(0.032)*	0.450 *(0.129)*	0.561 *(0.055)*	0.737 *(0.019)*	0.578 *(0.023)*
Seed Set									**(CXC)XP**				**(PXP)XC**			
									1.458 *(0.307)*	16.08 *(0.825)*	22.75 *(0.819)*	24.25 *(0.986)*	24.00 *(1.250)*	30.25 *(1.266)*	43.04 *(1.411)*	45.17 *(1.503)*
	(CXC)XC				**(PXP)XP**				**(CXP)XP**				**(CXP)XC**			
	45.62 *(0.934)*	45.88 *(1.045)*	30.38 *(0.909)*	22.75 *(0.774)*	29.04 *(0.726)*	31.00 *(0.625)*	45.88 *(1.139)*	46.88 *(0.850)*	15.08 *(0.586)*	22.88 *(0.887)*	33.42 *(0.868)*	38.79 *(1.020)*	15.79 *(0.684)*	22.67 *(0.576)*	33.29 *(1.062)*	39.38 *(0.996)*
									(PXC)XP				**(PXC)XC**			
									15.67 *(0.601)*	21.83 *(0.838)*	32.25 *(0.841)*	37.62 *(0.953)*	15.12 *(0.508)*	24.42 *(0.785)*	34.54 *(0.659)*	41.50 *(1.080)*

Table S1.4 Formulas derived to estimate reproductive isolation between the Carpathian and the Pannonian lineages.

GENE FLOW SOURCE	PAN → CAR		RI ESTIMATION	CAR → PAN		RI ESTIMATION
	CON-	HETERO-		CON-	HETERO-	
PREMATING						
Germination	**CXC**	**PXP**	$1-2\left(\frac{\mathrm{PXP}}{\mathrm{CXC}+\mathrm{PXP}}\right)$	**PXP**	**CXC**	$1-2\left(\frac{\mathrm{CXC}}{\mathrm{PXP}+\ \mathrm{CXC}}\right)$
Survival	**CXC**	**PXP**	$1-2\left(\frac{\mathrm{PXP}}{\mathrm{CXC}+\mathrm{PXP}}\right)$	**PXP**	**CXC**	$1-2\left(\frac{\mathrm{CXC}}{\mathrm{PXP}+\ \mathrm{CXC}}\right)$
Flowering Time	**CXC**	**PXP**	$1-\left(\frac{\mathrm{S}}{\mathrm{S}+\mathrm{U}}\right)*$	**PXP**	**CXC**	$1-\left(\frac{\mathrm{S}}{\mathrm{S}+\mathrm{U}}\right)*$
Pollen Viability	**CXC**	**PXP**	$1-2\left(\frac{\mathrm{PXP}}{\mathrm{CXC}+\mathrm{PXP}}\right)$	**PXP**	**CXC**	$1-2\left(\frac{\mathrm{CXC}}{\mathrm{PXP}+\ \mathrm{CXC}}\right)$
POSTMATING						
Seed Set	**CXC**	**CXP**	$1-2\left(\frac{\mathrm{CXP}}{\mathrm{CXC}+\mathrm{CXP}}\right)$	**PXP**	**PXC**	$1-2\left(\frac{\mathrm{PXC}}{\mathrm{PXP}+\mathrm{PXC}}\right)$
Hybrid Germination	**CXC**	**PXC, CXP**	$1-2\left[\frac{(\mathrm{PXC}+\mathrm{CXP})/2}{\mathrm{CXC}+(\mathrm{PXC}+\mathrm{CXP})/2}\right]$	**PXP**	**CXP, PXC**	$1-2\left[\frac{(\mathrm{CXP}+\mathrm{PXC})/2}{\mathrm{PXP}+(\mathrm{CXP}+\mathrm{PXC})/2}\right]$
Hybrid Survival	**CXC**	**PXC, CXP**	$1-2\left[\frac{(\mathrm{PXC}+\mathrm{CXP})/2}{\mathrm{CXC}+(\mathrm{PXC}+\mathrm{CXP})/2}\right]$	**PXP**	**CXP, PXC**	$1-2\left[\frac{(\mathrm{CXP}+\mathrm{PXC})/2}{\mathrm{PXP}+(\mathrm{CXP}+\mathrm{PXC})/2}\right]$
Hybrid Flowering Time	**CXC**	**PXC, CXP**	$1-\left(\frac{\mathrm{S}}{\mathrm{S}+\mathrm{U}}\right)*$	**PXP**	**CXP, PXC**	$1-\left(\frac{\mathrm{S}}{\mathrm{S}+\mathrm{U}}\right)*$
Hybrid Pollen Viability	**CXC**	**PXC, CXP**	$1-2\left[\frac{(\mathrm{PXC}+\mathrm{CXP})/2}{\mathrm{CXC}+(\mathrm{PXC}+\mathrm{CXP})/2}\right]$	**PXP**	**CXP, PXC**	$1-2\left[\frac{(\mathrm{CXP}+\mathrm{PXC})/2}{\mathrm{PXP}+(\mathrm{CXP}+\mathrm{PXC})/2}\right]$
Hybrid Seed Set	**CXC**	**(CXP)XC, (PXC)XC**	$1-2\left[\frac{((\mathrm{CXP})\mathrm{XC}+(\mathrm{PXC})\mathrm{XC})/2}{\mathrm{CXC}+((\mathrm{CXP})\mathrm{XC}+(\mathrm{PXC})\mathrm{XC})/2}\right]$	**PXP**	**(CXP)XP, (PXC)XP**	$1-2\left[\frac{((\mathrm{CXP})\mathrm{XP}+(\mathrm{PXC})\mathrm{XP})/2}{\mathrm{CXC}+((\mathrm{CXP})\mathrm{XP}+(\mathrm{PXC})\mathrm{XP})/2}\right]$

*S=Shared, U=Unshared

SUPPLEMENTARY MATERIAL FOR CHAPTER 2

SUPPLEMENTARY TABLES

Table S2.1. List of georeferenced localities for 358 (103 Carpathian diploid, 208 autotetraploid, 27 Pannonian diploid, and 20 Dinaric diploid) populations of *Arabidopsis arenosa* and their respective bibliographic sources.

PLOIDY	LONGITUDE	LATITUDE	ALTITUDE (M.A.S.L.)	REGION	SOURCE
4X	18.62°	49.74°	307	Carpathian	Kolář *et al.* (2016b)
4X	22.99°	49.46°	374	Carpathian	Kolář *et al.* (2016b)
4X	20.49°	49.38°	628	Carpathian	Schmickl *et al.* (2012)
4X	19.90°	49.27°	1078	Carpathian	Kolář *et al.* (2016b)
4X	19.98°	49.27°	1091	Carpathian	Kolář *et al.* (2016b)
4X	19.36°	49.26°	651	Carpathian	Kolář *et al.* (2016b)
4X	19.93°	49.25°	1096	Carpathian	Kolář *et al.* (2016b)
4X	20.21°	49.25°	1086	Carpathian	Kolář *et al.* (2016b)
4X	19.63°	49.24°	1258	Carpathian	Kolář *et al.* (2016b)
4X	19.71°	49.24°	1341	Carpathian	Kolář *et al.* (2016b)
4X	19.93°	49.24°	1551	Carpathian	Kolář *et al.* (2016b)
4X	19.06°	49.23°	870	Carpathian	Kolář *et al.* (2016b)
4X	19.72°	49.23°	1341	Carpathian	Kolář *et al.* (2016b)
4X	19.55°	49.21°	955	Carpathian	Kolář *et al.* (2016b)
4X	19.64°	49.21°	1258	Carpathian	Kolář *et al.* (2016b)
4X	19.71°	49.20°	1733	Carpathian	Kolář *et al.* (2016b)
4X	19.74°	49.20°	1733	Carpathian	Kolář *et al.* (2016b)
4X	19.80°	49.20°	1735	Carpathian	Kolář *et al.* (2016b)
4X	19.70°	49.19°	1616	Carpathian	Schmickl *et al.* (2012)
4X	18.58°	49.18°	411	Carpathian	Kolář *et al.* (2016b)
4X	19.58°	49.17°	894	Carpathian	Kolář *et al.* (2016b)
4X	23.05°	49.16°	621	Carpathian	Kolář *et al.* (2016b)
4X	17.33°	49.11°	377	Carpathian	Kolář *et al.* (2016b)
4X	19.28°	49.10°	699	Carpathian	Schmickl *et al.* (2012)
4X	23.50°	49.03°	618	Carpathian	Kolář *et al.* (2016b)
4X	20.38°	49.02°	680	Carpathian	Kolář *et al.* (2016b)
4X	20.30°	49.01°	697	Carpathian	Schmickl *et al.* (2012)
4X	19.67°	49.01°	885	Carpathian	Kolář *et al.* (2016b)
4X	19.58°	49.00°	895	Carpathian	Kolář *et al.* (2016b)
4X	20.29°	49.00°	732	Carpathian	Kolář *et al.* (2016b)
4X	20.78°	48.99°	466	Carpathian	Wright *et al.* (2015)
4X	19.63°	48.98°	1355	Carpathian	Kolář *et al.* (2016b)
4X	20.78°	48.98°	466	Carpathian	Kolář *et al.* (2016b)
4X	19.64°	48.94°	1637	Carpathian	Kolář *et al.* (2016b)
4X	18.24°	48.91°	518	Carpathian	Kolář *et al.* (2016b)
4X	21.93°	48.91°	261	Carpathian	Kolář *et al.* (2016b)
4X	18.04°	48.89°	212	Carpathian	Wright *et al.* (2015)
4X	21.09°	48.85°	486	Carpathian	Wright *et al.* (2015)
4X	17.90°	48.79°	212	Carpathian	Schmickl *et al.* (2012)
4X	20.00°	48.75°	1011	Carpathian	Kolář *et al.* (2016b)
4X	17.76°	48.73°	303	Carpathian	Kolář *et al.* (2016b)
4X	17.94°	48.68°	421	Carpathian	Schmickl *et al.* (2012)
4X	18.05°	48.66°	330	Carpathian	Kolář *et al.* (2016b)
4X	20.85°	48.64°	598	Carpathian	Kolář *et al.* (2016b)
4X	17.41°	48.54°	434	Carpathian	Kolář *et al.* (2016b)
4X	18.89°	48.45°	593	Carpathian	Kolář *et al.* (2016b)
4X	20.62°	48.11°	502	Carpathian	Kolář *et al.* (2016b)

4X	20.40°	48.10°	397	Carpathian	Schmickl *et al.* (2012)
4X	20.43°	48.09°	574	Carpathian	Kolář *et al.* (2016b)
4X	24.81°	47.59°	1276	Carpathian	Kolář *et al.* (2016b)
4X	25.08°	47.58°	1186	Carpathian	Kolář *et al.* (2016b)
4X	24.46°	47.54°	944	Carpathian	Kolář *et al.* (2016b)
4X	25.56°	47.45°	1249	Carpathian	Kolář *et al.* (2016b)
4X	25.56°	47.44°	1249	Carpathian	Kolář *et al.* (2016b)
4X	24.83°	47.17°	760	Carpathian	Kolář *et al.* (2016b)
4X	22.55°	46.93°	410	Carpathian	Kolář *et al.* (2016b)
4X	23.67°	46.57°	576	Carpathian	Wright *et al.* (2015)
4X	23.68°	46.56°	576	Carpathian	Kolář *et al.* (2016b)
4X	23.37°	46.48°	945	Carpathian	Kolář *et al.* (2016b)
4X	22.84°	46.47°	1053	Carpathian	Kolář *et al.* (2016b)
4X	24.63°	45.60°	1940	Carpathian	Kolář *et al.* (2016b)
4X	25.22°	45.44°	1045	Carpathian	Kolář *et al.* (2016b)
4X	14.19°	63.96°	374	Non-Carpathian	Kolář *et al.* (2016b)
4X	19.33°	63.80°	144	Non-Carpathian	Kolář *et al.* (2016b)
4X	18.52°	63.13°	17	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.96°	62.92°	339	Non-Carpathian	Yant *et al.* (2013)
4X	12.68°	62.44°	638	Non-Carpathian	Schmickl *et al.* (2012)
4X	23.74°	62.28°	107	Non-Carpathian	Schmickl *et al.* (2012)
4X	8.84°	61.49°	1204	Non-Carpathian	Kolář *et al.* (2016b)
4X	9.01°	60.88°	947	Non-Carpathian	Schmickl *et al.* (2012)
4X	18.36°	59.88°	38	Non-Carpathian	Schmickl *et al.* (2012)
4X	17.23°	54.72°	7	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.58°	54.42°	5	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.37°	52.50°	37	Non-Carpathian	Schmickl *et al.* (2012)
4X	16.71°	52.28°	77	Non-Carpathian	Wright *et al.* (2015)
4X	10.79°	51.75°	518	Non-Carpathian	Kolář *et al.* (2016b)
4X	18.00°	51.72°	132	Non-Carpathian	Wright *et al.* (2015)
4X	8.36°	51.01°	469	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.03°	50.77°	390	Non-Carpathian	Kolář *et al.* (2016b)
4X	5.61°	50.61°	112	Non-Carpathian	Schmickl *et al.* (2012)
4X	5.44°	50.59°	146	Non-Carpathian	Schmickl *et al.* (2012)
4X	16.17°	50.59°	530	Non-Carpathian	Kolář *et al.* (2016b)
4X	5.34°	50.56°	137	Non-Carpathian	Schmickl *et al.* (2012)
4X	4.98°	50.49°	143	Non-Carpathian	Kolář *et al.* (2016b)
4X	19.48°	50.28°	322	Non-Carpathian	Kolář *et al.* (2016b)
4X	16.84°	50.24°	956	Non-Carpathian	Kolář *et al.* (2016b)
4X	18.95°	50.24°	273	Non-Carpathian	Kolář *et al.* (2016b)
4X	19.83°	50.22°	422	Non-Carpathian	Kolář *et al.* (2016b)
4X	19.76°	50.16°	308	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.88°	50.11°	415	Non-Carpathian	Kolář *et al.* (2016b)
4X	7.93°	50.09°	363	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.07°	50.07°	418	Non-Carpathian	Kolář *et al.* (2016b)
4X	7.77°	50.06°	210	Non-Carpathian	Schmickl *et al.* (2012)
4X	17.24°	50.06°	1296	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.89°	50.05°	373	Non-Carpathian	Kolář *et al.* (2016b)
4X	7.74°	50.05°	337	Non-Carpathian	Kolář *et al.* (2016b)
4X	16.23°	50.00°	318	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.39°	49.96°	231	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.13°	49.93°	310	Non-Carpathian	Schmickl *et al.* (2012)
4X	17.44°	49.93°	561	Non-Carpathian	Kolář *et al.* (2016b)
4X	6.08°	49.91°	383	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.52°	49.87°	316	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.30°	49.69°	439	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.13°	49.68°	413	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.20°	49.61°	385	Non-Carpathian	Kolář *et al.* (2016b)
4X	6.13°	49.61°	302	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.13°	49.54°	419	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.19°	49.43°	405	Non-Carpathian	Kolář *et al.* (2016b)
4X	16.37°	49.42°	415	Non-Carpathian	Kolář *et al.* (2016b)
4X	16.71°	49.36°	484	Non-Carpathian	Kolář *et al.* (2016b)

4X	11.85°	49.20°	475	Non-Carpathian	Kolář *et al.* (2016b)
4X	4.47°	49.17°	136	Non-Carpathian	Schmickl *et al.* (2012)
4X	4.42°	49.11°	138	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.62°	48.94°	138	Non-Carpathian	Novikova *et al.* (2016)
4X	14.42°	48.92°	415	Non-Carpathian	Kolář *et al.* (2016b)
4X	10.02°	48.73°	647	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.66°	48.61°	340	Non-Carpathian	Schmickl and Koch (2011)
4X	15.33°	48.59°	532	Non-Carpathian	Schmickl and Koch (2011)
4X	15.66°	48.58°	369	Non-Carpathian	Schmickl and Koch (2011)
4X	15.69°	48.56°	281	Non-Carpathian	Schmickl and Koch (2011)
4X	15.69°	48.55°	281	Non-Carpathian	Schmickl and Koch (2011)
4X	15.69°	48.53°	301	Non-Carpathian	Schmickl and Koch (2011)
4X	15.60°	48.51°	443	Non-Carpathian	Schmickl and Koch (2011)
4X	15.61°	48.51°	443	Non-Carpathian	Schmickl and Koch (2011)
4X	15.63°	48.50°	385	Non-Carpathian	Schmickl and Koch (2011)
4X	9.40°	48.48°	637	Non-Carpathian	Yant *et al.* (2013)
4X	15.55°	48.45°	366	Non-Carpathian	Schmickl and Koch (2011)
4X	15.57°	48.45°	366	Non-Carpathian	Schmickl and Koch (2011)
4X	9.47°	48.44°	744	Non-Carpathian	Yant *et al.* (2013)
4X	15.49°	48.42°	568	Non-Carpathian	Schmickl and Koch (2011)
4X	15.44°	48.41°	483	Non-Carpathian	Schmickl and Koch (2011)
4X	15.47°	48.41°	321	Non-Carpathian	Schmickl and Koch (2011)
4X	15.48°	48.41°	321	Non-Carpathian	Schmickl and Koch (2011)
4X	15.51°	48.41°	319	Non-Carpathian	Schmickl and Koch (2011)
4X	15.52°	48.41°	319	Non-Carpathian	Schmickl and Koch (2011)
4X	15.43°	48.41°	483	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.47°	48.40°	321	Non-Carpathian	Schmickl and Koch (2011)
4X	14.19°	48.39°	554	Non-Carpathian	Schmickl *et al.* (2012)
4X	8.24°	48.14°	788	Non-Carpathian	Yant *et al.* (2013)
4X	9.05°	48.10°	754	Non-Carpathian	Yant *et al.* (2013)
4X	9.22°	48.09°	647	Non-Carpathian	Schmickl *et al.* (2012)
4X	9.22°	48.08°	630	Non-Carpathian	Schmickl *et al.* (2012)
4X	8.98°	48.07°	753	Non-Carpathian	Yant *et al.* (2013)
4X	4.35°	47.92°	219	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.62°	47.90°	649	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.67°	47.88°	583	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.37°	47.86°	1023	Non-Carpathian	Schmickl and Koch (2011)
4X	15.27°	47.85°	830	Non-Carpathian	Schmickl and Koch (2011)
4X	15.39°	47.85°	1048	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.00°	47.83°	1128	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.08°	47.82°	1323	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.54°	47.82°	1029	Non-Carpathian	Schmickl and Koch (2011)
4X	15.35°	47.79°	947	Non-Carpathian	Schmickl and Koch (2011)
4X	15.11°	47.77°	1062	Non-Carpathian	Schmickl and Koch (2011)
4X	13.49°	47.74°	653	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.80°	47.73°	948	Non-Carpathian	Schmickl *et al.* (2012)
4X	12.83°	47.72°	859	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.40°	47.65°	1447	Non-Carpathian	Schmickl *et al.* (2012)
4X	13.00°	47.63°	742	Non-Carpathian	Yant *et al.* (2013)
4X	13.86°	47.63°	1206	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.65°	47.61°	905	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.74°	47.61°	892	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.90°	47.54°	958	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.06°	47.54°	958	Non-Carpathian	Kolář *et al.* (2016b)
4X	12.07°	47.46°	679	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.01°	47.45°	1135	Non-Carpathian	Kolář *et al.* (2016b)
4X	9.91°	47.39°	724	Non-Carpathian	Schmickl *et al.* (2012)
4X	15.39°	47.37°	955	Non-Carpathian	Wright *et al.* (2015)
4X	15.34°	47.37°	592	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.68°	47.36°	592	Non-Carpathian	Novikova *et al.* (2016)
4X	14.55°	47.37°	1840	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.39°	47.34°	955	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.05°	47.31°	1586	Non-Carpathian	Schmickl *et al.* (2012)

4X	14.93°	47.29°	738	Non-Carpathian	Wright *et al.* (2015)
4X	15.69°	47.29°	601	Non-Carpathian	Schmickl *et al.* (2012)
4X	12.57°	47.28°	965	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.95°	47.28°	738	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.32°	47.28°	1874	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.93°	47.28°	738	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.21°	47.26°	1746	Non-Carpathian	Schmickl *et al.* (2012)
4X	13.97°	47.24°	1737	Non-Carpathian	Schmickl *et al.* (2012)
4X	6.97°	47.24°	992	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.53°	47.23°	861	Non-Carpathian	Schmickl *et al.* (2012)
4X	12.59°	47.22°	1635	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.34°	47.18°	1169	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.12°	47.10°	1675	Non-Carpathian	Schmickl *et al.* (2012)
4X	7.63°	47.06°	611	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.31°	47.04°	1394	Non-Carpathian	Schmickl *et al.* (2012)
4X	13.46°	46.99°	1340	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.25°	46.98°	941	Non-Carpathian	Schmickl *et al.* (2012)
4X	13.49°	46.96°	1340	Non-Carpathian	Schmickl *et al.* (2012)
4X	7.61°	46.94°	755	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.90°	46.85°	870	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.45°	46.80°	604	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.55°	46.80°	740	Non-Carpathian	Kolář *et al.* (2016b)
4X	14.87°	46.69°	502	Non-Carpathian	Yant *et al.* (2013)
4X	14.82°	46.63°	492	Non-Carpathian	Schmickl *et al.* (2012)
4X	14.97°	46.61°	508	Non-Carpathian	Schmickl *et al.* (2012)
4X	8.73°	46.50°	1775	Non-Carpathian	Schmickl *et al.* (2012)
4X	13.59°	46.42°	1419	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.75°	46.38°	1233	Non-Carpathian	Schmickl *et al.* (2012)
4X	8.91°	46.38°	906	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.73°	46.37°	1308	Non-Carpathian	Kolář *et al.* (2016b)
4X	16.00°	46.37°	284	Non-Carpathian	Kolář *et al.* (2016b)
4X	13.84°	46.28°	894	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.75°	46.26°	456	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.21°	46.12°	420	Non-Carpathian	Kolář *et al.* (2016b)
4X	15.12°	46.06°	553	Non-Carpathian	Schmickl *et al.* (2012)
2X	19.54°	49.57°	1508	Carpathian	Kolář et al. (2016a)
2X	19.72°	49.26°	1589	Carpathian	Kolář et al. (2016b)
2X	20.11°	49.26°	988	Carpathian	Kolář *et al.* (2016b)
2X	20.21°	49.25°	1377	Carpathian	Kolář *et al.* (2016b)
2X	20.23°	49.25°	1157	Carpathian	Kolář *et al.* (2016b)
2X	20.22°	49.24°	1864	Carpathian	Kolář *et al.* (2016a)
2X	20.20°	49.23°	1427	Carpathian	Schmickl and Koch (2011)
2X	20.22°	49.23°	1779	Carpathian	Kolář *et al.* (2016b)
2X	20.31°	49.23°	839	Carpathian	Kolář *et al.* (2016b)
2X	20.22°	49.21°	1662	Carpathian	Kolář *et al.* (2016b)
2X	20.03°	49.20°	1720	Carpathian	Schmickl et al. (2012)
2X	20.12°	49.20°	1553	Carpathian	Schmickl *et al.* (2012)
2X	20.21°	49.20°	1887	Carpathian	Kolář *et al.* (2016a)
2X	20.28°	49.20°	1259	Carpathian	Kolář *et al.* (2016b)
2X	20.03°	49.18°	1746	Carpathian	Schmickl *et al.* (2012)
2X	20.06°	49.18°	1954	Carpathian	Kolář *et al.* (2016b)
2X	20.09°	49.18°	2204	Carpathian	Kolář *et al.* (2016a)
2X	20.15°	49.18°	2231	Carpathian	Kolář *et al.* (2016a)
2X	18.86°	49.17°	358	Carpathian	Yant et al. (2013)
2X	20.14°	49.17°	2165	Carpathian	Kolář *et al.* (2016a)
2X	20.15°	49.16°	1916	Carpathian	Kolář *et al.* (2016b)
2X	20.25°	49.16°	1118	Carpathian	Kolář *et al.* (2016b)
2X	19.09°	49.15°	488	Carpathian	Kolář *et al.* (2016a)
2X	20.05°	49.15°	1802	Carpathian	Kolář *et al.* (2016b)
2X	20.16°	49.15°	1695	Carpathian	Kolář *et al.* (2016b)
2X	19.87°	49.12°	869	Carpathian	Kolář *et al.* (2016a)
2X	19.43°	49.11°	638	Carpathian	Kolář *et al.* (2016b)
2X	20.93°	49.06°	716	Carpathian	Kolář *et al.* (2016a)

2X	19.68°	49.04°	726	Carpathian	Kolář *et al.* (2016a)
2X	19.70°	49.04°	773	Carpathian	Kolář *et al.* (2016b)
2X	20.18°	49.04°	917	Carpathian	Kolář *et al.* (2016a)
2X	19.79°	49.03°	655	Carpathian	Schmickl *et al.* (2012)
2X	20.32°	49.03°	650	Carpathian	Kolář *et al.* (2016b)
2X	19.81°	49.02°	667	Carpathian	Kolář *et al.* (2016b)
2X	19.91°	49.02°	1150	Carpathian	Schmickl and Koch (2011)
2X	20.85°	49.01°	582	Carpathian	Kolář *et al.* (2016b)
2X	20.86°	49.00°	971	Carpathian	Kolář *et al.* (2016a)
2X	19.76°	48.98°	835	Carpathian	Kolář *et al.* (2016b)
2X	20.38°	48.96°	574	Carpathian	Kolář *et al.* (2016b)
2X	19.27°	48.95°	718	Carpathian	Kolář *et al.* (2016b)
2X	18.97°	48.94°	1189	Carpathian	Schmickl and Koch (2011)
2X	20.27°	48.92°	802	Carpathian	Schmickl *et al.* (2012)
2X	20.28°	48.90°	978	Carpathian	Kolář *et al.* (2016b)
2X	20.24°	48.89°	946	Carpathian	Kolář *et al.* (2016b)
2X	19.04°	48.88°	1309	Carpathian	Schmickl and Koch (2011)
2X	20.25°	48.88°	973	Carpathian	Schmickl and Koch (2011)
2X	20.53°	48.88°	814	Carpathian	Yant *et al.* (2013)
2X	19.02°	48.82°	669	Carpathian	Schmickl and Koch (2011)
2X	20.13°	48.82°	786	Carpathian	Kolář *et al.* (2016b)
2X	19.10°	48.81°	513	Carpathian	Schmickl *et al.* (2012)
2X	19.13°	48.81°	852	Carpathian	Kolář *et al.* (2016b)
2X	19.98°	48.79°	1145	Carpathian	Kolář *et al.* (2016b)
2X	20.08°	48.77°	997	Carpathian	Kolář *et al.* (2016b)
2X	20.10°	48.77°	733	Carpathian	Kolář *et al.* (2016b)
2X	20.02°	48.75°	783	Carpathian	Kolář *et al.* (2016b)
2X	18.37°	48.74°	505	Carpathian	Kolář *et al.* (2016b)
2X	20.14°	48.74°	610	Carpathian	Kolář *et al.* (2016b)
2X	19.96°	48.71°	1071	Carpathian	Kolář *et al.* (2016b)
2X	18.64°	48.69°	552	Carpathian	Kolář *et al.* (2016b)
2X	20.27°	48.62°	526	Carpathian	Kolář *et al.* (2016b)
2X	18.89°	48.58°	382	Carpathian	Schmickl *et al.* (2012)
2X	20.47°	48.57°	391	Carpathian	Kolář *et al.* (2016b)
2X	21.77°	48.43°	200	Carpathian	Kolář *et al.* (2016b)
2X	24.55°	47.40°	557	Carpathian	Kolář *et al.* (2016a)
2X	22.51°	46.96°	316	Carpathian	Schmickl *et al.* (2012)
2X	25.78°	46.72°	1267	Carpathian	Kolář *et al.* (2016b)
2X	25.23°	46.58°	853	Carpathian	Kolář *et al.* (2016b)
2X	24.08°	46.14°	438	Carpathian	Schmickl *et al.* (2012)
2X	21.72°	46.11°	189	Carpathian	Kolář *et al.* (2016b)
2X	25.85°	46.11°	641	Carpathian	Kolář *et al.* (2016b)
2X	22.90°	45.89°	241	Carpathian	Kolář *et al.* (2016b)
2X	23.65°	45.78°	1010	Carpathian	Schmickl *et al.* (2012)
2X	24.11°	45.70°	526	Carpathian	Kolář *et al.* (2016b)
2X	24.61°	45.64°	1555	Carpathian	Kolář *et al.* (2016a)
2X	24.70°	45.58°	1755	Carpathian	Kolář *et al.* (2016b)
2X	24.70°	45.57°	1461	Carpathian	Kolář *et al.* (2016b)
2X	23.70°	45.53°	1388	Carpathian	Kolář *et al.* (2016b)
2X	25.28°	45.53°	1145	Carpathian	Kolář *et al.* (2016a)
2X	25.29°	45.53°	948	Carpathian	Kolář *et al.* (2016a)
2X	23.51°	45.41°	1305	Carpathian	Kolář *et al.* (2016b)
2X	25.50°	45.41°	2075	Carpathian	Kolář *et al.* (2016b)
2X	22.76°	45.38°	955	Carpathian	Wright et al. (2015)
2X	24.64°	45.36°	1022	Carpathian	Kolář *et al.* (2016b)
2X	24.64°	45.35°	779	Carpathian	Kolář *et al.* (2016b)
2X	24.30°	45.29°	304	Carpathian	Kolář *et al.* (2016a)
2X	22.48°	44.86°	729	Carpathian	Schmickl *et al.* (2012)
2X	21.74°	44.71°	533	Carpathian	Kolář *et al.* (2016a)
2X	21.71°	44.66°	265	Carpathian	Kolář *et al.* (2016b)
2X	21.93°	44.42°	421	Carpathian	Kolář *et al.* (2016b)
2X	21.54°	44.27°	282	Carpathian	Kolář *et al.* (2016b)
2X	20.45°	43.52°	925	Carpathian	Kolář *et al.* (2016b)

2X	20.79°	43.40°	997	Carpathian	Kolář *et al.* (2016b)
2X	21.88°	42.59°	966	Carpathian	Kolář *et al.* (2016b)
2X	14.13°	53.99°	17	Baltic	Kolář *et al.* (2016a)
2X	14.42°	53.92°	13	Baltic	Kolář *et al.* (2016a)
2X	21.03°	55.38°	2	Baltic	Kolář *et al.* (2016a)
2X	21.10°	55.53°	12	Baltic	Kolář *et al.* (2016a)
2X	24.10°	57.04°	3	Baltic	Kolář *et al.* (2016a)
2X	23.96°	57.02°	9	Baltic	Kolář *et al.* (2016a)
2X	12.55°	54.96°	49	Baltic	Kolář *et al.* (2016a)
2X	12.44°	55.34°	19	Baltic	Kolář *et al.* (2016a)
2X	14.29°	53.89°	3	Baltic	Kolář *et al.* (2016a)
2X	16.10°	54.27°	-2	Baltic	Kolář *et al.* (2016a)
2X	17.28°	46.98°	175	Pannonian	Kolář et al. (2016a)
2X	17.45°	46.84°	142	Pannonian	Kolář et al. (2016a)
2X	17.90°	47.10°	243	Pannonian	Kolář et al. (2016a)
2X	18.23°	46.10°	340	Pannonian	Kolář et al. (2016a)
2X	18.78°	47.82°	163	Pannonian	Kolář et al. (2016a)
2X	18.92°	47.46°	267	Pannonian	Kolář et al. (2016a)
2X	18.99°	47.67°	398	Pannonian	Kolář et al. (2016a)
2X	19.00°	48.24°	329	Pannonian	Kolář et al. (2016a)
2X	19.51°	48.25°	236	Pannonian	Kolář et al. (2016a)
2X	19.86°	48.23°	299	Pannonian	Kolář et al. (2016a)
2X	19.86°	48.17°	407	Pannonian	Kolář et al. (2016a)
2X	20.03°	47.87°	703	Pannonian	Kolář et al. (2016a)
2X	20.20°	47.94°	192	Pannonian	Kolář et al. (2016a)
2X	20.33°	47.99°	337	Pannonian	Kolář et al. (2016a)
2X	17.30°	46.99°	242	Pannonian	Kolář et al. (2016a)
2X	17.43°	46.81°	112	Pannonian	Kolář et al. (2016a)
2X	17.45°	46.83°	112	Pannonian	Kolář et al. (2016a)
2X	17.88°	47.09°	243	Pannonian	Kolář et al. (2016a)
2X	17.90°	47.35°	284	Pannonian	Kolář et al. (2016a)
2X	17.93°	47.09°	244	Pannonian	Kolář et al. (2016a)
2X	18.09°	48.35°	318	Pannonian	Kolář et al. (2016a)
2X	18.21°	47.07°	179	Pannonian	Kolář et al. (2016a)
2X	18.56°	48.34°	259	Pannonian	Kolář et al. (2016a)
2X	18.93°	47.79°	195	Pannonian	Kolář et al. (2016a)
2X	19.00°	48.28°	280	Pannonian	Kolář et al. (2016a)
2X	19.00°	48.27°	280	Pannonian	Kolář et al. (2016a)
2X	19.05°	47.49°	109	Pannonian	Kolář et al. (2016a)
2X	13.87°	45.54°	265	Dinaric	Kolář et al. (2016a)
2X	13.99°	45.67°	456	Dinaric	Kolář et al. (2016a)
2X	14.06°	45.97°	630	Dinaric	Kolář et al. (2016a)
2X	14.29°	45.80°	582	Dinaric	Kolář et al. (2016a)
2X	14.72°	45.55°	872	Dinaric	Kolář et al. (2016a)
2X	14.83°	45.46°	404	Dinaric	Kolář et al. (2016a)
2X	14.86°	46.18°	691	Dinaric	Kolář et al. (2016a)
2X	15.59°	45.12°	292	Dinaric	Kolář et al. (2016a)
2X	15.61°	44.90°	606	Dinaric	Kolář et al. (2016a)
2X	15.85°	45.87°	347	Dinaric	Kolář et al. (2016a)
2X	15.90°	44.88°	352	Dinaric	Kolář et al. (2016a)
2X	15.99°	46.19°	368	Dinaric	Kolář et al. (2016a)
2X	16.12°	46.16°	360	Dinaric	Kolář et al. (2016a)
2X	17.27°	44.34°	555	Dinaric	Kolář et al. (2016a)
2X	17.37°	44.04°	1070	Dinaric	Kolář et al. (2016a)
2X	17.82°	43.98°	994	Dinaric	Kolář et al. (2016a)
2X	15.50°	44.85°	922	Dinaric	Kolář et al. (2016a)
2X	15.57°	44.86°	833	Dinaric	Kolář et al. (2016a)
2X	15.60°	44.87°	693	Dinaric	Kolář et al. (2016a)
2X	17.46°	44.04°	657	Dinaric	Kolář et al. (2016a)

Table S2.2. List of WorldClim variables used in the PCA-env analysis and their respective contributions on PC1 and PC2.

WORLDCLIM VARIABLE	DESCRIPTION	PC1	PC2
BIO1	Annual Mean Temperature	0.324	**-0.915**
BIO2	Mean Diurnal Range (Mean of monthly (max temp - min temp))	0.526	-0.301
BIO3	Isothermality (BIO2/BIO7) (* 100)	-0.076	-0.725
BIO4	Temperature Seasonality (Standard deviation *100)	0.718	0.492
BIO5	Max Temperature of Warmest Month	0.632	-0.683
BIO6	Min Temperature of Coldest Month	-0.084	**-0.951**
BIO7	Temperature Annual Range (BIO5-BIO6)	0.733	0.322
BIO8	Mean Temperature of Wettest Quarter	0.741	-0.192
BIO9	Mean Temperature of Driest Quarter	-0.187	-0.797
BIO10	Mean Temperature of Warmest Quarter	0.588	-0.732
BIO11	Mean Temperature of Coldest Quarter	-0.002	**-0.978**
BIO12	Annual Precipitation	**-0.957**	-0.088
BIO13	Precipitation of Wettest Month	-0.877	0.002
BIO14	Precipitation of Driest Month	-0.899	-0.198
BIO15	Precipitation Seasonality (Coefficient of Variation)	0.271	0.469
BIO16	Precipitation of Wettest Quarter	-0.894	0.016
BIO17	Precipitation of Driest Quarter	**-0.923**	-0.222
BIO18	Precipitation of Warmest Quarter	-0.732	0.249
BIO19	Precipitation of Coldest Quarter	**-0.922**	-0.205

SUPPLEMENTARY FIGURES

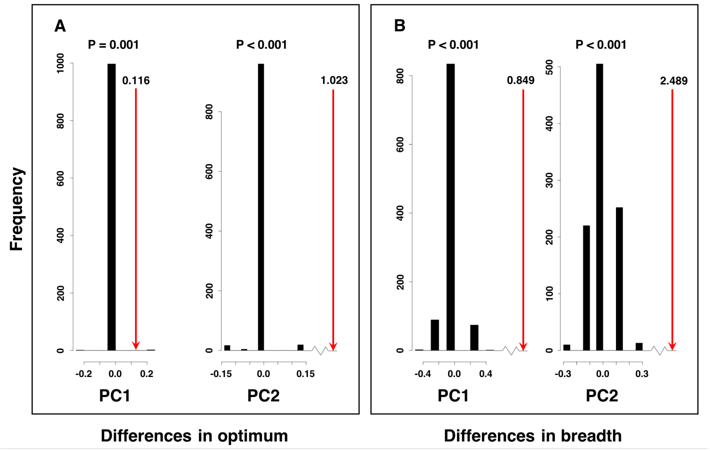

Figure S2.1. Histograms of bootstrap tests with 1000 resamples. Black bars indicate resamples of estimated differences and red line represents observed differences. **A.** niche optimum differences tests. **B.** niche breadth differences tests.

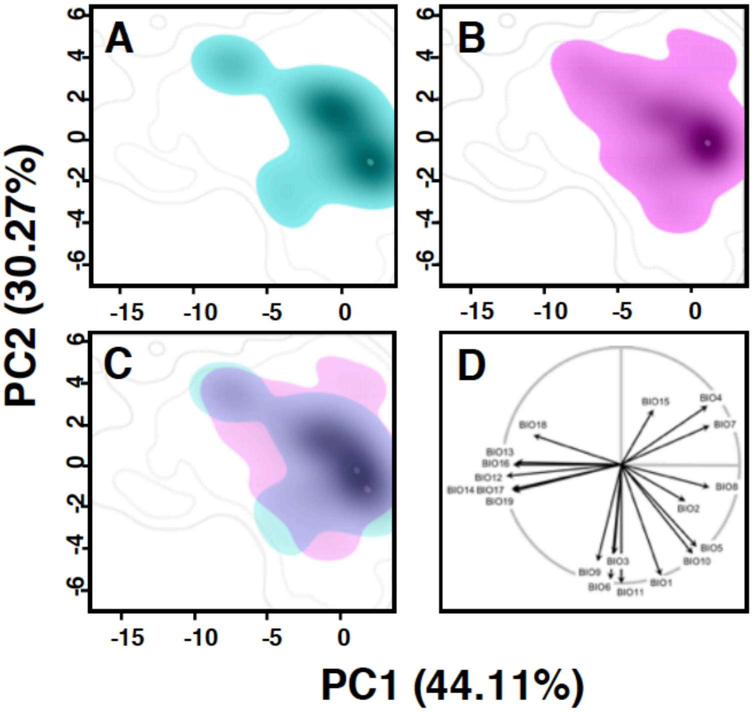

Figure S2.2. Niche dynamics observed comparing all diploid lineages (N = 150) and tetraploid (N = 208) *Arabidopsis arenosa* cytotypes in Central and Northern Europe. **A.** Diploid niche model. **B.** Tetraploid niche model. **C.** Overlap between diploid and tetraploid models. Continuous gray line delimits the full environmental space available within the background area; dashed gray line delimits the percentile 75 of the environmental space available within the background area. Darker shading indicates a higher density of presence data. Clearer dots represent niche centroids. **D.** Correlation circle of WorldClim variables used in the PCA-env (Complete list of climatic variables and respective contributions at table S2.2). Schoener's *D* = 0.6001. Tetraploid niche expansion = 10.16%.

SUPPLEMENTARY MATERIAL FOR CHAPTER 3

SUPPLEMENTARY TABLES

Table S3.1 Raw haploid chromosome counts for 816 Brassicaceae species.

SPECIES	COUNT TYPE	COUNT	INFERRED N	NUMBER RECORDS
Aethionema_arabicum	gam	11	11	2
Aethionema_arabicum	gam	18	18	2
Aethionema_arabicum	gam	21	21	2
Aethionema_arabicum	gam	22	22	4
Aethionema_arabicum	spor	22	11	2
Aethionema_arabicum	spor	24	12	2
Aethionema_grandiflorum	gam	12	12	2
Aethionema_grandiflorum	gam	14	14	2
Aethionema_grandiflorum	gam	24	24	1
Aethionema_grandiflorum	spor	24	12	1
Aethionema_grandiflorum	spor	48	24	3
Aethionema_saxatile	gam	12	12	9
Aethionema_saxatile	gam	16	16	4
Aethionema_saxatile	gam	24	24	6
Aethionema_saxatile	spor	16	8	1
Aethionema_saxatile	spor	24	12	26
Aethionema_saxatile	spor	36	18	2
Aethionema_saxatile	spor	48	24	31
Alliaria_petiolata	gam	7	7	12
Alliaria_petiolata	gam	18	18	2
Alliaria_petiolata	gam	21	21	12
Alliaria_petiolata	spor	36	18	19
Alliaria_petiolata	spor	40	20	3
Alliaria_petiolata	spor	42	21	58
Alliaria_petiolata	spor	43	22	4
Alyssoides_cretica	spor	16	8	8
Alyssoides_utriculata	spor	8	4	3
Alyssoides_utriculata	spor	16	8	29
Alyssopsis_mollis	gam	8	8	2
Alyssum_alpestre	gam	8	8	2
Alyssum_alpestre	spor	14	7	1
Alyssum_alpestre	spor	16	8	9
Alyssum_alpestre	spor	32	16	5
Alyssum_alyssoides	gam	8	8	2
Alyssum_alyssoides	gam	16	16	7
Alyssum_alyssoides	spor	16	8	7
Alyssum_alyssoides	spor	24	12	4
Alyssum_alyssoides	spor	32	16	74
Alyssum_antiatlanticum	gam	8	8	1

Alyssum_antiatlanticum	spor	16	8	2
Alyssum_argenteum	gam	8	8	2
Alyssum_argenteum	spor	16	8	4
Alyssum_aurantiacum	spor	16	8	2
Alyssum_bertolonii	spor	16	8	9
Alyssum_bracteatum	gam	8	8	1
Alyssum_condensatum	gam	8	8	2
Alyssum_condensatum	spor	16	8	2
Alyssum_condensatum	spor	32	16	3
Alyssum_condensatum_subsp._flexibile	gam	8	8	2
Alyssum_condensatum_subsp._flexibile	spor	16	8	1
Alyssum_condensatum_subsp._flexibile	spor	32	16	1
Alyssum_corsicum	spor	14	7	1
Alyssum_corsicum	spor	16	8	7
Alyssum_corymbosoides	spor	32	16	4
Alyssum_cuneifolium	gam	16	16	2
Alyssum_cuneifolium	gam	24	24	1
Alyssum_cuneifolium	spor	16	8	2
Alyssum_cuneifolium	spor	32	16	1
Alyssum_cuneifolium	spor	48	24	4
Alyssum_cypricum	gam	16	16	2
Alyssum_dasycarpum	gam	8	8	3
Alyssum_dasycarpum	spor	16	8	8
Alyssum_dasycarpum	spor	32	16	1
Alyssum_desertorum	gam	16	16	5
Alyssum_desertorum	spor	16	8	2
Alyssum_desertorum	spor	24	12	1
Alyssum_desertorum	spor	29	14	2
Alyssum_desertorum	spor	32	16	20
Alyssum_diffusum	gam	8	8	1
Alyssum_diffusum	spor	16	8	4
Alyssum_doerfleri	spor	16	8	1
Alyssum_euboeum	spor	16	8	2
Alyssum_fallacinum	gam	8	8	2
Alyssum_floribundum	spor	16	8	2
Alyssum_fragillimum	gam	8	8	2
Alyssum_giosnanum	spor	32	16	2
Alyssum_granatense	gam	24	24	3
Alyssum_granatense	spor	48	24	7
Alyssum_heldreichii	spor	16	8	2
Alyssum_hirsutum	gam	8	8	1
Alyssum_hirsutum	spor	46	23	5
Alyssum_hirsutum	spor	48	24	4
Alyssum_homalocarpum	gam	8	8	2
Alyssum_huber-morathii	spor	16	8	2
Alyssum_huber-morathii	spor	32	16	2
Alyssum_lenense	spor	16	8	4
Alyssum_lepidoto-stellatum	spor	32	16	2
Alyssum_linifolium	gam	7	7	1

Alyssum_linifolium	gam	8	8	7
Alyssum_linifolium	gam	16	16	2
Alyssum_linifolium	spor	14	7	10
Alyssum_linifolium	spor	16	8	14
Alyssum_linifolium	spor	24	12	1
Alyssum_linifolium	spor	32	16	1
Alyssum_linifolium	spor	48	24	1
Alyssum_loiseleurii	gam	16	16	1
Alyssum_loiseleurii	spor	16	8	1
Alyssum_markgrafii	spor	32	16	1
Alyssum_masmenaeum	spor	16	8	2
Alyssum_masmenaeum	spor	32	16	2
Alyssum_meniocoides	gam	8	8	3
Alyssum_meniocoides	gam	20	20	1
Alyssum_meniocoides	spor	14	7	2
Alyssum_minutum	gam	8	8	3
Alyssum_minutum	gam	24	24	3
Alyssum_minutum	spor	16	8	28
Alyssum_montanum	gam	8	8	2
Alyssum_montanum	gam	18	18	1
Alyssum_montanum	gam	24	24	1
Alyssum_montanum	spor	16	8	25
Alyssum_montanum	spor	32	16	39
Alyssum_montanum	spor	48	24	3
Alyssum_montanum_subsp._gmelinii	spor	16	8	1
Alyssum_montanum_subsp._gmelinii	spor	32	16	12
Alyssum_montanum_subsp._gmelinii	spor	48	24	1
Alyssum_murale	gam	8	8	1
Alyssum_murale	spor	16	8	25
Alyssum_murale	spor	32	16	4
Alyssum_nebrodense	spor	16	8	3
Alyssum_obovatum	spor	16	8	13
Alyssum_obovatum	spor	30	15	3
Alyssum_obovatum	spor	32	16	10
Alyssum_ovirense	spor	16	8	2
Alyssum_oxycarpum	gam	8	8	2
Alyssum_oxycarpum	spor	16	8	2
Alyssum_oxycarpum	spor	64	32	1
Alyssum_pateri	gam	16	16	2
Alyssum_pateri	spor	16	8	1
Alyssum_pateri	spor	32	16	2
Alyssum_praecox	spor	32	16	2
Alyssum_robertianum	spor	16	8	6
Alyssum_serpyllifolium	gam	8	8	3
Alyssum_serpyllifolium	gam	16	16	3
Alyssum_serpyllifolium	spor	16	8	13
Alyssum_serpyllifolium	spor	32	16	6
Alyssum_sibiricum	spor	16	8	2
Alyssum_siculum	spor	48	24	2

Alyssum_simplex	gam	8	8	3
Alyssum_simplex	gam	12	12	1
Alyssum_simplex	gam	24	24	3
Alyssum_simplex	spor	16	8	36
Alyssum_simplex	spor	32	16	5
Alyssum_smolikanum	gam	16	16	1
Alyssum_smolikanum	spor	32	16	2
Alyssum_stapfii	gam	8	8	2
Alyssum_stapfii	gam	12	12	1
Alyssum_stapfii	gam	24	24	3
Alyssum_stribryni	spor	32	16	1
Alyssum_strigosum	gam	8	8	7
Alyssum_strigosum	spor	16	8	16
Alyssum_strigosum	spor	64	32	2
Alyssum_tenuifolium	spor	88	44	3
Alyssum_tenuifolium	spor	92	46	3
Alyssum_tortuosum	gam	8	8	1
Alyssum_tortuosum	spor	16	8	9
Alyssum_tortuosum	spor	32	16	5
Alyssum_turkestanicum	gam	16	16	2
Alyssum_turkestanicum	gam	24	24	1
Alyssum_turkestanicum	spor	32	16	1
Alyssum_turkestanicum	spor	48	24	1
Alyssum_umbellatum	spor	14	7	13
Alyssum_umbellatum	spor	16	8	10
Anastatica_hierochuntica	spor	22	11	12
Anelsonia_eurycarpa	gam	7	7	2
Anelsonia_eurycarpa	spor	14	7	1
Arabidella_trisecta	gam	12	12	2
Arabidella_trisecta	gam	18	18	1
Arabidopsis_arenicola	gam	8	8	2
Arabidopsis_arenicola	spor	16	8	5
Arabidopsis_arenicola	spor	32	16	1
Arabidopsis_arenosa	gam	8	8	3
Arabidopsis_arenosa	gam	16	16	18
Arabidopsis_arenosa	spor	16	8	16
Arabidopsis_arenosa	spor	28	14	6
Arabidopsis_arenosa	spor	30	15	2
Arabidopsis_arenosa	spor	32	16	32
Arabidopsis_arenosa	spor	34	17	2
Arabidopsis_arenosa	spor	39	20	1
Arabidopsis_arenosa	spor	40	20	1
Arabidopsis_cebennensis	spor	16	8	1
Arabidopsis_halleri	gam	8	8	3
Arabidopsis_halleri	spor	16	8	37
Arabidopsis_halleri_subsp._gemmifera	spor	16	8	3
Arabidopsis_halleri_subsp._ovirensis	spor	16	8	4
Arabidopsis_lyrata	gam	8	8	3
Arabidopsis_lyrata	gam	16	16	1

Arabidopsis_lyrata	spor	16	8	14
Arabidopsis_lyrata	spor	32	16	4
Arabidopsis_lyrata_subsp._petraea	gam	16	16	5
Arabidopsis_lyrata_subsp._petraea	spor	16	8	58
Arabidopsis_lyrata_subsp._petraea	spor	32	16	12
Arabidopsis_neglecta	spor	16	8	12
Arabidopsis_neglecta	spor	32	16	1
Arabidopsis_suecica	gam	13	13	1
Arabidopsis_suecica	gam	14	14	1
Arabidopsis_suecica	spor	20	10	2
Arabidopsis_suecica	spor	22	11	2
Arabidopsis_suecica	spor	26	13	11
Arabidopsis_suecica	spor	28	14	5
Arabidopsis_thaliana	gam	5	5	22
Arabidopsis_thaliana	gam	6	6	1
Arabidopsis_thaliana	gam	7	7	1
Arabidopsis_thaliana	gam	8	8	1
Arabidopsis_thaliana	spor	10	5	102
Arabidopsis_thaliana	spor	20	10	2
Arabis_aculeolata	gam	16	16	1
Arabis_aculeolata	spor	32	16	3
Arabis_allionii	gam	8	8	3
Arabis_allionii	spor	16	8	25
Arabis_allionii	spor	32	16	12
Arabis_allionii	spor	195	98	1
Arabis_alpina	gam	8	8	17
Arabis_alpina	spor	16	8	109
Arabis_alpina	spor	17	8	4
Arabis_alpina	spor	20	10	2
Arabis_alpina	spor	32	16	5
Arabis_amplexicaulis	gam	16	16	3
Arabis_amplexicaulis	spor	16	8	1
Arabis_amplexicaulis	spor	32	16	1
Arabis_ariana	spor	16	8	2
Arabis_aucheri	gam	8	8	2
Arabis_blepharophylla	gam	8	8	1
Arabis_blepharophylla	spor	16	8	3
Arabis_brachycarpa	spor	16	8	3
Arabis_bryoides	spor	16	8	6
Arabis_caerulea	gam	8	8	3
Arabis_caerulea	spor	16	8	11
Arabis_caerulea	spor	24	12	3
Arabis_carduchorum	spor	16	8	2
Arabis_christianii	spor	32	16	1
Arabis_ciliata	gam	8	8	2
Arabis_ciliata	spor	16	8	33
Arabis_ciliata	spor	17	8	1
Arabis_ciliata	spor	32	16	2
Arabis_ciliata	spor	48	24	2

Arabis_ciliata	spor	56	28	1
Arabis_collina	gam	8	8	1
Arabis_collina	spor	16	8	12
Arabis_collina	spor	32	16	14
Arabis_conringioides	gam	7	7	4
Arabis_conringioides	spor	14	7	4
Arabis_crucisetosa	spor	32	16	1
Arabis_eschscholtziana	gam	32	32	2
Arabis_eschscholtziana	spor	32	16	1
Arabis_eschscholtziana	spor	64	32	1
Arabis_ferdinandi-coburgii	spor	18	9	2
Arabis_flagellosa	spor	32	16	1
Arabis_hirsuta	gam	8	8	3
Arabis_hirsuta	gam	16	16	31
Arabis_hirsuta	spor	8	4	4
Arabis_hirsuta	spor	16	8	31
Arabis_hirsuta	spor	24	12	1
Arabis_hirsuta	spor	28	14	9
Arabis_hirsuta	spor	30	15	9
Arabis_hirsuta	spor	32	16	184
Arabis_hirsuta	spor	33	16	1
Arabis_juressi	spor	32	16	1
Arabis_macdonaldiana	gam	8	8	1
Arabis_modesta	gam	8	8	1
Arabis_modesta	gam	16	16	2
Arabis_modesta	spor	32	16	3
Arabis_nordmanniana	spor	16	8	3
Arabis_nova	gam	6	6	1
Arabis_nova	gam	7	7	2
Arabis_nova	gam	8	8	15
Arabis_nova	spor	8	4	1
Arabis_nova	spor	14	7	4
Arabis_nova	spor	16	8	36
Arabis_oregana	gam	8	8	1
Arabis_oregana	spor	32	16	2
Arabis_parvula	spor	32	16	4
Arabis_planisiliqua	gam	8	8	8
Arabis_planisiliqua	gam	16	16	1
Arabis_planisiliqua	spor	16	8	60
Arabis_planisiliqua	spor	24	12	1
Arabis_procurrens	gam	8	8	1
Arabis_procurrens	spor	16	8	10
Arabis_procurrens	spor	24	12	1
Arabis_procurrens	spor	32	16	4
Arabis_pterosperma	gam	8	8	2
Arabis_pubescens	spor	16	8	2
Arabis_pubescens_subsp._decumbens	gam	8	8	2
Arabis_pubescens_subsp._decumbens	spor	16	8	2
Arabis_pumila	gam	8	8	3

Arabis_pumila	spor	16	8	17
Arabis_pumila	spor	32	16	27
Arabis_sagittata	gam	8	8	13
Arabis_sagittata	gam	9	9	1
Arabis_sagittata	spor	12	6	4
Arabis_sagittata	spor	16	8	77
Arabis_sagittata	spor	17	8	1
Arabis_sagittata	spor	24	12	2
Arabis_sagittata	spor	32	16	2
Arabis_scabra	spor	16	8	7
Arabis_serrata	gam	16	16	1
Arabis_serrata	spor	16	8	1
Arabis_serrata	spor	32	16	4
Arabis_serrata	spor	40	20	1
Arabis_soyeri	spor	16	8	4
Arabis_soyeri_subsp._subcoriacea	gam	8	8	1
Arabis_soyeri_subsp._subcoriacea	spor	16	8	34
Arabis_soyeri_subsp._subcoriacea	spor	32	16	3
Arabis_stelleri	spor	16	8	3
Arabis_stelleri	spor	32	16	3
Arabis_stellulata	spor	16	8	9
Arabis_stenocarpa	spor	16	8	4
Armoracia_rusticana	gam	14	14	2
Armoracia_rusticana	gam	16	16	3
Armoracia_rusticana	spor	32	16	23
Asperuginoides_axillaris	spor	16	8	2
Athysanus_pusillus	spor	26	13	2
Aubrieta_deltoidea	gam	8	8	1
Aubrieta_deltoidea	spor	16	8	23
Aubrieta_parviflora	gam	8	8	7
Aubrieta_parviflora	spor	16	8	1
Aurinia_corymbosa	gam	8	8	1
Aurinia_corymbosa	spor	16	8	6
Aurinia_gionae	gam	8	8	1
Aurinia_gionae	spor	16	8	2
Aurinia_moreana	spor	16	8	2
Aurinia_petraea	gam	8	8	1
Aurinia_petraea	gam	16	16	1
Aurinia_petraea	spor	16	8	6
Aurinia_rupestris	gam	8	8	3
Aurinia_rupestris	spor	16	8	2
Aurinia_saxatilis	gam	8	8	4
Aurinia_saxatilis	spor	16	8	25
Aurinia_saxatilis_subsp._orientalis	gam	8	8	4
Aurinia_saxatilis_subsp._orientalis	spor	16	8	21
Aurinia_sinuata	spor	16	8	5
Barbarea_orthoceras	gam	8	8	6
Barbarea_orthoceras	spor	16	8	19
Barbarea_verna	gam	8	8	5

Barbarea_verna	spor	16	8	9
Barbarea_vulgaris	gam	7	7	1
Barbarea_vulgaris	gam	8	8	25
Barbarea_vulgaris	spor	14	7	1
Barbarea_vulgaris	spor	16	8	75
Barbarea_vulgaris	spor	18	9	3
Berteroa_incana	gam	8	8	5
Berteroa_incana	spor	16	8	63
Berteroa_mutabilis	spor	16	8	5
Berteroa_obliqua	spor	16	8	2
Berteroa_orbiculata	spor	16	8	2
Biscutella_auriculata	gam	8	8	15
Biscutella_auriculata	spor	16	8	16
Biscutella_baetica	gam	8	8	13
Biscutella_baetica	spor	16	8	4
Biscutella_cichoriifolia	spor	16	8	6
Biscutella_didyma	gam	8	8	6
Biscutella_didyma	spor	16	8	15
Biscutella_laevigata	gam	9	9	15
Biscutella_laevigata	gam	18	18	16
Biscutella_laevigata	gam	38	38	2
Biscutella_laevigata	spor	9	4	3
Biscutella_laevigata	spor	18	9	46
Biscutella_laevigata	spor	26	13	2
Biscutella_laevigata	spor	27	14	2
Biscutella_laevigata	spor	34	17	5
Biscutella_laevigata	spor	35	18	6
Biscutella_laevigata	spor	36	18	127
Biscutella_laevigata	spor	37	18	8
Biscutella_laevigata	spor	45	22	2
Biscutella_laevigata	spor	54	27	5
Biscutella_lyrata	gam	6	6	5
Biscutella_lyrata	gam	8	8	14
Biscutella_lyrata	spor	12	6	7
Biscutella_lyrata	spor	16	8	11
Biscutella_maritima	spor	16	8	6
Blennodia_pterosperma	gam	12	12	1
Boechera_arcuata	gam	6	6	1
Boechera_canadensis	gam	7	7	1
Boechera_canadensis	spor	14	7	2
Boechera_cobrensis	gam	7	7	1
Boechera_cobrensis	spor	14	7	1
Boechera_collinsii	spor	14	7	3
Boechera_collinsii	spor	28	14	1
Boechera_constancei	spor	14	7	2
Boechera_crandallii	gam	7	7	1
Boechera_crandallii	spor	14	7	3
Boechera_demissa	spor	21	10	2
Boechera_divaricarpa	gam	5	5	1

Boechera_divaricarpa	gam	7	7	2
Boechera_divaricarpa	gam	8	8	1
Boechera_divaricarpa	gam	10	10	1
Boechera_divaricarpa	gam	11	11	2
Boechera_divaricarpa	gam	14	14	1
Boechera_divaricarpa	gam	15	15	2
Boechera_divaricarpa	gam	21	21	3
Boechera_divaricarpa	spor	13	6	1
Boechera_divaricarpa	spor	14	7	10
Boechera_divaricarpa	spor	21	10	5
Boechera_divaricarpa	spor	22	11	3
Boechera_divaricarpa	spor	28	14	2
Boechera_falcata	spor	14	7	7
Boechera_fendleri	gam	7	7	5
Boechera_fendleri	gam	14	14	2
Boechera_fendleri	gam	21	21	1
Boechera_fendleri	spor	14	7	3
Boechera_fendleri	spor	21	10	2
Boechera_formosa	spor	14	7	1
Boechera_glaucovalvula	gam	7	7	1
Boechera_glaucovalvula	spor	14	7	1
Boechera_grahamii	gam	21	21	1
Boechera_grahamii	spor	21	10	1
Boechera_gunnisoniana	gam	7	7	1
Boechera_gunnisoniana	spor	14	7	1
Boechera_gunnisoniana	spor	21	10	2
Boechera_inyoensis	spor	21	10	3
Boechera_inyoensis	spor	23	12	2
Boechera_koehleri	spor	14	7	1
Boechera_laevigata	gam	7	7	6
Boechera_laevigata	spor	14	7	2
Boechera_lemmonii	gam	21	21	1
Boechera_lemmonii	spor	14	7	5
Boechera_lignifera	gam	7	7	1
Boechera_lignifera	spor	14	7	5
Boechera_lincolnensis	spor	14	7	1
Boechera_lyallii	gam	15	15	1
Boechera_lyallii	gam	21	21	1
Boechera_lyallii	spor	20	10	4
Boechera_lyallii	spor	21	10	6
Boechera_parishii	gam	7	7	1
Boechera_parishii	spor	14	7	3
Boechera_pendulocarpa	spor	14	7	1
Boechera_perennans	gam	7	7	3
Boechera_perennans	spor	14	7	2
Boechera_perstellata	gam	7	7	4
Boechera_perstellata	spor	14	7	1
Boechera_platysperma	gam	7	7	1
Boechera_platysperma	spor	14	7	1

Boechera_puberula	gam	7	7	1
Boechera_puberula	gam	21	21	1
Boechera_puberula	spor	14	7	1
Boechera_repanda	gam	7	7	2
Boechera_repanda	spor	14	7	1
Boechera_retrofracta	spor	14	7	1
Boechera_schistacea	spor	14	7	2
Boechera_serotina	spor	14	7	3
Boechera_spatifolia	spor	14	7	1
Boechera_stricta	gam	7	7	8
Boechera_stricta	gam	21	21	1
Boechera_stricta	spor	14	7	16
Boechera_stricta	spor	20	10	1
Boechera_stricta	spor	21	10	1
Boechera_stricta	spor	28	14	3
Boechera_subpinnatifida	gam	7	7	4
Boechera_subpinnatifida	spor	14	7	2
Boechera_williamsii	gam	14	14	2
Bornmuellera_baldaccii	spor	16	8	2
Bornmuellera_tymphaea	spor	16	8	3
Borodinia_macrophylla	spor	14	7	5
Brassica_balearica	gam	16	16	4
Brassica_balearica	gam	18	18	5
Brassica_balearica	spor	18	9	5
Brassica_balearica	spor	32	16	10
Brassica_balearica	spor	36	18	4
Brassica_barrelieri	gam	9	9	2
Brassica_barrelieri	gam	10	10	16
Brassica_barrelieri	spor	18	9	1
Brassica_barrelieri	spor	20	10	5
Brassica_carinata	gam	17	17	10
Brassica_carinata	spor	16	8	1
Brassica_carinata	spor	34	17	25
Brassica_carinata	spor	36	18	2
Brassica_cretica	gam	9	9	9
Brassica_cretica	spor	18	9	26
Brassica_cretica	spor	20	10	3
Brassica_cretica	spor	36	18	2
Brassica_deflexa	gam	7	7	3
Brassica_desnottesii	gam	10	10	3
Brassica_elongata	gam	11	11	4
Brassica_elongata	spor	22	11	17
Brassica_fruticulosa	gam	8	8	8
Brassica_fruticulosa	spor	16	8	7
Brassica_gravinae	gam	10	10	3
Brassica_gravinae	gam	20	20	2
Brassica_gravinae	spor	20	10	4
Brassica_incana	gam	9	9	4
Brassica_incana	spor	18	9	6

Brassica_insularis	gam	9	9	6
Brassica_insularis	spor	18	9	24
Brassica_insularis	spor	27	14	2
Brassica_juncea	gam	10	10	3
Brassica_juncea	gam	16	16	1
Brassica_juncea	gam	18	18	50
Brassica_juncea	gam	19	19	2
Brassica_juncea	spor	16	8	2
Brassica_juncea	spor	18	9	1
Brassica_juncea	spor	20	10	7
Brassica_juncea	spor	36	18	107
Brassica_juncea	spor	38	19	2
Brassica_macrocarpa	gam	9	9	3
Brassica_macrocarpa	spor	18	9	7
Brassica_montana	gam	9	9	6
Brassica_montana	spor	18	9	6
Brassica_napus	gam	9	9	4
Brassica_napus	gam	10	10	6
Brassica_napus	gam	16	16	2
Brassica_napus	gam	18	18	2
Brassica_napus	gam	19	19	29
Brassica_napus	gam	20	20	5
Brassica_napus	gam	38	38	1
Brassica_napus	spor	10	5	2
Brassica_napus	spor	18	9	2
Brassica_napus	spor	20	10	7
Brassica_napus	spor	28	14	2
Brassica_napus	spor	29	14	1
Brassica_napus	spor	32	16	8
Brassica_napus	spor	36	18	3
Brassica_napus	spor	38	19	59
Brassica_napus	spor	40	20	1
Brassica_napus	spor	57	28	1
Brassica_napus	spor	60	30	1
Brassica_napus	spor	63	32	1
Brassica_napus	spor	65	32	1
Brassica_napus	spor	67	34	1
Brassica_napus	spor	68	34	1
Brassica_napus	spor	76	38	1
Brassica_nigra	gam	8	8	27
Brassica_nigra	gam	16	16	4
Brassica_nigra	spor	16	8	74
Brassica_nigra	spor	18	9	3
Brassica_nigra	spor	24	12	2
Brassica_nigra	spor	32	16	1
Brassica_oleracea	gam	9	9	37
Brassica_oleracea	gam	18	18	4
Brassica_oleracea	spor	18	9	132
Brassica_oleracea	spor	20	10	6

Brassica_oleracea	spor	24	12	2
Brassica_oleracea	spor	36	18	8
Brassica_oleracea	spor	72	36	1
Brassica_oxyrrhina	gam	9	9	16
Brassica_oxyrrhina	spor	18	9	12
Brassica_rapa	gam	9	9	10
Brassica_rapa	gam	10	10	108
Brassica_rapa	gam	11	11	2
Brassica_rapa	gam	20	20	1
Brassica_rapa	spor	10	5	2
Brassica_rapa	spor	18	9	9
Brassica_rapa	spor	20	10	184
Brassica_rapa	spor	22	11	2
Brassica_rapa	spor	29	14	2
Brassica_rapa	spor	30	15	3
Brassica_rapa	spor	36	18	2
Brassica_rapa	spor	38	19	2
Brassica_rapa	spor	40	20	6
Brassica_repanda	gam	10	10	3
Brassica_repanda	gam	11	11	1
Brassica_repanda	gam	30	30	3
Brassica_repanda	gam	80	80	3
Brassica_repanda	spor	20	10	12
Brassica_repanda_subsp._blancoana	spor	20	10	8
Brassica_repanda_subsp._latisiliqua	spor	20	10	4
Brassica_repanda_subsp._saxatilis	gam	10	10	1
Brassica_repanda_subsp._saxatilis	spor	20	10	4
Brassica_tournefortii	gam	10	10	13
Brassica_tournefortii	spor	20	10	19
Brassica_villosa	gam	9	9	2
Brassica_villosa	spor	18	9	6
Braya_alpina	gam	16	16	1
Braya_alpina	gam	21	21	3
Braya_alpina	spor	32	16	4
Braya_alpina	spor	42	21	4
Braya_fernaldii	spor	56	28	2
Braya_glabella	gam	28	28	7
Braya_glabella	gam	42	42	1
Braya_glabella	gam	56	56	1
Braya_glabella	spor	28	14	3
Braya_glabella	spor	42	21	8
Braya_glabella	spor	48	24	2
Braya_glabella	spor	56	28	33
Braya_glabella	spor	64	32	4
Braya_humilis	gam	14	14	3
Braya_humilis	gam	21	21	5
Braya_humilis	gam	25	25	1
Braya_humilis	gam	28	28	5
Braya_humilis	gam	32	32	2

Braya_humilis	gam	56	56	1
Braya_humilis	spor	28	14	9
Braya_humilis	spor	30	15	2
Braya_humilis	spor	40	20	4
Braya_humilis	spor	42	21	20
Braya_humilis	spor	50	25	1
Braya_humilis	spor	56	28	16
Braya_humilis	spor	64	32	2
Braya_humilis	spor	70	35	3
Braya_linearis	gam	21	21	6
Braya_linearis	spor	42	21	11
Braya_linearis	spor	64	32	2
Braya_longii	spor	56	28	2
Braya_pilosa	spor	28	14	2
Braya_rosea	gam	21	21	2
Braya_rosea	spor	18	9	1
Braya_rosea	spor	28	14	7
Braya_rosea	spor	42	21	3
Braya_rosea	spor	56	28	2
Braya_thorild-wulffii	gam	14	14	1
Braya_thorild-wulffii	spor	28	14	8
Bunias_orientalis	gam	7	7	4
Bunias_orientalis	spor	14	7	41
Bunias_orientalis	spor	28	14	2
Bunias_orientalis	spor	42	21	4
Cakile_arabica	gam	9	9	7
Cakile_edentula	gam	9	9	4
Cakile_edentula	gam	18	18	1
Cakile_edentula	spor	18	9	12
Cakile_edentula	spor	36	18	5
Cakile_lanceolata	gam	9	9	2
Cakile_lanceolata	spor	18	9	4
Cakile_maritima	gam	9	9	37
Cakile_maritima	spor	18	9	46
Cakile_maritima	spor	36	18	3
Calepina_irregularis	gam	14	14	7
Calepina_irregularis	gam	21	21	2
Calepina_irregularis	spor	14	7	11
Calepina_irregularis	spor	16	8	1
Calepina_irregularis	spor	28	14	9
Calepina_irregularis	spor	42	21	4
Camelina_alyssum	gam	21	21	1
Camelina_alyssum	spor	40	20	13
Camelina_alyssum	spor	42	21	2
Camelina_microcarpa	gam	8	8	2
Camelina_microcarpa	gam	13	13	4
Camelina_microcarpa	gam	19	19	3
Camelina_microcarpa	gam	20	20	3
Camelina_microcarpa	spor	16	8	4

Camelina_microcarpa	spor	18	9	6
Camelina_microcarpa	spor	20	10	6
Camelina_microcarpa	spor	24	12	3
Camelina_microcarpa	spor	26	13	9
Camelina_microcarpa	spor	32	16	3
Camelina_microcarpa	spor	38	19	1
Camelina_microcarpa	spor	40	20	29
Camelina_rumelica	gam	6	6	4
Camelina_rumelica	gam	12	12	3
Camelina_rumelica	spor	12	6	3
Camelina_rumelica	spor	16	8	1
Camelina_rumelica	spor	26	13	3
Camelina_rumelica	spor	32	16	1
Camelina_rumelica	spor	40	20	2
Camelina_sativa	gam	6	6	3
Camelina_sativa	gam	13	13	1
Camelina_sativa	gam	14	14	1
Camelina_sativa	gam	20	20	3
Camelina_sativa	spor	12	6	3
Camelina_sativa	spor	26	13	6
Camelina_sativa	spor	28	14	3
Camelina_sativa	spor	36	18	3
Camelina_sativa	spor	40	20	16
Camelina_sativa	spor	42	21	1
Capsella_bursa-pastoris	gam	8	8	16
Capsella_bursa-pastoris	gam	16	16	50
Capsella_bursa-pastoris	gam	20	20	2
Capsella_bursa-pastoris	spor	12	6	1
Capsella_bursa-pastoris	spor	16	8	27
Capsella_bursa-pastoris	spor	20	10	1
Capsella_bursa-pastoris	spor	32	16	116
Capsella_bursa-pastoris	spor	40	20	1
Capsella_grandiflora	spor	16	8	1
Capsella_rubella	spor	12	6	1
Capsella_rubella	spor	16	8	19
Cardamine_africana	gam	16	16	3
Cardamine_africana	spor	16	8	9
Cardamine_amara	gam	8	8	9
Cardamine_amara	gam	16	16	8
Cardamine_amara	gam	32	32	1
Cardamine_amara	spor	16	8	455
Cardamine_amara	spor	24	12	7
Cardamine_amara	spor	30	15	1
Cardamine_amara	spor	32	16	54
Cardamine_amara	spor	56	28	2
Cardamine_amara	spor	58	29	1
Cardamine_amara	spor	60	30	1
Cardamine_amara	spor	64	32	1
Cardamine_amara	spor	68	34	1

Cardamine_amara	spor	72	36	1
Cardamine_amara	spor	76	38	1
Cardamine_amara	spor	84	42	1
Cardamine_amara_subsp._pyrenaea	spor	16	8	19
Cardamine_angustata	spor	110	55	1
Cardamine_angustata	spor	116	58	1
Cardamine_angustata	spor	119	60	1
Cardamine_angustata	spor	128	64	9
Cardamine_angustata	spor	130	65	1
Cardamine_angustata	spor	134	67	1
Cardamine_asarifolia	spor	14	7	4
Cardamine_asarifolia	spor	16	8	4
Cardamine_asarifolia	spor	48	24	4
Cardamine_bellidifolia	gam	8	8	13
Cardamine_bellidifolia	gam	16	16	4
Cardamine_bellidifolia	spor	16	8	63
Cardamine_bonariensis	gam	8	8	1
Cardamine_breweri	gam	42	42	2
Cardamine_breweri	gam	48	48	2
Cardamine_breweri	spor	42	21	3
Cardamine_breweri	spor	48	24	3
Cardamine_bulbosa	gam	16	16	1
Cardamine_bulbosa	gam	28	28	2
Cardamine_bulbosa	gam	32	32	7
Cardamine_bulbosa	gam	40	40	3
Cardamine_bulbosa	gam	48	48	3
Cardamine_bulbosa	gam	56	56	2
Cardamine_bulbosa	spor	16	8	2
Cardamine_bulbosa	spor	32	16	1
Cardamine_bulbosa	spor	48	24	1
Cardamine_bulbosa	spor	56	28	1
Cardamine_bulbosa	spor	64	32	8
Cardamine_bulbosa	spor	80	40	1
Cardamine_bulbosa	spor	96	48	1
Cardamine_bulbosa	spor	112	56	1
Cardamine_castellana	spor	16	8	16
Cardamine_concatenata	gam	64	64	5
Cardamine_concatenata	gam	128	128	5
Cardamine_concatenata	spor	128	64	1
Cardamine_concatenata	spor	240	120	6
Cardamine_concatenata	spor	256	128	1
Cardamine_conferta	spor	48	24	6
Cardamine_cordifolia	gam	12	12	12
Cardamine_cordifolia	spor	24	12	10
Cardamine_crassifolia	spor	16	8	17
Cardamine_crassifolia	spor	44	22	1
Cardamine_debilis	gam	24	24	25
Cardamine_debilis	spor	48	24	1
Cardamine_digitata	spor	28	14	46

Cardamine_digitata	spor	32	16	5
Cardamine_digitata	spor	40	20	4
Cardamine_digitata	spor	42	21	29
Cardamine_digitata	spor	48	24	1
Cardamine_diphylla	spor	74	37	1
Cardamine_diphylla	spor	96	48	7
Cardamine_diphylla	spor	240	120	1
Cardamine_enneaphyllos	gam	26	26	2
Cardamine_enneaphyllos	gam	27	27	2
Cardamine_enneaphyllos	spor	52	26	1
Cardamine_enneaphyllos	spor	54	27	1
Cardamine_enneaphyllos	spor	80	40	16
Cardamine_flexuosa	gam	15	15	4
Cardamine_flexuosa	gam	16	16	7
Cardamine_flexuosa	spor	16	8	1
Cardamine_flexuosa	spor	30	15	1
Cardamine_flexuosa	spor	32	16	90
Cardamine_glanduligera	spor	42	21	5
Cardamine_glanduligera	spor	48	24	17
Cardamine_glauca	spor	16	8	13
Cardamine_graeca	gam	8	8	3
Cardamine_graeca	spor	16	8	12
Cardamine_graeca	spor	18	9	17
Cardamine_hirsuta	gam	7	7	4
Cardamine_hirsuta	gam	8	8	21
Cardamine_hirsuta	gam	16	16	6
Cardamine_hirsuta	spor	16	8	145
Cardamine_hirsuta	spor	32	16	12
Cardamine_hirsuta	spor	64	32	5
Cardamine_hirsuta	spor	80	40	1
Cardamine_hirsuta	spor	90	45	1
Cardamine_impatiens	gam	8	8	8
Cardamine_impatiens	gam	16	16	2
Cardamine_impatiens	spor	16	8	80
Cardamine_impatiens	spor	32	16	10
Cardamine_leucantha	gam	8	8	1
Cardamine_leucantha	spor	16	8	14
Cardamine_leucantha	spor	18	9	3
Cardamine_leucantha	spor	24	12	3
Cardamine_macrophylla	gam	8	8	1
Cardamine_macrophylla	gam	16	16	3
Cardamine_macrophylla	spor	16	8	2
Cardamine_macrophylla	spor	50	25	1
Cardamine_macrophylla	spor	64	32	5
Cardamine_macrophylla	spor	80	40	1
Cardamine_macrophylla	spor	96	48	10
Cardamine_microphylla	spor	16	8	1
Cardamine_microphylla	spor	28	14	7
Cardamine_microphylla	spor	42	21	6

Cardamine_microphylla	spor	52	26	1
Cardamine_microphylla	spor	64	32	5
Cardamine_microphylla	spor	100	50	3
Cardamine_monteluccii	spor	16	8	2
Cardamine_niigatensis	spor	32	16	1
Cardamine_occidentalis	gam	32	32	5
Cardamine_occidentalis	spor	32	16	1
Cardamine_occidentalis	spor	64	32	7
Cardamine_oligosperma	spor	16	8	12
Cardamine_parviflora	gam	8	8	6
Cardamine_parviflora	gam	22	22	1
Cardamine_parviflora	gam	24	24	1
Cardamine_parviflora	spor	16	8	28
Cardamine_parviflora	spor	24	12	1
Cardamine_parviflora	spor	32	16	1
Cardamine_pedata	spor	30	15	5
Cardamine_pensylvanica	gam	16	16	5
Cardamine_pensylvanica	gam	32	32	1
Cardamine_pensylvanica	spor	32	16	20
Cardamine_pensylvanica	spor	64	32	5
Cardamine_pentaphyllos	gam	22	22	3
Cardamine_pentaphyllos	gam	24	24	4
Cardamine_pentaphyllos	spor	48	24	8
Cardamine_plumieri	spor	16	8	2
Cardamine_pratensis	gam	8	8	2
Cardamine_pratensis	gam	14	14	2
Cardamine_pratensis	gam	15	15	2
Cardamine_pratensis	gam	16	16	8
Cardamine_pratensis	gam	21	21	2
Cardamine_pratensis	gam	28	28	12
Cardamine_pratensis	gam	29	29	1
Cardamine_pratensis	gam	30	30	8
Cardamine_pratensis	gam	32	32	4
Cardamine_pratensis	gam	38	38	1
Cardamine_pratensis	spor	16	8	334
Cardamine_pratensis	spor	17	8	12
Cardamine_pratensis	spor	18	9	21
Cardamine_pratensis	spor	19	10	10
Cardamine_pratensis	spor	20	10	15
Cardamine_pratensis	spor	21	10	4
Cardamine_pratensis	spor	23	12	1
Cardamine_pratensis	spor	24	12	21
Cardamine_pratensis	spor	28	14	29
Cardamine_pratensis	spor	30	15	356
Cardamine_pratensis	spor	31	16	2
Cardamine_pratensis	spor	32	16	163
Cardamine_pratensis	spor	33	16	2
Cardamine_pratensis	spor	34	17	15
Cardamine_pratensis	spor	36	18	4

Cardamine_pratensis	spor	37	18	2
Cardamine_pratensis	spor	38	19	56
Cardamine_pratensis	spor	39	20	3
Cardamine_pratensis	spor	40	20	18
Cardamine_pratensis	spor	42	21	4
Cardamine_pratensis	spor	43	22	1
Cardamine_pratensis	spor	44	22	118
Cardamine_pratensis	spor	45	22	6
Cardamine_pratensis	spor	46	23	12
Cardamine_pratensis	spor	48	24	73
Cardamine_pratensis	spor	50	25	7
Cardamine_pratensis	spor	52	26	7
Cardamine_pratensis	spor	53	26	1
Cardamine_pratensis	spor	54	27	10
Cardamine_pratensis	spor	56	28	85
Cardamine_pratensis	spor	58	29	18
Cardamine_pratensis	spor	59	30	2
Cardamine_pratensis	spor	60	30	28
Cardamine_pratensis	spor	62	31	7
Cardamine_pratensis	spor	64	32	55
Cardamine_pratensis	spor	66	33	3
Cardamine_pratensis	spor	67	34	1
Cardamine_pratensis	spor	68	34	19
Cardamine_pratensis	spor	69	34	1
Cardamine_pratensis	spor	70	35	9
Cardamine_pratensis	spor	71	36	1
Cardamine_pratensis	spor	72	36	31
Cardamine_pratensis	spor	73	36	1
Cardamine_pratensis	spor	74	37	8
Cardamine_pratensis	spor	76	38	33
Cardamine_pratensis	spor	78	39	11
Cardamine_pratensis	spor	80	40	20
Cardamine_pratensis	spor	84	42	4
Cardamine_pratensis	spor	88	44	4
Cardamine_pratensis	spor	90	45	9
Cardamine_pratensis	spor	96	48	6
Cardamine_pratensis	spor	100	50	4
Cardamine_pratensis	spor	118	59	2
Cardamine_purpurea	spor	80	40	3
Cardamine_purpurea	spor	96	48	8
Cardamine_raphanifolia	spor	44	22	4
Cardamine_raphanifolia	spor	46	23	9
Cardamine_raphanifolia	spor	48	24	29
Cardamine_raphanifolia	spor	64	32	8
Cardamine_resedifolia	gam	8	8	2
Cardamine_resedifolia	spor	16	8	25
Cardamine_scutata	gam	16	16	4
Cardamine_scutata	spor	32	16	12
Cardamine_scutata	spor	72	36	1

Cardamine_tangutorum	spor	42	21	3
Cardamine_trifolia	gam	8	8	2
Cardamine_trifolia	spor	16	8	36
Cardamine_victoris	spor	28	14	10
Cardamine_yezoensis	spor	16	8	5
Cardamine_yezoensis	spor	32	16	7
Cardamine_yezoensis	spor	46	23	2
Cardamine_yezoensis	spor	48	24	3
Cardamine_yezoensis	spor	56	28	3
Cardamine_yezoensis	spor	64	32	2
Cardamine_yezoensis	spor	72	36	3
Cardamine_yezoensis	spor	80	40	1
Cardamine_yezoensis	spor	88	44	1
Cardamine_yezoensis	spor	96	48	1
Carrichtera_annua	gam	8	8	22
Carrichtera_annua	spor	16	8	50
Carrichtera_annua	spor	32	16	3
Catolobus_pendulus	spor	16	8	5
Catolobus_pendulus	spor	21	10	5
Caulanthus_coulteri	gam	14	14	6
Caulanthus_coulteri	spor	28	14	2
Caulanthus_crassicaulis	gam	12	12	2
Caulanthus_crassicaulis	gam	14	14	1
Caulanthus_crassicaulis	spor	24	12	3
Caulanthus_crassicaulis	spor	28	14	2
Caulanthus_glaucus	gam	10	10	2
Caulanthus_glaucus	spor	20	10	1
Caulanthus_heterophyllus	gam	14	14	3
Caulanthus_heterophyllus	spor	28	14	1
Caulanthus_inflatus	gam	10	10	3
Caulanthus_inflatus	gam	14	14	5
Caulanthus_inflatus	spor	28	14	3
Caulanthus_major	spor	28	14	2
Caulanthus_simulans	spor	28	14	1
Caulanthus_simulans	spor	38	19	1
Chalcanthus_renifolius	gam	7	7	1
Chalcanthus_renifolius	spor	14	7	1
Chorispora_macropoda	gam	7	7	2
Chorispora_persica	gam	7	7	1
Chorispora_tenella	gam	7	7	8
Chorispora_tenella	gam	12	12	2
Chorispora_tenella	gam	14	14	2
Chorispora_tenella	spor	14	7	20
Christolea_crassifolia	spor	14	7	12
Chrysochamela_velutina	spor	16	8	1
Chrysochamela_velutina	spor	22	11	1
Cithareloma_lehmannii	gam	13	13	2
Cithareloma_lehmannii	spor	26	13	2
Clastopus_vestitus	spor	16	8	2

Clausia_aprica	spor	14	7	3
Clausia_aprica	spor	28	14	4
Clypeola_aspera	gam	7	7	2
Clypeola_aspera	gam	13	13	2
Clypeola_aspera	gam	14	14	2
Clypeola_aspera	spor	14	7	2
Clypeola_aspera	spor	26	13	2
Clypeola_dichotoma	gam	7	7	5
Clypeola_jonthlaspi	gam	8	8	2
Clypeola_jonthlaspi	gam	14	14	3
Clypeola_jonthlaspi	gam	16	16	4
Clypeola_jonthlaspi	spor	16	8	10
Clypeola_jonthlaspi	spor	32	16	12
Clypeola_lappacea	gam	7	7	6
Cochlearia_aestuaria	gam	6	6	2
Cochlearia_aestuaria	spor	12	6	11
Cochlearia_anglica	gam	6	6	1
Cochlearia_anglica	gam	18	18	1
Cochlearia_anglica	gam	24	24	4
Cochlearia_anglica	gam	25	25	1
Cochlearia_anglica	spor	36	18	4
Cochlearia_anglica	spor	37	18	4
Cochlearia_anglica	spor	42	21	1
Cochlearia_anglica	spor	48	24	23
Cochlearia_anglica	spor	49	24	2
Cochlearia_anglica	spor	50	25	5
Cochlearia_anglica	spor	54	27	2
Cochlearia_anglica	spor	60	30	2
Cochlearia_aragonensis	spor	48	24	6
Cochlearia_danica	gam	21	21	4
Cochlearia_danica	spor	33	16	1
Cochlearia_danica	spor	42	21	43
Cochlearia_glastifolia	spor	38	19	6
Cochlearia_officinalis	gam	6	6	3
Cochlearia_officinalis	gam	7	7	3
Cochlearia_officinalis	gam	12	12	14
Cochlearia_officinalis	gam	14	14	2
Cochlearia_officinalis	gam	18	18	1
Cochlearia_officinalis	spor	12	6	2
Cochlearia_officinalis	spor	14	7	8
Cochlearia_officinalis	spor	18	9	1
Cochlearia_officinalis	spor	24	12	72
Cochlearia_officinalis	spor	26	13	1
Cochlearia_officinalis	spor	28	14	7
Cochlearia_officinalis	spor	32	16	1
Cochlearia_officinalis	spor	34	17	1
Cochlearia_officinalis	spor	36	18	3
Cochlearia_pyrenaica	gam	6	6	9
Cochlearia_pyrenaica	spor	8	4	2

Cochlearia_pyrenaica	spor	11	6	2
Cochlearia_pyrenaica	spor	12	6	91
Cochlearia_pyrenaica	spor	14	7	1
Cochlearia_pyrenaica	spor	24	12	5
Cochlearia_pyrenaica	spor	26	13	2
Cochlearia_pyrenaica	spor	28	14	2
Cochlearia_pyrenaica	spor	48	24	5
Cochlearia_tatrae	spor	42	21	13
Coincya_monensis	gam	8	8	1
Coincya_monensis	gam	9	9	1
Coincya_monensis	gam	10	10	1
Coincya_monensis	gam	12	12	7
Coincya_monensis	gam	24	24	1
Coincya_monensis	spor	20	10	1
Coincya_monensis	spor	24	12	10
Coincya_monensis	spor	48	24	2
Conringia_orientalis	gam	7	7	6
Conringia_orientalis	spor	14	7	17
Conringia_orientalis	spor	28	14	1
Conringia_planisiliqua	gam	7	7	2
Conringia_planisiliqua	gam	9	9	3
Conringia_planisiliqua	spor	14	7	3
Conringia_planisiliqua	spor	16	8	1
Conringia_planisiliqua	spor	18	9	1
Cordylocarpus_muricatus	spor	16	8	4
Crambe_orientalis	gam	15	15	9
Crambe_orientalis	spor	30	15	2
Crucihimalaya_himalaica	gam	8	8	3
Crucihimalaya_himalaica	spor	16	8	8
Crucihimalaya_mollissima	gam	8	8	6
Crucihimalaya_mollissima	spor	16	8	2
Crucihimalaya_mollissima	spor	32	16	1
Crucihimalaya_stricta	gam	7	7	1
Crucihimalaya_stricta	spor	14	7	2
Crucihimalaya_wallichii	gam	8	8	2
Crucihimalaya_wallichii	gam	9	9	3
Crucihimalaya_wallichii	spor	14	7	3
Crucihimalaya_wallichii	spor	16	8	12
Crucihimalaya_wallichii	spor	18	9	2
Cryptospora_falcata	spor	14	7	2
Degenia_velebitica	spor	16	8	4
Dendroarabis_fruticulosa	spor	16	8	1
Descurainia_artemisioides	spor	14	7	2
Descurainia_bourgeauana	spor	14	7	2
Descurainia_californica	gam	7	7	2
Descurainia_californica	spor	14	7	3
Descurainia_gilva	spor	14	7	2
Descurainia_gonzalezii	gam	7	7	1
Descurainia_gonzalezii	gam	14	14	1

Descurainia_gonzalezii	spor	14	7	4
Descurainia_gonzalezii	spor	21	10	2
Descurainia_impatiens	gam	7	7	2
Descurainia_incana	gam	7	7	1
Descurainia_incana	spor	14	7	6
Descurainia_incana	spor	28	14	3
Descurainia_incana	spor	42	21	1
Descurainia_incisa_subsp._incisa	spor	14	7	1
Descurainia_lemsii	gam	7	7	1
Descurainia_lemsii	spor	14	7	2
Descurainia_leptoclada	spor	14	7	1
Descurainia_millefolia	spor	14	7	4
Descurainia_myriophylla	gam	7	7	1
Descurainia_myriophylla	spor	14	7	4
Descurainia_myriophylla	spor	28	14	1
Descurainia_pinnata	gam	7	7	3
Descurainia_pinnata	gam	14	14	1
Descurainia_pinnata	gam	21	21	1
Descurainia_pinnata	spor	14	7	2
Descurainia_pinnata	spor	28	14	4
Descurainia_pinnata	spor	42	21	1
Descurainia_pinnata_subsp._brachycarpa	gam	7	7	3
Descurainia_pinnata_subsp._brachycarpa	spor	14	7	1
Descurainia_pinnata_subsp._brachycarpa	spor	28	14	3
Descurainia_pinnata_subsp._glabra	spor	28	14	1
Descurainia_pinnata_subsp._halictorum	gam	7	7	4
Descurainia_pinnata_subsp._halictorum	spor	14	7	2
Descurainia_pinnata_subsp._halictorum	spor	28	14	1
Descurainia_pinnata_subsp._halictorum	spor	42	21	1
Descurainia_pinnata_subsp._intermedia	spor	28	14	1
Descurainia_pinnata_subsp._menziesii	spor	28	14	2
Descurainia_pinnata_subsp._ochroleuca	gam	14	14	3
Descurainia_preauxiana	spor	14	7	4
Descurainia_sophia	gam	7	7	1
Descurainia_sophia	gam	10	10	6
Descurainia_sophia	gam	14	14	23
Descurainia_sophia	spor	12	6	1
Descurainia_sophia	spor	14	7	13
Descurainia_sophia	spor	20	10	6
Descurainia_sophia	spor	28	14	67
Descurainia_sophia	spor	56	28	5
Descurainia_sophioides	spor	14	7	16
Descurainia_sophioides	spor	36	18	2
Descurainia_streptocarpa	gam	14	14	1
Descurainia_virletii	gam	14	14	1
Didymophysa_aucheri	spor	14	7	2
Didymophysa_aucheri	spor	16	8	2
Dimorphocarpa_wislizeni	gam	9	9	13
Dimorphocarpa_wislizeni	spor	18	9	6

Diplotaxis_acris	gam	11	11	4
Diplotaxis_acris	spor	22	11	2
Diplotaxis_catholica	gam	9	9	17
Diplotaxis_catholica	gam	10	10	3
Diplotaxis_catholica	spor	10	5	2
Diplotaxis_catholica	spor	18	9	19
Diplotaxis_catholica	spor	20	10	2
Diplotaxis_erucoides	gam	7	7	25
Diplotaxis_erucoides	gam	9	9	2
Diplotaxis_erucoides	spor	14	7	27
Diplotaxis_erucoides	spor	18	9	2
Diplotaxis_harra	gam	11	11	1
Diplotaxis_harra	gam	13	13	10
Diplotaxis_harra	spor	26	13	8
Diplotaxis_harra	spor	38	19	3
Diplotaxis_tenuifolia	gam	10	10	3
Diplotaxis_tenuifolia	gam	11	11	10
Diplotaxis_tenuifolia	spor	14	7	4
Diplotaxis_tenuifolia	spor	20	10	6
Diplotaxis_tenuifolia	spor	22	11	44
Diplotaxis_tenuifolia	spor	42	21	3
Diptychocarpus_strictus	gam	7	7	7
Diptychocarpus_strictus	spor	14	7	5
Dithyrea_californica	gam	10	10	7
Dithyrea_californica	spor	20	10	2
Dontostemon_crassifolius	gam	7	7	2
Dontostemon_crassifolius	spor	14	7	3
Dontostemon_dentatus	spor	14	7	1
Dontostemon_hispidus	spor	14	7	2
Dontostemon_integrifolius	spor	14	7	4
Dontostemon_intermedius	spor	14	7	1
Dontostemon_pinnatifidus	spor	14	7	1
Dontostemon_senilis	spor	28	14	3
Draba_aizoides	gam	8	8	5
Draba_aizoides	spor	16	8	35
Draba_albertina	gam	12	12	8
Draba_albertina	spor	24	12	4
Draba_alpina	gam	32	32	4
Draba_alpina	gam	37	37	1
Draba_alpina	gam	40	40	5
Draba_alpina	spor	62	31	1
Draba_alpina	spor	64	32	19
Draba_alpina	spor	66	33	2
Draba_alpina	spor	80	40	16
Draba_alpina	spor	112	56	3
Draba_alpina	spor	120	60	2
Draba_altaica	spor	16	8	1
Draba_altaica	spor	18	9	1
Draba_arabisans	gam	48	48	3

Draba_arabisans	spor	94	47	2
Draba_arabisans	spor	96	48	3
Draba_asprella	gam	15	15	2
Draba_asprella	gam	16	16	4
Draba_asprella	spor	30	15	4
Draba_aurea	gam	32	32	2
Draba_aurea	gam	36	36	2
Draba_aurea	gam	37	37	5
Draba_aurea	gam	38	38	2
Draba_aurea	gam	41	41	2
Draba_aurea	spor	40	20	2
Draba_aurea	spor	64	32	3
Draba_aurea	spor	72	36	2
Draba_aurea	spor	74	37	2
Draba_aurea	spor	76	38	2
Draba_aureola	spor	20	10	2
Draba_bellardii	spor	48	24	1
Draba_borealis	gam	40	40	3
Draba_borealis	spor	16	8	2
Draba_borealis	spor	64	32	3
Draba_borealis	spor	80	40	3
Draba_borealis	spor	82	41	1
Draba_brachystylis	spor	44	22	1
Draba_breweri	spor	32	16	1
Draba_bruniifolia	spor	32	16	2
Draba_burkei	gam	10	10	2
Draba_burkei	spor	20	10	1
Draba_cana	gam	16	16	3
Draba_cana	spor	32	16	6
Draba_chionophila	spor	48	24	1
Draba_cinerea	gam	24	24	8
Draba_cinerea	gam	32	32	3
Draba_cinerea	gam	48	48	2
Draba_cinerea	spor	16	8	1
Draba_cinerea	spor	24	12	1
Draba_cinerea	spor	32	16	9
Draba_cinerea	spor	48	24	33
Draba_cinerea	spor	56	28	2
Draba_cinerea	spor	64	32	4
Draba_cinerea	spor	80	40	1
Draba_corymbosa	gam	64	64	2
Draba_corymbosa	gam	72	72	1
Draba_corymbosa	spor	10	5	1
Draba_corymbosa	spor	32	16	2
Draba_corymbosa	spor	80	40	3
Draba_corymbosa	spor	90	45	2
Draba_corymbosa	spor	100	50	5
Draba_corymbosa	spor	120	60	5
Draba_corymbosa	spor	128	64	7

Draba_corymbosa	spor	135	68	2
Draba_corymbosa	spor	144	72	1
Draba_crassa	gam	24	24	1
Draba_crassa	spor	24	12	1
Draba_crassifolia	gam	20	20	15
Draba_crassifolia	gam	40	40	1
Draba_crassifolia	spor	40	20	8
Draba_crassifolia	spor	64	32	1
Draba_cretica	spor	16	8	1
Draba_cusickii	gam	13	13	2
Draba_cusickii	spor	26	13	1
Draba_dedeana	gam	16	16	2
Draba_dedeana	spor	32	16	6
Draba_densifolia	spor	36	18	1
Draba_dubia	gam	8	8	4
Draba_dubia	spor	16	8	21
Draba_eriopoda	spor	16	8	5
Draba_exunguiculata	gam	5	5	1
Draba_exunguiculata	gam	56	56	1
Draba_exunguiculata	spor	56	28	1
Draba_fladnizensis	gam	8	8	14
Draba_fladnizensis	spor	16	8	46
Draba_fladnizensis	spor	32	16	9
Draba_gilliesii	gam	24	24	2
Draba_gilliesii	spor	48	24	1
Draba_glabella	gam	32	32	6
Draba_glabella	gam	40	40	4
Draba_glabella	gam	41	41	1
Draba_glabella	spor	40	20	1
Draba_glabella	spor	64	32	7
Draba_glabella	spor	75	38	2
Draba_glabella	spor	80	40	3
Draba_glacialis	spor	16	8	2
Draba_hederifolia	gam	15	15	1
Draba_hederifolia	spor	30	15	2
Draba_helleriana	gam	9	9	2
Draba_helleriana	spor	18	9	1
Draba_hirta	gam	40	40	1
Draba_hirta	spor	64	32	7
Draba_hirta	spor	80	40	2
Draba_hispanica	gam	8	8	6
Draba_hispanica	spor	16	8	15
Draba_hispida	spor	48	24	1
Draba_hitchcockii	gam	27	27	2
Draba_hitchcockii	spor	54	27	1
Draba_hyperborea	gam	18	18	2
Draba_hyperborea	gam	19	19	4
Draba_hyperborea	spor	14	7	1
Draba_hyperborea	spor	16	8	2

Draba_hyperborea	spor	32	16	2
Draba_hyperborea	spor	36	18	3
Draba_incana	gam	16	16	11
Draba_incana	spor	16	8	1
Draba_incana	spor	32	16	21
Draba_incerta	gam	56	56	3
Draba_incerta	spor	100	50	1
Draba_incerta	spor	112	56	6
Draba_jaegeri	gam	27	27	2
Draba_jaegeri	spor	54	27	3
Draba_jorullensis	gam	12	12	2
Draba_juvenilis	gam	32	32	5
Draba_juvenilis	spor	48	24	4
Draba_juvenilis	spor	64	32	5
Draba_kassii	gam	11	11	2
Draba_kassii	spor	22	11	1
Draba_kotschyi	spor	32	16	1
Draba_kotschyi	spor	48	24	1
Draba_lacaitae	spor	16	8	3
Draba_lacaitae	spor	32	16	1
Draba_lactea	gam	24	24	10
Draba_lactea	spor	16	8	1
Draba_lactea	spor	32	16	11
Draba_lactea	spor	48	24	31
Draba_ladina	spor	32	16	3
Draba_lasiocarpa	gam	8	8	1
Draba_lasiocarpa	spor	16	8	27
Draba_lemmonii	spor	50	25	1
Draba_lonchocarpa	gam	8	8	6
Draba_lonchocarpa	spor	16	8	14
Draba_lonchocarpa	spor	24	12	1
Draba_lonchocarpa	spor	32	16	1
Draba_lutescens	gam	8	8	2
Draba_lutescens	spor	16	8	7
Draba_magellanica	gam	32	32	1
Draba_magellanica	spor	48	24	1
Draba_magellanica	spor	64	32	1
Draba_magellanica	spor	80	40	1
Draba_maguirei	gam	16	16	2
Draba_maguirei	spor	16	8	1
Draba_maguirei	spor	32	16	1
Draba_melanopus	gam	16	16	2
Draba_micropetala	gam	16	16	2
Draba_micropetala	spor	32	16	3
Draba_micropetala	spor	48	24	2
Draba_mogollonica	gam	16	16	2
Draba_mogollonica	spor	22	11	1
Draba_murrayi	spor	28	14	1
Draba_murrayi	spor	48	24	3

Draba_nemorosa	gam	8	8	13
Draba_nemorosa	spor	16	8	25
Draba_nivalis	gam	8	8	10
Draba_nivalis	spor	16	8	36
Draba_norvegica	gam	24	24	18
Draba_norvegica	spor	48	24	26
Draba_nuda	gam	8	8	2
Draba_oblongata	gam	24	24	2
Draba_oblongata	gam	32	32	6
Draba_oblongata	gam	40	40	4
Draba_oblongata	spor	16	8	2
Draba_oblongata	spor	32	16	1
Draba_oblongata	spor	48	24	6
Draba_oblongata	spor	64	32	13
Draba_oblongata	spor	80	40	11
Draba_ochroleuca	spor	80	40	2
Draba_ogilviensis	spor	16	8	1
Draba_olgae	spor	12	6	3
Draba_oligosperma	gam	11	11	2
Draba_oligosperma	gam	32	32	2
Draba_oligosperma	spor	32	16	3
Draba_oligosperma	spor	60	30	2
Draba_oligosperma	spor	64	32	3
Draba_oreades	spor	40	20	2
Draba_oreadum	gam	16	16	5
Draba_oreadum	spor	32	16	2
Draba_oxycarpa	gam	32	32	4
Draba_oxycarpa	spor	64	32	5
Draba_palanderiana	spor	16	8	6
Draba_palanderiana	spor	32	16	7
Draba_palanderiana	spor	48	24	1
Draba_palanderiana	spor	64	32	1
Draba_parnassica	spor	16	8	3
Draba_pauciflora	gam	16	16	1
Draba_pauciflora	gam	24	24	2
Draba_pauciflora	spor	32	16	7
Draba_pauciflora	spor	48	24	4
Draba_paysonii	spor	42	21	3
Draba_pectinipila	spor	22	11	1
Draba_pickeringii	gam	12	12	1
Draba_pickeringii	spor	24	12	2
Draba_pilosa	spor	32	16	1
Draba_porsildii	gam	16	16	3
Draba_porsildii	spor	32	16	4
Draba_praealta	gam	28	28	2
Draba_praealta	spor	56	28	1
Draba_ramosissima	gam	8	8	2
Draba_ramosissima	spor	16	8	1
Draba_rectifructa	gam	12	12	2

Draba_rectifructa	spor	24	12	1
Draba_reptans	gam	15	15	3
Draba_reptans	gam	16	16	1
Draba_reptans	spor	16	8	1
Draba_reptans	spor	30	15	3
Draba_reptans	spor	32	16	3
Draba_rosularis	spor	16	8	2
Draba_ruaxes	spor	72	36	3
Draba_sachalinensis	spor	64	32	2
Draba_sibirica	spor	16	8	7
Draba_sobolifera	gam	13	13	2
Draba_sobolifera	spor	26	13	1
Draba_spectabilis	gam	10	10	5
Draba_spectabilis	gam	16	16	8
Draba_spectabilis	spor	40	20	1
Draba_sphaerocarpa	gam	10	10	2
Draba_sphaerocarpa	spor	20	10	1
Draba_sphaeroides	gam	10	10	2
Draba_sphaeroides	spor	20	10	1
Draba_stenoloba	gam	12	12	2
Draba_stenoloba	gam	20	20	4
Draba_stenoloba	spor	40	20	2
Draba_stenopetala	gam	12	12	1
Draba_stenopetala	spor	24	12	1
Draba_stenopetala	spor	64	32	5
Draba_streptobrachia	gam	5	5	3
Draba_streptobrachia	gam	32	32	3
Draba_streptobrachia	spor	64	32	1
Draba_streptocarpa	gam	20	20	1
Draba_streptocarpa	spor	20	10	1
Draba_streptocarpa	spor	40	20	1
Draba_stylaris	spor	32	16	8
Draba_subalpina	gam	13	13	2
Draba_subalpina	spor	26	13	1
Draba_subamplexicaulis	spor	48	24	2
Draba_subcapitata	gam	8	8	5
Draba_subcapitata	spor	16	8	16
Draba_supranivalis	spor	14	7	1
Draba_supranivalis	spor	16	8	1
Draba_tomentosa	gam	8	8	1
Draba_tomentosa	spor	16	8	21
Draba_ussuriensis	spor	16	8	3
Draba_ussuriensis	spor	32	16	3
Draba_ventosa	spor	36	18	3
Dryopetalon_viereckii	spor	28	14	3
Elburzia_fenestrata	gam	7	7	2
Eremobium_aegyptiacum	gam	10	10	1
Eremobium_aegyptiacum	gam	13	13	3
Eremobium_aegyptiacum	spor	16	8	2

Eremobium_aegyptiacum	spor	20	10	2
Erophila_verna	gam	7	7	8
Erophila_verna	gam	8	8	2
Erophila_verna	gam	10	10	3
Erophila_verna	gam	12	12	2
Erophila_verna	gam	14	14	2
Erophila_verna	gam	15	15	7
Erophila_verna	gam	16	16	2
Erophila_verna	gam	17	17	1
Erophila_verna	gam	18	18	3
Erophila_verna	gam	19	19	2
Erophila_verna	gam	20	20	8
Erophila_verna	gam	26	26	3
Erophila_verna	gam	27	27	1
Erophila_verna	gam	29	29	2
Erophila_verna	gam	32	32	4
Erophila_verna	gam	34	34	1
Erophila_verna	gam	47	47	2
Erophila_verna	gam	54	54	1
Erophila_verna	spor	14	7	9
Erophila_verna	spor	16	8	3
Erophila_verna	spor	20	10	1
Erophila_verna	spor	24	12	2
Erophila_verna	spor	28	14	2
Erophila_verna	spor	30	15	8
Erophila_verna	spor	32	16	7
Erophila_verna	spor	34	17	5
Erophila_verna	spor	36	18	10
Erophila_verna	spor	38	19	2
Erophila_verna	spor	39	20	2
Erophila_verna	spor	40	20	4
Erophila_verna	spor	42	21	1
Erophila_verna	spor	44	22	1
Erophila_verna	spor	46	23	1
Erophila_verna	spor	48	24	1
Erophila_verna	spor	52	26	6
Erophila_verna	spor	54	27	1
Erophila_verna	spor	58	29	2
Erophila_verna	spor	60	30	5
Erophila_verna	spor	64	32	5
Erophila_verna	spor	94	47	1
Erophila_verna_subsp._praecox	spor	32	16	4
Erophila_verna_subsp._praecox	spor	34	17	1
Erophila_verna_subsp._praecox	spor	36	18	2
Erophila_verna_subsp._praecox	spor	48	24	2
Erophila_verna_subsp._praecox	spor	52	26	1
Erophila_verna_subsp._praecox	spor	54	27	1
Erophila_verna_subsp._praecox	spor	56	28	2
Erucaria_erucarioides	gam	8	8	1

Erucaria_erucarioides	spor	16	8	5
Erucastrum_gallicum	gam	15	15	9
Erucastrum_gallicum	spor	30	15	25
Erysimum_arbuscula	spor	28	14	1
Erysimum_asperum	gam	18	18	5
Erysimum_asperum	spor	36	18	5
Erysimum_baeticum	gam	14	14	1
Erysimum_baeticum	gam	28	28	3
Erysimum_bicolor	gam	14	14	3
Erysimum_bicolor	spor	28	14	5
Erysimum_bicolor	spor	32	16	1
Erysimum_bicolor	spor	42	21	2
Erysimum_bonannianum	gam	11	11	1
Erysimum_bonannianum	spor	16	8	1
Erysimum_bonannianum	spor	24	12	1
Erysimum_boreale	spor	16	8	1
Erysimum_caespitosum	gam	28	28	2
Erysimum_capitatum	gam	18	18	41
Erysimum_capitatum	spor	36	18	7
Erysimum_carniolicum	spor	32	16	2
Erysimum_cazorlense	gam	14	14	3
Erysimum_cazorlense	spor	56	28	3
Erysimum_cheiranthoides	gam	8	8	20
Erysimum_cheiranthoides	spor	16	8	52
Erysimum_comatum	spor	14	7	6
Erysimum_comatum	spor	28	14	2
Erysimum_crassicaule	spor	48	24	1
Erysimum_crassipes	gam	7	7	3
Erysimum_crassipes	spor	14	7	5
Erysimum_crassistylum	spor	14	7	9
Erysimum_crassistylum	spor	24	12	1
Erysimum_crassistylum	spor	42	21	4
Erysimum_crepidifolium	gam	7	7	2
Erysimum_crepidifolium	spor	14	7	4
Erysimum_cuspidatum	gam	7	7	2
Erysimum_cuspidatum	gam	8	8	1
Erysimum_cuspidatum	spor	16	8	10
Erysimum_diffusum	gam	14	14	4
Erysimum_diffusum	gam	35	35	1
Erysimum_diffusum	spor	14	7	13
Erysimum_diffusum	spor	28	14	50
Erysimum_diffusum	spor	32	16	4
Erysimum_diffusum	spor	42	21	2
Erysimum_diffusum	spor	56	28	10
Erysimum_diffusum	spor	70	35	6
Erysimum_diffusum	spor	72	36	2
Erysimum_duriaei	gam	7	7	3
Erysimum_duriaei	gam	8	8	1
Erysimum_duriaei	gam	10	10	1

Erysimum_duriaei	gam	11	11	2
Erysimum_duriaei	gam	12	12	1
Erysimum_duriaei	gam	13	13	6
Erysimum_duriaei	gam	14	14	1
Erysimum_duriaei	spor	14	7	10
Erysimum_duriaei	spor	16	8	1
Erysimum_duriaei	spor	20	10	1
Erysimum_duriaei	spor	22	11	2
Erysimum_duriaei	spor	26	13	7
Erysimum_duriaei	spor	28	14	1
Erysimum_duriaei	spor	30	15	1
Erysimum_duriaei	spor	32	16	1
Erysimum_duriaei	spor	38	19	1
Erysimum_duriaei	spor	40	20	1
Erysimum_gelidum	spor	14	7	2
Erysimum_gelidum	spor	56	28	2
Erysimum_hieraciifolium	gam	8	8	1
Erysimum_hieraciifolium	gam	12	12	1
Erysimum_hieraciifolium	gam	16	16	2
Erysimum_hieraciifolium	gam	18	18	1
Erysimum_hieraciifolium	gam	20	20	1
Erysimum_hieraciifolium	spor	16	8	2
Erysimum_hieraciifolium	spor	32	16	8
Erysimum_hieraciifolium	spor	48	24	9
Erysimum_incanum	gam	8	8	4
Erysimum_incanum	gam	16	16	4
Erysimum_incanum	spor	16	8	12
Erysimum_incanum	spor	24	12	2
Erysimum_incanum	spor	32	16	4
Erysimum_incanum	spor	34	17	2
Erysimum_incanum	spor	36	18	2
Erysimum_incanum	spor	48	24	5
Erysimum_ischnostylum	gam	20	20	2
Erysimum_jugicola	gam	9	9	3
Erysimum_jugicola	spor	18	9	36
Erysimum_jugicola	spor	20	10	2
Erysimum_krendlii	spor	14	7	3
Erysimum_kurdicum	spor	16	8	1
Erysimum_leucanthemum	gam	6	6	1
Erysimum_leucanthemum	spor	12	6	1
Erysimum_linariifolium	gam	7	7	2
Erysimum_linariifolium	gam	14	14	1
Erysimum_linariifolium	gam	15	15	1
Erysimum_linariifolium	spor	14	7	4
Erysimum_linariifolium	spor	24	12	1
Erysimum_linifolium	gam	7	7	2
Erysimum_linifolium	spor	14	7	11
Erysimum_majellense	spor	28	14	12
Erysimum_metlesicsii	spor	14	7	3

Erysimum_myriophyllum	gam	14	14	4
Erysimum_myriophyllum	spor	14	7	4
Erysimum_naxense	spor	12	6	1
Erysimum_naxense	spor	24	12	1
Erysimum_nevadense	gam	7	7	4
Erysimum_nevadense	gam	8	8	1
Erysimum_nevadense	spor	14	7	2
Erysimum_ochroleucum	gam	15	15	1
Erysimum_ochroleucum	gam	16	16	1
Erysimum_ochroleucum	spor	16	8	2
Erysimum_ochroleucum	spor	30	15	2
Erysimum_ochroleucum	spor	32	16	1
Erysimum_ochroleucum	spor	34	17	2
Erysimum_ochroleucum	spor	51	26	3
Erysimum_ochroleucum	spor	311	156	2
Erysimum_odoratum	gam	7	7	2
Erysimum_odoratum	gam	14	14	1
Erysimum_odoratum	gam	16	16	7
Erysimum_odoratum	spor	14	7	17
Erysimum_odoratum	spor	16	8	4
Erysimum_odoratum	spor	24	12	2
Erysimum_odoratum	spor	32	16	39
Erysimum_pachycarpum	gam	9	9	2
Erysimum_pectinatum	spor	12	6	1
Erysimum_pectinatum	spor	14	7	2
Erysimum_penyalarense	spor	38	19	1
Erysimum_perofskianum	gam	8	8	1
Erysimum_perofskianum	gam	9	9	2
Erysimum_perofskianum	spor	12	6	3
Erysimum_perofskianum	spor	14	7	2
Erysimum_perofskianum	spor	18	9	1
Erysimum_perofskianum	spor	32	16	3
Erysimum_perofskianum	spor	36	18	4
Erysimum_perofskianum	spor	38	19	1
Erysimum_perofskianum	spor	40	20	2
Erysimum_popovii	gam	14	14	3
Erysimum_pseudorhaeticum	spor	14	7	57
Erysimum_pulchellum	spor	56	28	1
Erysimum_purpureum	spor	40	20	3
Erysimum_pusillum	spor	14	7	8
Erysimum_pusillum	spor	18	9	3
Erysimum_pusillum	spor	30	15	2
Erysimum_redowskii	gam	12	12	4
Erysimum_redowskii	gam	14	14	3
Erysimum_redowskii	spor	24	12	16
Erysimum_redowskii	spor	28	14	3
Erysimum_redowskii	spor	36	18	19
Erysimum_redowskii	spor	42	21	5
Erysimum_repandum	gam	7	7	7

Erysimum_repandum	gam	8	8	8
Erysimum_repandum	gam	14	14	1
Erysimum_repandum	spor	14	7	3
Erysimum_repandum	spor	16	8	24
Erysimum_rhaeticum	gam	24	24	1
Erysimum_rhaeticum	gam	28	28	7
Erysimum_rhaeticum	spor	14	7	1
Erysimum_rhaeticum	spor	56	28	25
Erysimum_rhodium	spor	12	6	3
Erysimum_rhodium	spor	18	9	2
Erysimum_salangense	spor	70	35	1
Erysimum_scabrum	spor	28	14	3
Erysimum_scoparium	gam	14	14	2
Erysimum_scoparium	spor	28	14	18
Erysimum_semperflorens	spor	14	7	1
Erysimum_senoneri	spor	12	6	5
Erysimum_senoneri	spor	13	6	2
Erysimum_senoneri	spor	18	9	2
Erysimum_senoneri	spor	28	14	2
Erysimum_siliculosum	spor	14	7	3
Erysimum_sisymbrioides	spor	18	9	2
Erysimum_sisymbrioides	spor	20	10	1
Erysimum_smyrnaeum	spor	14	7	3
Erysimum_stenophyllum	spor	14	7	1
Erysimum_subulatum	spor	28	14	1
Erysimum_sylvestre	gam	7	7	8
Erysimum_sylvestre	spor	14	7	56
Erysimum_sylvestre	spor	18	9	3
Erysimum_sylvestre	spor	22	11	4
Erysimum_sylvestre	spor	27	14	2
Erysimum_sylvestre	spor	28	14	2
Erysimum_sylvestre	spor	42	21	3
Erysimum_sylvestre	spor	48	24	1
Erysimum_sylvestre	spor	56	28	2
Erysimum_virgatum	spor	16	8	1
Erysimum_virgatum	spor	32	16	1
Erysimum_virgatum	spor	48	24	7
Erysimum_witmannii	spor	14	7	13
Euclidium_syriacum	gam	7	7	7
Euclidium_syriacum	spor	14	7	5
Eutrema_edwardsii	gam	14	14	2
Eutrema_edwardsii	spor	18	9	3
Eutrema_edwardsii	spor	28	14	25
Eutrema_edwardsii	spor	36	18	1
Eutrema_edwardsii	spor	42	21	10
Eutrema_edwardsii	spor	56	28	3
Eutrema_halophilum	gam	7	7	2
Eutrema_heterophyllum	gam	14	14	1
Eutrema_heterophyllum	spor	14	7	1

Eutrema_japonicum	gam	14	14	3
Eutrema_japonicum	spor	28	14	7
Eutrema_salsugineum	spor	14	7	14
Exhalimolobos_parryi	gam	8	8	2
Exhalimolobos_parryi	gam	16	16	4
Exhalimolobos_weddellii	spor	32	16	2
Farsetia_aegyptia	gam	24	24	2
Farsetia_aegyptia	spor	24	12	2
Farsetia_aegyptia	spor	60	30	2
Farsetia_aegyptia	spor	72	36	8
Farsetia_aegyptia	spor	78	39	1
Farsetia_stylosa	gam	12	12	2
Farsetia_stylosa	spor	12	6	3
Farsetia_stylosa	spor	24	12	2
Farsetia_undulicarpa	gam	12	12	2
Fezia_pterocarpa	gam	11	11	2
Fibigia_clypeata	gam	8	8	2
Fibigia_clypeata	spor	14	7	1
Fibigia_clypeata	spor	16	8	21
Fibigia_clypeata	spor	26	13	2
Fibigia_eriocarpa	spor	14	7	1
Fibigia_eriocarpa	spor	16	8	3
Fibigia_lunarioides	spor	16	8	1
Fibigia_macrocarpa	gam	7	7	2
Fibigia_macrocarpa	gam	8	8	1
Fibigia_macrocarpa	gam	16	16	1
Fibigia_spathulata	spor	16	8	1
Fibigia_suffruticosa	gam	8	8	4
Fibigia_suffruticosa	spor	16	8	3
Fibigia_triquetra	spor	16	8	3
Fibigia_umbellata	gam	8	8	1
Galitzkya_macrocarpa	spor	16	8	2
Galitzkya_macrocarpa	spor	17	8	2
Galitzkya_spathulata	spor	16	8	3
Goldbachia_laevigata	gam	14	14	8
Goldbachia_laevigata	spor	14	7	2
Goldbachia_laevigata	spor	28	14	9
Halimolobos_henricksonii	spor	16	8	2
Halimolobos_lasiolobus	gam	8	8	2
Hesperis_dinarica	spor	24	12	5
Hesperis_dinarica	spor	32	16	1
Hesperis_laciniata	gam	6	6	3
Hesperis_laciniata	spor	12	6	7
Hesperis_laciniata	spor	14	7	3
Hesperis_matronalis	gam	6	6	2
Hesperis_matronalis	gam	7	7	8
Hesperis_matronalis	gam	8	8	2
Hesperis_matronalis	gam	9	9	1
Hesperis_matronalis	gam	12	12	5

Hesperis_matronalis	gam	14	14	6
Hesperis_matronalis	gam	16	16	2
Hesperis_matronalis	gam	24	24	1
Hesperis_matronalis	spor	12	6	1
Hesperis_matronalis	spor	14	7	21
Hesperis_matronalis	spor	16	8	3
Hesperis_matronalis	spor	23	12	1
Hesperis_matronalis	spor	24	12	38
Hesperis_matronalis	spor	25	12	1
Hesperis_matronalis	spor	26	13	4
Hesperis_matronalis	spor	28	14	20
Hesperis_matronalis	spor	32	16	3
Hilliella_fumarioides	spor	42	21	1
Hilliella_paradoxa	spor	42	21	1
Hilliella_shuangpaiensis	spor	44	22	6
Hilliella_sinuata	spor	42	21	1
Hilliella_sinuata	spor	44	22	1
Hilliella_yixianensis	spor	42	21	5
Hirschfeldia_incana	gam	7	7	33
Hirschfeldia_incana	gam	8	8	4
Hirschfeldia_incana	gam	9	9	1
Hirschfeldia_incana	spor	14	7	22
Hirschfeldia_incana	spor	15	8	4
Hirschfeldia_incana	spor	16	8	3
Hirschfeldia_incana	spor	18	9	1
Hormathophylla_halimifolia	gam	16	16	3
Hormathophylla_halimifolia	spor	32	16	2
Hornungia_alpina	gam	6	6	1
Hornungia_alpina	spor	12	6	14
Hornungia_petraea	gam	6	6	8
Hornungia_petraea	spor	12	6	50
Ianhedgea_minutiflora	spor	28	14	2
Iberis_amara	gam	7	7	16
Iberis_amara	gam	8	8	1
Iberis_amara	gam	14	14	4
Iberis_amara	spor	14	7	34
Iberis_amara	spor	15	8	2
Iberis_amara	spor	16	8	6
Iberis_amara	spor	18	9	2
Iberis_amara	spor	28	14	2
Iberis_amara	spor	36	18	2
Iberis_saxatilis	gam	8	8	1
Iberis_saxatilis	gam	11	11	2
Iberis_saxatilis	spor	22	11	29
Iberis_saxatilis	spor	23	12	3
Iberis_saxatilis	spor	24	12	3
Iberis_saxatilis	spor	33	16	3
Iberis_sempervirens	gam	11	11	5
Iberis_sempervirens	gam	33	33	3

Iberis_sempervirens	gam	35	35	3
Iberis_sempervirens	spor	16	8	3
Iberis_sempervirens	spor	22	11	27
Iberis_sempervirens	spor	66	33	3
Iberis_spathulata	gam	7	7	2
Iberis_spathulata	spor	14	7	12
Iberis_umbellata	gam	7	7	2
Iberis_umbellata	gam	9	9	7
Iberis_umbellata	gam	17	17	2
Iberis_umbellata	spor	14	7	7
Iberis_umbellata	spor	16	8	5
Iberis_umbellata	spor	18	9	10
Iberis_umbellata	spor	19	10	3
Iberis_umbellata	spor	20	10	3
Iberis_umbellata	spor	22	11	3
Iberis_umbellata	spor	34	17	1
Iberis_umbellata	spor	36	18	1
Ionopsidium_savianum	gam	16	16	5
Ionopsidium_savianum	spor	32	16	11
Ionopsidium_savianum	spor	40	20	1
Isatis_buschiana	spor	14	7	4
Isatis_cappadocica_subsp._besseri	gam	21	21	2
Isatis_gaubae	gam	7	7	2
Isatis_kotschyana	spor	28	14	2
Isatis_leuconeura	spor	14	7	2
Isatis_lusitanica	gam	7	7	9
Isatis_lusitanica	spor	14	7	1
Isatis_microcarpa	spor	14	7	2
Isatis_minima	gam	21	21	1
Isatis_minima	spor	34	17	4
Isatis_minima	spor	42	21	4
Isatis_raphanifolia	spor	14	7	1
Isatis_stocksii	gam	14	14	2
Isatis_tinctoria	gam	7	7	1
Isatis_tinctoria	gam	14	14	6
Isatis_tinctoria	spor	14	7	34
Isatis_tinctoria	spor	26	13	4
Isatis_tinctoria	spor	28	14	48
Kernera_saxatilis_subsp._boissieri	spor	14	7	2
Kernera_saxatilis_subsp._boissieri	spor	16	8	2
Leavenworthia_alabamica	gam	11	11	8
Leavenworthia_alabamica	spor	22	11	3
Leavenworthia_aurea	gam	11	11	1
Leavenworthia_aurea	gam	24	24	3
Leavenworthia_aurea	spor	22	11	1
Leavenworthia_aurea	spor	48	24	1
Leavenworthia_crassa	gam	11	11	8
Leavenworthia_crassa	spor	22	11	3
Leavenworthia_exigua	gam	11	11	13

Leavenworthia_exigua	spor	22	11	3
Leavenworthia_stylosa	gam	15	15	2
Leavenworthia_stylosa	spor	30	15	4
Leavenworthia_texana	spor	22	11	4
Leavenworthia_torulosa	gam	15	15	3
Leavenworthia_torulosa	spor	30	15	5
Leavenworthia_uniflora	gam	15	15	2
Leavenworthia_uniflora	spor	30	15	3
Leiospora_eriocalyx	spor	14	7	2
Lepidium_africanum	spor	16	8	6
Lepidium_africanum	spor	32	16	2
Lepidium_alyssoides	gam	16	16	9
Lepidium_alyssoides	spor	32	16	1
Lepidium_apetalum	gam	16	16	1
Lepidium_apetalum	spor	32	16	5
Lepidium_aucheri	gam	8	8	4
Lepidium_bonariense	spor	32	16	3
Lepidium_bonariense	spor	64	32	6
Lepidium_campestre	gam	8	8	11
Lepidium_campestre	spor	16	8	36
Lepidium_davisii	spor	32	16	1
Lepidium_densiflorum	gam	16	16	6
Lepidium_densiflorum	spor	16	8	1
Lepidium_densiflorum	spor	24	12	1
Lepidium_densiflorum	spor	32	16	34
Lepidium_didymum	gam	8	8	3
Lepidium_didymum	gam	16	16	13
Lepidium_didymum	spor	16	8	1
Lepidium_didymum	spor	32	16	27
Lepidium_draba	gam	16	16	3
Lepidium_draba	gam	32	32	2
Lepidium_draba	spor	32	16	2
Lepidium_draba	spor	62	31	4
Lepidium_draba	spor	64	32	39
Lepidium_draba	spor	66	33	1
Lepidium_draba	spor	67	34	1
Lepidium_draba	spor	68	34	1
Lepidium_draba	spor	69	34	1
Lepidium_draba	spor	70	35	1
Lepidium_draba	spor	72	36	2
Lepidium_draba	spor	80	40	1
Lepidium_graminifolium	gam	8	8	1
Lepidium_graminifolium	gam	16	16	1
Lepidium_graminifolium	spor	14	7	1
Lepidium_graminifolium	spor	16	8	3
Lepidium_graminifolium	spor	48	24	19
Lepidium_heterophyllum	spor	16	8	16
Lepidium_heterophyllum	spor	48	24	1
Lepidium_hirtum	spor	16	8	8

Lepidium_meyenii	gam	32	32	1
Lepidium_meyenii	spor	64	32	1
Lepidium_montanum	gam	16	16	9
Lepidium_montanum	gam	32	32	2
Lepidium_montanum	spor	32	16	4
Lepidium_naufragorum	gam	72	72	1
Lepidium_naufragorum	spor	144	72	1
Lepidium_navasii	spor	32	16	5
Lepidium_oleraceum	gam	36	36	1
Lepidium_oleraceum	spor	72	36	1
Lepidium_perfoliatum	gam	8	8	7
Lepidium_perfoliatum	spor	16	8	27
Lepidium_ruderale	gam	8	8	5
Lepidium_ruderale	gam	16	16	5
Lepidium_ruderale	spor	16	8	20
Lepidium_ruderale	spor	24	12	1
Lepidium_ruderale	spor	28	14	2
Lepidium_ruderale	spor	32	16	38
Lepidium_sativum	gam	8	8	1
Lepidium_sativum	gam	12	12	8
Lepidium_sativum	gam	16	16	3
Lepidium_sativum	spor	12	6	1
Lepidium_sativum	spor	16	8	8
Lepidium_sativum	spor	21	10	1
Lepidium_sativum	spor	24	12	26
Lepidium_sativum	spor	32	16	5
Lepidium_virginicum	gam	8	8	2
Lepidium_virginicum	gam	16	16	10
Lepidium_virginicum	spor	16	8	6
Lepidium_virginicum	spor	32	16	28
Leptaleum_filifolium	gam	7	7	4
Leptaleum_filifolium	spor	14	7	4
Litwinowia_tenuissima	gam	7	7	1
Litwinowia_tenuissima	spor	14	7	4
Lobularia_arabica	gam	18	18	2
Lobularia_arabica	gam	21	21	3
Lobularia_arabica	gam	22	22	1
Lobularia_arabica	gam	23	23	2
Lobularia_arabica	gam	24	24	3
Lobularia_arabica	gam	27	27	4
Lobularia_arabica	gam	36	36	2
Lobularia_arabica	spor	36	18	2
Lobularia_arabica	spor	42	21	4
Lobularia_arabica	spor	46	23	4
Lobularia_arabica	spor	94	47	2
Lobularia_arabica	spor	96	48	2
Lobularia_canariensis_subsp._fruticosa	gam	11	11	2
Lobularia_canariensis_subsp._fruticosa	spor	22	11	2
Lobularia_canariensis_subsp._marginata	gam	11	11	4

Lobularia_canariensis_subsp._marginata	spor	22	11	5
Lobularia_canariensis_subsp._palmensis	gam	11	11	5
Lobularia_canariensis_subsp._palmensis	gam	22	22	4
Lobularia_canariensis_subsp._palmensis	spor	22	11	6
Lobularia_canariensis_subsp._palmensis	spor	44	22	4
Lobularia_canariensis_subsp._spathulata	gam	11	11	3
Lobularia_canariensis_subsp._spathulata	spor	22	11	4
Lobularia_libyca	gam	6	6	1
Lobularia_libyca	gam	11	11	12
Lobularia_libyca	spor	22	11	15
Lobularia_maritima	gam	11	11	4
Lobularia_maritima	gam	12	12	29
Lobularia_maritima	gam	24	24	4
Lobularia_maritima	gam	35	35	2
Lobularia_maritima	gam	36	36	4
Lobularia_maritima	spor	22	11	4
Lobularia_maritima	spor	23	12	3
Lobularia_maritima	spor	24	12	80
Lobularia_maritima	spor	30	15	5
Lobularia_maritima	spor	36	18	7
Lobularia_maritima	spor	42	21	7
Lobularia_maritima	spor	48	24	8
Lunaria_annua	spor	28	14	7
Lunaria_annua	spor	30	15	19
Lunaria_rediviva	gam	14	14	6
Lunaria_rediviva	gam	15	15	1
Lunaria_rediviva	spor	28	14	11
Lunaria_rediviva	spor	30	15	21
Lunaria_rediviva	spor	60	30	3
Lyrocarpa_coulteri	gam	20	20	1
Lyrocarpa_coulteri	spor	20	10	6
Lyrocarpa_coulteri	spor	36	18	1
Lyrocarpa_coulteri	spor	40	20	3
Lyrocarpa_coulteri	spor	42	21	1
Macropodium_nivale	gam	15	15	2
Macropodium_nivale	spor	30	15	10
Macropodium_pterospermum	spor	30	15	2
Malcolmia_africana	gam	7	7	5
Malcolmia_africana	gam	14	14	17
Malcolmia_africana	spor	14	7	8
Malcolmia_africana	spor	28	14	10
Malcolmia_littorea	gam	10	10	2
Malcolmia_littorea	spor	20	10	20
Malcolmia_maritima	gam	7	7	1
Malcolmia_maritima	gam	8	8	6
Malcolmia_maritima	spor	14	7	6
Malcolmia_maritima	spor	15	8	1
Malcolmia_maritima	spor	16	8	8
Malcolmia_maritima	spor	17	8	1

Malcolmia_maritima	spor	18	9	1
Malcolmia_maritima	spor	21	10	1
Malcolmia_orsiniana	spor	16	8	2
Malcolmia_orsiniana_subsp._angulifolia	spor	16	8	1
Malcolmia_ramosissima	spor	14	7	1
Malcolmia_ramosissima	spor	24	12	2
Malcolmia_ramosissima	spor	28	14	5
Malcolmia_triloba	spor	24	12	3
Maresia_nana	gam	13	13	1
Maresia_nana	spor	26	13	5
Maresia_nana	spor	28	14	8
Matthiola_farinosa	gam	6	6	2
Matthiola_farinosa	spor	12	6	4
Matthiola_fruticulosa	gam	6	6	9
Matthiola_fruticulosa	spor	12	6	19
Matthiola_fruticulosa	spor	16	8	3
Matthiola_incana	gam	7	7	9
Matthiola_incana	spor	12	6	1
Matthiola_incana	spor	13	6	1
Matthiola_incana	spor	14	7	59
Matthiola_longipetala	gam	6	6	1
Matthiola_longipetala	gam	7	7	7
Matthiola_longipetala	spor	14	7	8
Matthiola_maderensis	spor	14	7	4
Matthiola_parviflora	gam	7	7	1
Matthiola_parviflora	gam	8	8	1
Matthiola_parviflora	spor	8	4	3
Matthiola_parviflora	spor	12	6	3
Matthiola_parviflora	spor	14	7	6
Matthiola_stoddartii	spor	12	6	1
Megadenia_pygmaea	spor	12	6	2
Megadenia_pygmaea	spor	20	10	4
Menonvillea_litoralis	spor	22	11	3
Microthlaspi_granatense	gam	7	7	5
Microthlaspi_granatense	spor	14	7	13
Microthlaspi_umbellatum	spor	14	7	3
Morettia_canescens	gam	11	11	3
Morettia_canescens	spor	22	11	1
Moricandia_arvensis	gam	9	9	3
Moricandia_arvensis	gam	12	12	2
Moricandia_arvensis	gam	14	14	19
Moricandia_arvensis	spor	18	9	2
Moricandia_arvensis	spor	24	12	2
Moricandia_arvensis	spor	28	14	41
Moricandia_foetida	gam	14	14	4
Moricandia_foetida	spor	28	14	4
Moricandia_foleyi	gam	11	11	3
Moricandia_foleyi	spor	22	11	2
Moricandia_moricandioides	gam	14	14	10

Moricandia_moricandioides	spor	28	14	15
Moricandia_nitens	spor	28	14	3
Moricandia_sinaica	spor	28	14	3
Moricandia_spinosa	gam	14	14	2
Moricandia_spinosa	spor	84	42	1
Moricandia_suffruticosa	gam	4	4	1
Moricandia_suffruticosa	gam	14	14	3
Moricandia_suffruticosa	spor	14	7	1
Moricandia_suffruticosa	spor	56	28	1
Myagrum_perfoliatum	gam	7	7	5
Myagrum_perfoliatum	spor	14	7	20
Nasturtiopsis_coronopifolia	gam	7	7	2
Nasturtium_microphyllum	gam	32	32	5
Nasturtium_microphyllum	spor	32	16	2
Nasturtium_microphyllum	spor	60	30	1
Nasturtium_microphyllum	spor	64	32	18
Nasturtium_officinale	gam	7	7	6
Nasturtium_officinale	gam	8	8	3
Nasturtium_officinale	gam	14	14	3
Nasturtium_officinale	gam	16	16	47
Nasturtium_officinale	spor	14	7	2
Nasturtium_officinale	spor	18	9	1
Nasturtium_officinale	spor	32	16	84
Nasturtium_officinale	spor	33	16	3
Nasturtium_officinale	spor	34	17	3
Nasturtium_officinale	spor	36	18	3
Nasturtium_officinale	spor	48	24	8
Nasturtium_officinale	spor	60	30	3
Nasturtium_officinale	spor	64	32	9
Neotorularia_contortuplicata	gam	7	7	1
Neotorularia_dentata	gam	7	7	2
Neotorularia_tetracmoides	gam	7	7	4
Neotorularia_torulosa	gam	7	7	11
Neotorularia_torulosa	spor	14	7	7
Neotorularia_torulosa	spor	28	14	1
Neotorularia_torulosa	spor	42	21	1
Nerisyrenia_johnstonii	spor	20	10	2
Nerisyrenia_linearifolia	gam	8	8	3
Nerisyrenia_linearifolia	gam	9	9	3
Nerisyrenia_linearifolia	gam	10	10	1
Nerisyrenia_linearifolia	gam	16	16	1
Nerisyrenia_linearifolia	spor	18	9	5
Nerisyrenia_linearifolia	spor	19	10	2
Nerisyrenia_linearifolia	spor	20	10	3
Nerisyrenia_linearifolia	spor	34	17	3
Nerisyrenia_linearifolia	spor	36	18	3
Neslia_paniculata	gam	7	7	4
Neslia_paniculata	gam	14	14	3
Neslia_paniculata	spor	14	7	21

Neslia_paniculata	spor	28	14	1
Nevada_holmgrenii	gam	7	7	2
Nevada_holmgrenii	spor	14	7	3
Noccaea_caerulescens_subsp._caerulescens	spor	14	7	1
Noccaea_fendleri	gam	7	7	9
Noccaea_fendleri	spor	14	7	5
Noccaea_fendleri	spor	28	14	3
Noccaea_fendleri_subsp._glauca	gam	7	7	4
Noccaea_fendleri_subsp._glauca	gam	14	14	4
Noccaea_fendleri_subsp._glauca	spor	14	7	3
Noccaea_fendleri_subsp._glauca	spor	28	14	7
Noccaea_fendleri_subsp._idahoensis	gam	7	7	1
Noccaea_fendleri_subsp._idahoensis	gam	14	14	1
Noccaea_fendleri_subsp._idahoensis	spor	14	7	1
Noccaea_fendleri_subsp._idahoensis	spor	28	14	1
Noccaea_fendleri_subsp._siskiyouensis	gam	7	7	4
Noccaea_fendleri_subsp._siskiyouensis	spor	14	7	1
Noccaea_papyracea	gam	14	14	2
Noccaea_papyracea	spor	28	14	2
Notoceras_bicorne	gam	11	11	6
Notoceras_bicorne	spor	22	11	8
Octoceras_lehmannianum	spor	14	7	2
Olimarabidopsis_cabulica	spor	48	24	6
Olimarabidopsis_pumila	gam	8	8	5
Olimarabidopsis_pumila	gam	16	16	1
Olimarabidopsis_pumila	spor	16	8	1
Olimarabidopsis_pumila	spor	30	15	1
Olimarabidopsis_pumila	spor	32	16	16
Onuris_graminifolia	spor	18	9	2
Oreophyton_falcatum	spor	32	16	2
Ornithocarpa_torulosa	gam	24	24	2
Ornithocarpa_torulosa	spor	48	24	4
Orychophragmus_violaceus	gam	12	12	5
Orychophragmus_violaceus	spor	22	11	4
Orychophragmus_violaceus	spor	24	12	21
Orychophragmus_violaceus	spor	39	20	1
Orychophragmus_violaceus	spor	48	24	1
Orychophragmus_violaceus	spor	61	30	1
Orychophragmus_violaceus	spor	64	32	1
Orychophragmus_violaceus	spor	70	35	1
Orychophragmus_violaceus	spor	74	37	1
Parlatoria_rostrata	gam	7	7	7
Parolinia_intermedia	spor	22	11	2
Parrya_arctica	spor	14	7	2
Parrya_arctica	spor	21	10	3
Parrya_nudicaulis	spor	14	7	20
Parrya_nudicaulis	spor	28	14	28
Parrya_schugnana	spor	14	7	2
Parrya_schugnana	spor	28	14	3

Parrya_turkestanica	spor	14	7	1
Paysonia_auriculata	gam	8	8	5
Paysonia_auriculata	spor	16	8	4
Paysonia_densipila	gam	8	8	4
Paysonia_densipila	spor	16	8	1
Paysonia_grandiflora	gam	9	9	5
Paysonia_grandiflora	spor	18	9	7
Paysonia_lasiocarpa	gam	7	7	2
Paysonia_lasiocarpa	spor	14	7	5
Paysonia_lescurii	gam	8	8	4
Paysonia_lescurii	spor	16	8	2
Paysonia_stonensis	gam	8	8	2
Paysonia_stonensis	spor	16	8	1
Peltaria_alliacea	spor	14	7	13
Peltaria_alliacea	spor	28	14	6
Peltaria_alliacea	spor	56	28	2
Peltaria_alliacea	spor	58	29	1
Pennellia_longifolia	gam	8	8	5
Pennellia_longifolia	spor	16	8	4
Phoenicaulis_cheiranthoides	spor	28	14	1
Physaria_acutifolia	gam	4	4	2
Physaria_acutifolia	gam	5	5	4
Physaria_acutifolia	gam	8	8	3
Physaria_acutifolia	gam	12	12	2
Physaria_acutifolia	spor	8	4	4
Physaria_acutifolia	spor	10	5	7
Physaria_acutifolia	spor	14	7	2
Physaria_acutifolia	spor	16	8	3
Physaria_acutifolia	spor	24	12	3
Physaria_argyraea	gam	6	6	2
Physaria_argyraea	gam	7	7	1
Physaria_argyraea	gam	8	8	1
Physaria_argyraea	gam	9	9	2
Physaria_argyraea	gam	12	12	2
Physaria_argyraea	gam	15	15	1
Physaria_argyraea	gam	16	16	2
Physaria_argyraea	gam	17	17	2
Physaria_argyraea	gam	18	18	1
Physaria_argyraea	spor	18	9	2
Physaria_argyraea	spor	30	15	2
Physaria_bellii	gam	4	4	1
Physaria_bellii	spor	8	4	6
Physaria_fendleri	gam	6	6	10
Physaria_fendleri	gam	7	7	1
Physaria_fendleri	gam	12	12	2
Physaria_fendleri	spor	12	6	9
Physaria_fendleri	spor	14	7	1
Physaria_fendleri	spor	24	12	1
Physaria_filiformis	gam	7	7	2

Physaria_filiformis	spor	14	7	1
Physaria_gracilis	gam	6	6	3
Physaria_gracilis	spor	12	6	5
Physaria_intermedia	gam	8	8	1
Physaria_intermedia	gam	10	10	1
Physaria_intermedia	gam	18	18	2
Physaria_intermedia	spor	16	8	2
Physaria_intermedia	spor	18	9	3
Physaria_intermedia	spor	20	10	1
Physaria_intermedia	spor	36	18	1
Physaria_newberryi	gam	8	8	3
Physaria_newberryi	spor	8	4	1
Physaria_newberryi	spor	16	8	4
Physaria_occidentalis	gam	5	5	2
Physaria_occidentalis	spor	10	5	3
Physaria_pallida	gam	6	6	1
Physaria_pallida	spor	12	6	1
Physaria_spatulata	gam	5	5	1
Physaria_spatulata	spor	10	5	1
Physaria_spatulata	spor	12	6	2
Physaria_subumbellata	spor	10	5	3
Physoptychis_caspica	spor	16	8	3
Pringlea_antiscorbutica	spor	24	12	4
Pritzelago_alpina	spor	12	6	2
Pseudoarabidopsis_toxophylla	spor	12	6	2
Pseudoarabidopsis_toxophylla	spor	24	12	1
Pseudocamelina_glaucophylla	gam	7	7	1
Pseudocamelina_glaucophylla	spor	14	7	3
Pseudoclausia_turkestanica	gam	7	7	2
Pseudoclausia_turkestanica	spor	14	7	1
Pseudovesicaria_digitata	spor	10	5	4
Psychine_stylosa	gam	15	15	2
Psychine_stylosa	spor	16	8	2
Psychine_stylosa	spor	30	15	3
Raphanus_raphanistrum	gam	9	9	23
Raphanus_raphanistrum	gam	18	18	1
Raphanus_raphanistrum	spor	18	9	65
Raphanus_raphanistrum_subsp._landra	gam	9	9	4
Raphanus_raphanistrum_subsp._landra	spor	18	9	15
Rapistrum_rugosum	gam	8	8	13
Rapistrum_rugosum	spor	14	7	1
Rapistrum_rugosum	spor	16	8	57
Rhizobotrya_alpina	gam	7	7	1
Rhizobotrya_alpina	spor	14	7	3
Ricotia_lunaria	spor	28	14	5
Rorippa_amphibia	gam	14	14	3
Rorippa_amphibia	gam	15	15	2
Rorippa_amphibia	gam	16	16	5
Rorippa_amphibia	spor	16	8	28

Rorippa_amphibia	spor	32	16	61
Rorippa_amphibia	spor	48	24	2
Rorippa_austriaca	gam	8	8	4
Rorippa_austriaca	spor	16	8	40
Rorippa_cantoniensis	spor	16	8	1
Rorippa_indica	gam	8	8	7
Rorippa_indica	gam	12	12	3
Rorippa_indica	gam	14	14	8
Rorippa_indica	gam	16	16	10
Rorippa_indica	gam	21	21	1
Rorippa_indica	gam	24	24	7
Rorippa_indica	gam	28	28	4
Rorippa_indica	spor	16	8	7
Rorippa_indica	spor	24	12	1
Rorippa_indica	spor	28	14	1
Rorippa_indica	spor	32	16	3
Rorippa_indica	spor	48	24	8
Rorippa_indica	spor	56	28	1
Rorippa_islandica	gam	8	8	6
Rorippa_islandica	spor	16	8	25
Rorippa_islandica	spor	32	16	19
Rorippa_palustris	gam	16	16	20
Rorippa_palustris	spor	16	8	7
Rorippa_palustris	spor	32	16	86
Rorippa_sylvestris	gam	16	16	13
Rorippa_sylvestris	gam	24	24	4
Rorippa_sylvestris	spor	16	8	1
Rorippa_sylvestris	spor	32	16	72
Rorippa_sylvestris	spor	40	20	24
Rorippa_sylvestris	spor	41	20	2
Rorippa_sylvestris	spor	48	24	41
Rorippa_sylvestris	spor	96	48	1
Rorippa_teres	spor	32	16	1
Rytidocarpus_moricandioides	spor	28	14	5
Sandbergia_perplexa	spor	14	7	6
Savignya_parviflora	gam	15	15	5
Savignya_parviflora_subsp._longistyla	gam	15	15	2
Schimpera_arabica	gam	7	7	4
Schimpera_arabica	spor	14	7	2
Schivereckia_podolica	spor	16	8	7
Schivereckia_podolica	spor	18	9	3
Schizopetalon_walkeri	gam	10	10	2
Schizopetalon_walkeri	spor	18	9	3
Schouwia_purpurea	gam	18	18	3
Schouwia_purpurea	spor	36	18	6
Selenia_aurea	gam	23	23	5
Selenia_aurea	gam	69	69	2
Selenia_aurea	spor	46	23	1
Selenia_aurea	spor	138	69	1

Selenia_dissecta	gam	7	7	2
Selenia_dissecta	spor	14	7	1
Selenia_grandis	gam	12	12	4
Selenia_grandis	spor	24	12	1
Selenia_jonesii	gam	12	12	1
Selenia_jonesii	spor	24	12	1
Sibara_angelorum	gam	14	14	4
Sibara_deserti	gam	14	14	3
Sibara_deserti	spor	26	13	3
Sibara_deserti	spor	28	14	1
Sibara_laxa	gam	14	14	2
Sibaropsis_hammittii	spor	28	14	2
Sinapidendron_frutescens	gam	9	9	1
Sinapidendron_frutescens	gam	10	10	4
Sinapidendron_frutescens	spor	20	10	4
Sinapis_alba	gam	12	12	12
Sinapis_alba	spor	24	12	71
Sinapis_arvensis	gam	8	8	2
Sinapis_arvensis	gam	9	9	35
Sinapis_arvensis	gam	16	16	1
Sinapis_arvensis	spor	16	8	1
Sinapis_arvensis	spor	18	9	91
Sisymbrella_aspera	gam	8	8	2
Sisymbrella_aspera	spor	16	8	15
Sisymbrium_altissimum	gam	7	7	22
Sisymbrium_altissimum	spor	14	7	40
Sisymbrium_altissimum	spor	195	98	3
Sisymbrium_austriacum	gam	7	7	1
Sisymbrium_austriacum	spor	14	7	8
Sisymbrium_irio	gam	7	7	21
Sisymbrium_irio	gam	8	8	1
Sisymbrium_irio	gam	9	9	2
Sisymbrium_irio	gam	14	14	11
Sisymbrium_irio	gam	21	21	1
Sisymbrium_irio	gam	28	28	1
Sisymbrium_irio	spor	14	7	47
Sisymbrium_irio	spor	16	8	3
Sisymbrium_irio	spor	18	9	2
Sisymbrium_irio	spor	21	10	2
Sisymbrium_irio	spor	28	14	20
Sisymbrium_irio	spor	42	21	12
Sisymbrium_irio	spor	56	28	11
Sisymbrium_loeselii	gam	7	7	15
Sisymbrium_loeselii	spor	14	7	34
Sisymbrium_officinale	gam	7	7	22
Sisymbrium_officinale	spor	14	7	76
Sisymbrium_officinale	spor	195	98	2
Sisymbrium_orientale	gam	7	7	14
Sisymbrium_orientale	gam	14	14	3

Sisymbrium_orientale	spor	7	4	1
Sisymbrium_orientale	spor	14	7	68
Smelowskia_alba	spor	12	6	7
Smelowskia_americana	spor	12	6	2
Smelowskia_americana	spor	22	11	4
Smelowskia_bifurcata	spor	12	6	2
Smelowskia_borealis	spor	12	6	8
Smelowskia_calycina	spor	12	6	6
Smelowskia_calycina	spor	22	11	1
Smelowskia_jacutica	spor	12	6	1
Smelowskia_jacutica	spor	36	18	1
Smelowskia_johnsonii	spor	12	6	1
Smelowskia_media	spor	12	6	4
Smelowskia_media	spor	22	11	1
Smelowskia_parryoides	spor	12	6	6
Smelowskia_parryoides	spor	24	12	4
Smelowskia_porsildii	spor	12	6	3
Smelowskia_porsildii	spor	18	9	2
Smelowskia_porsildii	spor	22	11	5
Smelowskia_porsildii	spor	24	12	4
Smelowskia_porsildii	spor	32	16	2
Smelowskia_pyriformis	spor	12	6	3
Smelowskia_sophiifolia	spor	20	10	2
Smelowskia_tibetica	spor	24	12	1
Sobolewskia_caucasica	spor	16	8	2
Solms-laubachia_eurycarpa	spor	14	7	2
Solms-laubachia_lanata	spor	14	7	1
Solms-laubachia_linearifolia	spor	14	7	2
Solms-laubachia_minor	spor	14	7	1
Solms-laubachia_platycarpa	spor	14	7	2
Solms-laubachia_pulcherrima	spor	14	7	4
Solms-laubachia_retropilosa	spor	14	7	1
Solms-laubachia_retropilosa	spor	28	14	1
Solms-laubachia_xerophyta	spor	14	7	2
Sphaerocardamum_macropetalum	gam	8	8	2
Sphaerocardamum_stellatum	gam	8	8	4
Stanleya_bipinnata	gam	12	12	4
Stanleya_bipinnata	spor	28	14	1
Stanleya_elata	gam	12	12	2
Stanleya_elata	spor	24	12	1
Stanleya_elata	spor	28	14	3
Stanleya_pinnata	gam	12	12	3
Stanleya_pinnata	gam	14	14	5
Stanleya_pinnata	gam	24	24	1
Stanleya_pinnata	gam	28	28	6
Stanleya_pinnata	spor	24	12	5
Stanleya_pinnata	spor	28	14	1
Stanleya_pinnata	spor	48	24	2
Stanleya_pinnata	spor	56	28	3

Stanleya_viridiflora	gam	12	12	2
Stanleya_viridiflora	spor	24	12	2
Stanleya_viridiflora	spor	28	14	2
Sterigmostemum_acanthocarpum	gam	7	7	1
Sterigmostemum_acanthocarpum	spor	14	7	2
Sterigmostemum_incanum	gam	7	7	1
Sterigmostemum_incanum	spor	14	7	1
Sterigmostemum_ramosissimum	spor	14	7	1
Sterigmostemum_sulphureum	gam	7	7	2
Stevenia_cheiranthoides	spor	32	16	3
Streptanthella_longirostris	gam	7	7	2
Streptanthella_longirostris	gam	14	14	4
Streptanthella_longirostris	spor	14	7	1
Streptanthella_longirostris	spor	28	14	4
Streptanthus_barbatus	spor	28	14	1
Streptanthus_barbatus	spor	56	28	1
Streptanthus_barbiger	gam	14	14	2
Streptanthus_barbiger	spor	28	14	2
Streptanthus_batrachopus	gam	14	14	1
Streptanthus_bernardinus	spor	14	7	1
Streptanthus_bernardinus	spor	28	14	1
Streptanthus_brachiatus	spor	28	14	2
Streptanthus_breweri	gam	14	14	2
Streptanthus_breweri	spor	28	14	2
Streptanthus_callistus	gam	14	14	1
Streptanthus_callistus	spor	28	14	1
Streptanthus_carinatus	gam	14	14	5
Streptanthus_carinatus	spor	28	14	2
Streptanthus_carinatus_subsp._arizonicus	gam	14	14	4
Streptanthus_carinatus_subsp._arizonicus	spor	28	14	3
Streptanthus_cordatus	gam	12	12	3
Streptanthus_cordatus	gam	14	14	3
Streptanthus_cordatus	spor	24	12	2
Streptanthus_cordatus	spor	28	14	1
Streptanthus_cordatus	spor	56	28	1
Streptanthus_cutleri	gam	14	14	1
Streptanthus_diversifolius	gam	14	14	2
Streptanthus_diversifolius	spor	28	14	2
Streptanthus_drepanoides	gam	14	14	3
Streptanthus_drepanoides	spor	28	14	2
Streptanthus_farnsworthianus	spor	28	14	2
Streptanthus_fenestratus	spor	28	14	1
Streptanthus_glandulosus	gam	14	14	5
Streptanthus_glandulosus	spor	28	14	2
Streptanthus_glandulosus_subsp._albidus	gam	14	14	3
Streptanthus_glandulosus_subsp._albidus	spor	28	14	2
Streptanthus_glandulosus_subsp._niger	gam	14	14	4
Streptanthus_glandulosus_subsp._niger	spor	28	14	1
Streptanthus_glandulosus_subsp._pulchellus	gam	14	14	3

Streptanthus_glandulosus_subsp._pulchellus	spor	28	14	1
Streptanthus_glandulosus_subsp._sonomensis	spor	28	14	1
Streptanthus_hesperidis	gam	14	14	1
Streptanthus_hesperidis	spor	28	14	2
Streptanthus_hispidus	gam	14	14	1
Streptanthus_howellii	gam	14	14	3
Streptanthus_howellii	spor	28	14	2
Streptanthus_hyacinthoides	spor	28	14	2
Streptanthus_morrisonii	spor	28	14	2
Streptanthus_petiolaris	gam	14	14	1
Streptanthus_petiolaris	spor	28	14	2
Streptanthus_platycarpus	gam	14	14	1
Streptanthus_platycarpus	spor	28	14	3
Streptanthus_polygaloides	spor	28	14	3
Streptanthus_tortuosus	gam	14	14	1
Streptanthus_tortuosus	spor	28	14	1
Succowia_balearica	gam	16	16	2
Succowia_balearica	gam	18	18	9
Succowia_balearica	spor	32	16	2
Succowia_balearica	spor	36	18	13
Synthlipsis_greggii	gam	10	10	4
Synthlipsis_greggii	spor	20	10	5
Teesdalia_nudicaulis	gam	18	18	7
Teesdalia_nudicaulis	spor	18	9	1
Teesdalia_nudicaulis	spor	36	18	30
Tetracme_quadricornis	spor	14	7	2
Thelypodiopsis_ambigua	gam	11	11	3
Thelypodiopsis_ambigua	spor	22	11	1
Thelypodiopsis_vaseyi	gam	10	10	2
Thelypodiopsis_vaseyi	spor	20	10	1
Thelypodium_crispum	gam	13	13	2
Thelypodium_crispum	spor	26	13	1
Thelypodium_flexuosum	gam	13	13	2
Thelypodium_flexuosum	spor	26	13	1
Thelypodium_integrifolium	gam	13	13	4
Thelypodium_integrifolium	spor	26	13	1
Thelypodium_laciniatum	gam	12	12	2
Thelypodium_laciniatum	gam	13	13	2
Thelypodium_laciniatum	spor	26	13	1
Thelypodium_sagittatum	spor	26	13	1
Thlaspi_arvense	gam	7	7	37
Thlaspi_arvense	spor	14	7	96
Thlaspi_bulbosum	spor	14	7	2
Thlaspi_goesingense	gam	28	28	11
Thlaspi_goesingense	spor	14	7	3
Thlaspi_goesingense	spor	50	25	1
Thlaspi_goesingense	spor	56	28	10
Thlaspi_jankae	spor	14	7	1
Thlaspi_jankae	spor	24	12	1

Thlaspi_jankae	spor	28	14	5
Thlaspi_montanum	gam	7	7	2
Thlaspi_montanum	gam	14	14	7
Thlaspi_montanum	spor	28	14	9
Thlaspi_nevadense	gam	14	14	2
Thlaspi_nevadense	spor	28	14	1
Thlaspi_perfoliatum	gam	7	7	3
Thlaspi_perfoliatum	gam	14	14	5
Thlaspi_perfoliatum	gam	21	21	13
Thlaspi_perfoliatum	gam	35	35	1
Thlaspi_perfoliatum	spor	14	7	27
Thlaspi_perfoliatum	spor	28	14	16
Thlaspi_perfoliatum	spor	40	20	7
Thlaspi_perfoliatum	spor	42	21	85
Thlaspi_perfoliatum	spor	70	35	4
Thlaspi_praecox	spor	14	7	12
Thysanocarpus_curvipes	gam	7	7	2
Thysanocarpus_curvipes	gam	28	28	1
Thysanocarpus_curvipes	spor	28	14	5
Tropidocarpum_gracile	gam	8	8	3
Tropidocarpum_gracile	spor	16	8	1
Turritis_glabra	gam	6	6	17
Turritis_glabra	gam	8	8	4
Turritis_glabra	gam	16	16	2
Turritis_glabra	spor	12	6	62
Turritis_glabra	spor	16	8	15
Turritis_glabra	spor	32	16	7
Turritis_laxa	gam	6	6	4
Vella_anremerica	spor	34	17	3
Vella_bourgaeana	gam	17	17	4
Vella_bourgaeana	spor	34	17	4
Vella_bourgaeana	spor	48	24	3
Vella_castrilensis	spor	68	34	1
Vella_lucentina	spor	34	17	2
Vella_mairei	spor	68	34	2
Vella_pseudocytisus_subsp._glabrata	spor	34	17	1
Vella_pseudocytisus_subsp._paui	spor	34	17	3
Vella_spinosa	gam	17	17	11
Vella_spinosa	spor	34	17	12
Xerodraba_pycnophylloides	spor	22	11	3
Yinshania_acutangula_subsp._wilsonii	spor	12	6	4
Yinshania_henryi	spor	12	6	5
Yinshania_henryi	spor	14	7	2
Zerdana_anchonioides	spor	14	7	2

Table S3.2 Ploidy levels and macroevolutionary rates inferred for 1,333 Brassicaceae species.
State: 0 = Diploid, 1 = Polyploid.

SPECIES	PLOIDY (MEDIAN)	STATE	SPECIATION	EXTINCTION	EXTINCTION FRACTION	NET DIVERSIFICATION	TURNOVER
Alliaria_grandifolia	--	0	0.279	0.122	0.109	0.157	0.401
Alliaria_petiolata	19	1	0.388	0.238	0.056	0.150	0.627
Alyssoides_cretica	4	0	0.273	0.117	0.108	0.156	0.389
Alyssoides_utriculata	6	1	0.359	0.211	0.050	0.148	0.569
Alyssopsis_mollis	8	1	0.400	0.249	0.059	0.151	0.648
Alyssopsis_trinervis	--	0	0.279	0.122	0.109	0.157	0.401
Alyssum_alpestre	8	1	0.370	0.221	0.052	0.149	0.592
Alyssum_alyssoides	8	1	0.390	0.240	0.057	0.150	0.629
Alyssum_americanum	--	1	0.418	0.266	0.063	0.152	0.683
Alyssum_anatolicum	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_antiatlanticum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_antilibanoticum	--	1	0.450	0.295	0.070	0.155	0.745
Alyssum_argenteum	8	1	0.373	0.224	0.053	0.149	0.596
Alyssum_aurantiacum	8	1	0.605	0.439	0.104	0.166	1.043
Alyssum_aureum	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_baldaccii	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_baumgartnerianum	--	1	0.491	0.333	0.079	0.158	0.824
Alyssum_bertolonii	8	1	0.631	0.464	0.110	0.168	1.095
Alyssum_biovulatum	--	1	0.363	0.215	0.051	0.148	0.579
Alyssum_borzaeanum	--	1	0.359	0.211	0.050	0.148	0.569
Alyssum_bracteatum	8	1	0.530	0.369	0.087	0.160	0.899
Alyssum_caespitosum	--	1	0.380	0.231	0.055	0.149	0.612
Alyssum_caricum	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_chalcidicum	--	1	0.365	0.217	0.051	0.148	0.582
Alyssum_condensatum	8	1	0.363	0.215	0.051	0.148	0.579
Alyssum_corningii	--	1	1.710	1.464	0.346	0.247	3.174
Alyssum_corsicum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_corymbosoides	16	1	0.359	0.211	0.050	0.148	0.569
Alyssum_cuneifolium	16	1	0.800	0.619	0.147	0.180	1.419
Alyssum_cypricum	16	1	0.359	0.211	0.050	0.148	0.570
Alyssum_dasycarpum	8	1	0.363	0.215	0.051	0.148	0.577
Alyssum_davisianum	--	1	0.359	0.211	0.050	0.148	0.569
Alyssum_densistellatum	--	1	0.727	0.553	0.131	0.175	1.280
Alyssum_desertorum	14	1	0.415	0.263	0.062	0.152	0.677
Alyssum_diffusum	8	1	0.376	0.227	0.054	0.149	0.604
Alyssum_doerfleri	8	1	0.362	0.214	0.051	0.148	0.576
Alyssum_euboeum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_fallacinum	8	1	0.400	0.250	0.059	0.151	0.650
Alyssum_fastigiatum	--	1	0.955	0.763	0.181	0.191	1.718
Alyssum_filiforme	--	1	0.530	0.369	0.087	0.160	0.899
Alyssum_flexicaule	--	1	0.800	0.619	0.147	0.180	1.419
Alyssum_floribundum	8	1	0.448	0.293	0.069	0.154	0.741
Alyssum_fragillimum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_gevgelicense	--	1	0.365	0.217	0.051	0.148	0.582
Alyssum_giosnanum	16	1	0.359	0.211	0.050	0.148	0.569

Alyssum_granatense	24	1	0.359	0.211	0.050	0.148	0.569
Alyssum_harputicum	--	1	3.964	3.552	0.840	0.411	7.516
Alyssum_heldreichii	8	1	0.369	0.221	0.052	0.149	0.590
Alyssum_hirsutum	23	1	0.359	0.211	0.050	0.148	0.569
Alyssum_homalocarpum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_huber-morathii	12	1	0.359	0.211	0.050	0.148	0.570
Alyssum_inflatum	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_iranicum	--	1	0.380	0.231	0.055	0.149	0.612
Alyssum_kavadarcense	--	1	0.365	0.217	0.051	0.148	0.582
Alyssum_lenense	8	1	0.401	0.250	0.059	0.151	0.651
Alyssum_lepidoto-stellatum	16	1	4.034	3.617	0.856	0.417	7.650
Alyssum_lepidotum	--	1	0.367	0.218	0.052	0.148	0.585
Alyssum_lesbiacum	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_linifolium	10	1	0.359	0.211	0.050	0.148	0.570
Alyssum_loiseleurii	12	1	0.519	0.359	0.085	0.160	0.878
Alyssum_marginatum	--	1	0.366	0.218	0.052	0.148	0.584
Alyssum_markgrafii	16	1	0.362	0.214	0.051	0.148	0.576
Alyssum_masmenaeum	12	1	0.359	0.211	0.050	0.148	0.570
Alyssum_meniocoides	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_minus	--	1	0.391	0.240	0.057	0.150	0.631
Alyssum_minutum	8	1	0.388	0.238	0.056	0.150	0.625
Alyssum_misirdalianum	--	1	0.902	0.715	0.169	0.188	1.617
Alyssum_montanum	12	1	0.615	0.448	0.106	0.167	1.063
Alyssum_montis-stellae	--	1	0.401	0.250	0.059	0.151	0.651
Alyssum_murale	8	1	0.362	0.214	0.051	0.148	0.576
Alyssum_nebrodense	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_nevadense	--	1	0.936	0.746	0.176	0.190	1.682
Alyssum_niveum	--	1	0.360	0.212	0.050	0.148	0.572
Alyssum_obovatum	15	1	0.359	0.211	0.050	0.148	0.570
Alyssum_orophilum	--	1	0.389	0.239	0.056	0.150	0.627
Alyssum_ovirense	8	1	3.498	3.121	0.738	0.377	6.620
Alyssum_oxycarpum	8	1	0.359	0.211	0.050	0.148	0.571
Alyssum_paphlagonicum	--	1	3.964	3.552	0.840	0.411	7.516
Alyssum_pateri	16	1	0.359	0.211	0.050	0.148	0.570
Alyssum_peltarioides	--	1	0.375	0.226	0.053	0.149	0.601
Alyssum_persicum	--	1	0.359	0.211	0.050	0.148	0.571
Alyssum_pinifolium	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_pintodasilvae	--	1	1.162	0.956	0.226	0.207	2.118
Alyssum_polycladum	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_praecox	16	1	0.902	0.715	0.169	0.188	1.617
Alyssum_pterocarpum	--	1	0.375	0.226	0.053	0.149	0.601
Alyssum_repens_subsp._transsilvanicum	--	1	0.376	0.227	0.054	0.149	0.603
Alyssum_robertianum	8	1	0.370	0.221	0.052	0.149	0.590
Alyssum_samariferum	--	1	0.448	0.293	0.069	0.154	0.741
Alyssum_serpentinum	--	1	0.365	0.217	0.051	0.148	0.582
Alyssum_serpyllifolium	12	1	1.162	0.956	0.226	0.207	2.118
Alyssum_sibiricum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_siculum	24	1	0.391	0.240	0.057	0.150	0.631
Alyssum_simplex	12	1	0.388	0.238	0.056	0.150	0.625

Alyssum_skopjense	--	1	0.362	0.214	0.051	0.148	0.576
Alyssum_smolikanum	16	1	0.367	0.219	0.052	0.148	0.586
Alyssum_sp._BF-2014	--	1	0.443	0.289	0.068	0.154	0.732
Alyssum_sp._JZL-2014	--	1	0.955	0.763	0.181	0.191	1.718
Alyssum_stapfii	12	1	0.450	0.295	0.070	0.155	0.745
Alyssum_stribryni	16	1	0.366	0.218	0.051	0.148	0.583
Alyssum_strigosum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_sulphureum	--	1	0.359	0.211	0.050	0.148	0.571
Alyssum_tavolarae	--	1	0.631	0.464	0.110	0.168	1.095
Alyssum_tenium	--	1	0.400	0.250	0.059	0.151	0.650
Alyssum_tenuifolium	45	1	0.359	0.212	0.050	0.148	0.571
Alyssum_tetrastemon	--	1	1.710	1.464	0.346	0.247	3.174
Alyssum_thymops	--	1	4.034	3.617	0.856	0.417	7.650
Alyssum_tortuosum	8	1	0.418	0.266	0.063	0.152	0.683
Alyssum_turkestanicum	20	1	0.415	0.263	0.062	0.152	0.677
Alyssum_umbellatum	8	1	0.359	0.211	0.050	0.148	0.570
Alyssum_virgatum	--	1	0.359	0.211	0.050	0.148	0.570
Alyssum_wulfenianum_subsp._wulfenianum	--	1	3.498	3.121	0.738	0.377	6.620
Alyssum_xanthocarpum	--	1	0.359	0.211	0.050	0.148	0.569
Ammosperma_cinerea	--	0	0.279	0.122	0.109	0.157	0.401
Anchonium_billardierei	--	0	0.286	0.128	0.110	0.158	0.414
Anchonium_elichrysifolium_subsp._canescens	--	0	0.279	0.122	0.109	0.157	0.401
Anelsonia_eurycarpa	7	0	0.279	0.122	0.109	0.157	0.401
Arabidella_trisecta	15	1	0.396	0.245	0.058	0.151	0.641
Arabidopsis_arenicola	8	1	2.705	2.385	0.564	0.319	5.090
Arabidopsis_arenosa_subsp._arenosa	--	1	0.402	0.251	0.059	0.151	0.654
Arabidopsis_cebennensis	8	1	0.367	0.218	0.052	0.148	0.585
Arabidopsis_croatica	--	1	0.381	0.232	0.055	0.150	0.613
Arabidopsis_halleri	8	1	0.521	0.362	0.086	0.160	0.883
Arabidopsis_kamchatica	--	1	0.383	0.233	0.055	0.150	0.616
Arabidopsis_lyrata	12	1	0.383	0.233	0.055	0.150	0.616
Arabidopsis_neglecta	12	1	0.402	0.251	0.059	0.151	0.654
Arabidopsis_pedemontana	--	1	0.367	0.218	0.052	0.148	0.585
Arabidopsis_petraea_subsp._umbrosa	--	1	2.705	2.385	0.564	0.319	5.090
Arabidopsis_suecica	13	1	0.733	0.558	0.132	0.175	1.291
Arabidopsis_thaliana	5	0	0.503	0.316	0.140	0.188	0.819
Arabidopsis_umezawana	--	1	0.521	0.362	0.086	0.160	0.883
Arabis_abietina	--	1	4.084	3.663	0.867	0.420	7.747
Arabis_aculeolata	16	1	1.813	1.559	0.369	0.254	3.372
Arabis_alaschanica	--	1	0.359	0.212	0.050	0.148	0.571
Arabis_allionii	8	1	0.938	0.748	0.177	0.190	1.687
Arabis_alpina	8	1	0.359	0.211	0.050	0.148	0.570
Arabis_amplexicaulis	16	1	4.002	3.588	0.849	0.414	7.591
Arabis_androsacea	--	1	0.378	0.229	0.054	0.149	0.607
Arabis_ariana	8	1	1.766	1.515	0.358	0.251	3.281
Arabis_armena	--	1	0.622	0.455	0.108	0.167	1.077
Arabis_aucheri	8	1	0.641	0.472	0.112	0.168	1.113
Arabis_auriculata	--	1	2.335	2.042	0.483	0.292	4.377
Arabis_axillaris	--	0	0.277	0.120	0.109	0.157	0.398

Arabis_axilliflora	--	1	0.359	0.211	0.050	0.148	0.570
Arabis_beirana	--	1	1.568	1.331	0.315	0.236	2.899
Arabis_bijuga	--	1	4.121	3.698	0.875	0.423	7.820
Arabis_blepharophylla	8	1	1.897	1.636	0.387	0.260	3.533
Arabis_borealis	--	1	4.080	3.660	0.866	0.420	7.741
Arabis_brachycarpa	8	1	3.995	3.582	0.847	0.414	7.577
Arabis_bryoides	8	1	0.359	0.211	0.050	0.148	0.569
Arabis_caerulea	8	1	0.359	0.211	0.050	0.148	0.570
Arabis_carduchorum	8	1	0.622	0.455	0.108	0.167	1.077
Arabis_christianii	16	1	3.147	2.795	0.661	0.352	5.942
Arabis_ciliata	8	1	0.938	0.748	0.177	0.190	1.687
Arabis_collina	8	1	1.368	1.146	0.271	0.222	2.514
Arabis_conringioides	7	1	0.879	0.693	0.164	0.186	1.571
Arabis_cretica	--	1	0.411	0.260	0.061	0.152	0.671
Arabis_crucisetosa	16	1	2.929	2.593	0.613	0.336	5.522
Arabis_doumetii	--	1	2.805	2.478	0.586	0.327	5.283
Arabis_erikii	--	1	1.583	1.346	0.318	0.237	2.930
Arabis_erubescens	--	1	2.805	2.478	0.586	0.327	5.283
Arabis_eschscholtziana	32	1	4.002	3.588	0.849	0.414	7.590
Arabis_ferdinandi-coburgii	9	1	0.371	0.222	0.053	0.149	0.593
Arabis_flagellosa	16	1	0.604	0.438	0.104	0.166	1.042
Arabis_furcata	--	1	1.897	1.636	0.387	0.260	3.533
Arabis_georgiana	--	1	1.871	1.612	0.381	0.258	3.483
Arabis_graellsiiformis	--	1	3.995	3.582	0.847	0.414	7.577
Arabis_hirsuta	13	1	0.748	0.572	0.135	0.176	1.320
Arabis_josiae	--	1	0.879	0.693	0.164	0.186	1.571
Arabis_juressi	16	1	3.096	2.748	0.650	0.348	5.845
Arabis_kamelinii	--	1	1.734	1.486	0.351	0.248	3.220
Arabis_karategina	--	1	1.766	1.515	0.358	0.251	3.281
Arabis_kennedyae	--	1	0.360	0.212	0.050	0.148	0.571
Arabis_kokanica	--	1	0.359	0.211	0.050	0.148	0.569
Arabis_macdonaldiana	8	1	1.636	1.395	0.330	0.241	3.031
Arabis_modesta	16	1	1.766	1.515	0.358	0.251	3.282
Arabis_montbretiana	--	1	2.335	2.042	0.483	0.292	4.377
Arabis_nipponica	--	1	4.002	3.588	0.849	0.414	7.590
Arabis_nordmanniana	8	1	1.478	1.248	0.295	0.230	2.726
Arabis_nova	7	1	0.359	0.211	0.050	0.148	0.570
Arabis_nuristanica	--	1	2.995	2.654	0.628	0.341	5.649
Arabis_nuttallii	--	1	2.929	2.593	0.613	0.336	5.522
Arabis_olympica	--	1	2.770	2.446	0.579	0.324	5.216
Arabis_oregana	12	1	1.842	1.586	0.375	0.256	3.428
Arabis_ottonis-schulzii	--	0	0.277	0.120	0.109	0.157	0.397
Arabis_pangiensis	--	1	4.121	3.698	0.875	0.423	7.820
Arabis_paniculata	--	1	0.597	0.431	0.102	0.165	1.028
Arabis_parvula	16	1	0.641	0.472	0.112	0.168	1.113
Arabis_planisiliqua	8	1	4.105	3.683	0.871	0.422	7.789
Arabis_planisiliqua_subsp._planisiliqua	--	1	3.912	3.504	0.829	0.408	7.416
Arabis_procurrens	8	1	0.371	0.222	0.053	0.149	0.593
Arabis_pterosperma	8	1	0.586	0.422	0.100	0.164	1.008

Arabis_pubescens	8	1	0.362	0.214	0.051	0.148	0.575
Arabis_pumila	8	1	3.207	2.851	0.674	0.356	6.057
Arabis_pycnocarpa	--	1	4.080	3.660	0.866	0.420	7.741
Arabis_rosea	--	1	1.368	1.146	0.271	0.222	2.514
Arabis_sadina	--	1	0.800	0.620	0.147	0.180	1.420
Arabis_sagittata	8	1	0.762	0.585	0.138	0.177	1.348
Arabis_scabra	8	1	0.407	0.256	0.061	0.151	0.664
Arabis_scopoliana	--	1	0.361	0.213	0.050	0.148	0.575
Arabis_serpyllifolia	--	1	0.439	0.286	0.068	0.154	0.725
Arabis_serrata	16	1	3.299	2.936	0.694	0.363	6.234
Arabis_setosifolia	--	1	0.359	0.211	0.050	0.148	0.570
Arabis_soyeri	8	1	3.207	2.851	0.674	0.356	6.057
Arabis_stelleri	12	1	3.299	2.936	0.694	0.363	6.234
Arabis_stellulata	4	0	0.268	0.112	0.107	0.156	0.380
Arabis_stenocarpa	8	1	4.105	3.683	0.871	0.422	7.789
Arabis_subflava	--	1	0.360	0.212	0.050	0.148	0.571
Arabis_sudetica	--	1	4.084	3.663	0.867	0.420	7.747
Arabis_surculosa	--	1	0.518	0.359	0.085	0.160	0.877
Arabis_takesimana	--	1	0.748	0.572	0.135	0.176	1.320
Arabis_vochinensis	--	1	0.439	0.286	0.068	0.154	0.725
Armoracia_rusticana	16	1	0.386	0.236	0.056	0.150	0.622
Asperuginoides_axillaris	8	1	0.364	0.216	0.051	0.148	0.580
Aurinia_corymbosa	8	1	0.409	0.258	0.061	0.152	0.667
Aurinia_gionae	8	1	0.394	0.243	0.058	0.150	0.637
Aurinia_leucadea_subsp._diomedea	--	1	0.364	0.215	0.051	0.148	0.579
Aurinia_moreana	8	1	0.385	0.235	0.056	0.150	0.620
Aurinia_petraea	8	1	0.409	0.258	0.061	0.152	0.667
Aurinia_rupestris	8	1	0.359	0.211	0.050	0.148	0.570
Aurinia_saxatilis	8	1	0.394	0.243	0.058	0.150	0.637
Aurinia_sinuata	8	1	0.367	0.218	0.052	0.148	0.585
Barbarea_vulgaris	8	0	0.279	0.122	0.109	0.157	0.401
Berteroa_incana	8	1	1.989	1.722	0.407	0.267	3.711
Berteroa_mutabilis	8	1	0.471	0.315	0.074	0.156	0.786
Berteroa_obliqua	8	1	2.022	1.752	0.414	0.269	3.774
Berteroa_orbiculata	8	1	2.022	1.752	0.414	0.269	3.774
Bivonaea_lutea	--	0	0.279	0.122	0.109	0.157	0.401
Blennodia_canescens	--	0	0.279	0.122	0.109	0.157	0.401
Blennodia_pterosperma	12	1	0.471	0.315	0.075	0.156	0.786
Boechera_arcuata	6	0	0.330	0.166	0.116	0.164	0.495
Boechera_bodiensis	--	0	1.009	0.752	0.210	0.256	1.761
Boechera_canadensis	7	0	0.279	0.122	0.109	0.157	0.401
Boechera_cobrensis	7	0	0.312	0.150	0.113	0.162	0.461
Boechera_collinsii	10	1	0.428	0.275	0.065	0.153	0.702
Boechera_constancei	7	0	0.534	0.342	0.144	0.192	0.877
Boechera_crandallii	7	0	0.366	0.197	0.121	0.169	0.563
Boechera_cusickii	--	0	1.009	0.752	0.210	0.256	1.761
Boechera_davidsonii	--	0	0.290	0.131	0.110	0.159	0.422
Boechera_demissa	10	1	1.041	0.843	0.199	0.198	1.884
Boechera_dispar	--	0	0.839	0.605	0.187	0.233	1.444

Boechera_divaricarpa	10	1	0.585	0.420	0.099	0.164	1.005
Boechera_evadens	--	0	0.290	0.131	0.110	0.159	0.421
Boechera_falcata	7	0	0.295	0.135	0.111	0.159	0.430
Boechera_falcifructa	--	0	0.312	0.150	0.113	0.162	0.461
Boechera_fendleri	10	1	1.091	0.890	0.210	0.201	1.981
Boechera_formosa	7	0	0.300	0.140	0.112	0.160	0.440
Boechera_glaucovalvula	7	0	0.341	0.176	0.118	0.166	0.517
Boechera_gracilipes	--	0	1.201	0.918	0.237	0.282	2.119
Boechera_grahamii	16	1	0.746	0.570	0.135	0.176	1.316
Boechera_gunnisoniana	7	0	0.279	0.122	0.109	0.157	0.401
Boechera_howellii	--	0	1.044	0.782	0.215	0.261	1.826
Boechera_inyoensis	11	1	2.321	2.030	0.480	0.291	4.350
Boechera_johnstonii	--	0	0.404	0.230	0.126	0.174	0.634
Boechera_koehleri	7	0	0.896	0.655	0.195	0.241	1.551
Boechera_laevigata	7	0	0.379	0.208	0.123	0.171	0.587
Boechera_lasiocarpa	--	0	0.282	0.125	0.109	0.158	0.407
Boechera_lemmonii	14	1	0.541	0.380	0.090	0.161	0.921
Boechera_lignifera	7	0	0.348	0.182	0.119	0.167	0.530
Boechera_lincolnensis	7	0	0.341	0.176	0.118	0.166	0.517
Boechera_lyallii	10	1	0.398	0.247	0.058	0.151	0.645
Boechera_macounii	--	0	0.392	0.220	0.125	0.173	0.612
Boechera_missouriensis	--	0	0.642	0.435	0.159	0.206	1.077
Boechera_nevadensis	--	0	0.479	0.294	0.137	0.184	0.773
Boechera_oxylobula	--	1	1.041	0.843	0.199	0.198	1.884
Boechera_pallidifolia	--	0	3.606	2.997	0.571	0.609	6.603
Boechera_parishii	7	0	0.404	0.230	0.126	0.174	0.634
Boechera_paupercula	--	0	1.281	0.988	0.248	0.293	2.269
Boechera_pendulocarpa	7	0	0.294	0.135	0.111	0.159	0.429
Boechera_perennans	7	0	0.437	0.258	0.131	0.179	0.695
Boechera_perstellata	7	0	0.282	0.124	0.109	0.158	0.406
Boechera_platysperma	7	0	1.044	0.782	0.215	0.261	1.826
Boechera_polyantha	--	0	0.295	0.135	0.111	0.159	0.430
Boechera_puberula	7	0	0.896	0.655	0.195	0.241	1.551
Boechera_pygmaea	--	0	0.608	0.406	0.155	0.202	1.015
Boechera_rectissima	--	0	0.330	0.166	0.116	0.164	0.495
Boechera_repanda	7	0	0.279	0.122	0.109	0.157	0.401
Boechera_retrofracta	7	0	0.795	0.568	0.181	0.227	1.363
Boechera_rollei	--	0	0.364	0.195	0.121	0.169	0.560
Boechera_schistacea	7	0	0.375	0.205	0.122	0.170	0.580
Boechera_selbyi	--	0	3.606	2.997	0.571	0.609	6.603
Boechera_serotina	7	0	0.642	0.435	0.159	0.206	1.077
Boechera_serpenticola	--	0	0.839	0.605	0.187	0.233	1.444
Boechera_shockleyi	--	1	2.321	2.030	0.480	0.291	4.350
Boechera_shortii	--	0	0.282	0.124	0.109	0.158	0.406
Boechera_spatifolia	7	0	1.201	0.918	0.237	0.282	2.119
Boechera_stricta	10	1	0.746	0.570	0.135	0.176	1.316
Boechera_subpinnatifida	7	0	0.361	0.193	0.120	0.168	0.553
Boechera_suffrutescens	--	0	0.534	0.342	0.144	0.192	0.877
Boechera_texana	--	0	0.366	0.197	0.121	0.169	0.563

Boechera_tiehmii	--	0	0.295	0.136	0.111	0.159	0.431
Boechera_villosa	--	0	1.153	0.877	0.230	0.276	2.031
Boechera_williamsii	14	1	0.464	0.309	0.073	0.156	0.773
Boechera_yorkii	--	0	0.361	0.193	0.120	0.168	0.553
Bornmuellera_baldaccii	8	1	0.361	0.213	0.050	0.148	0.574
Bornmuellera_cappadocica	--	1	0.359	0.211	0.050	0.148	0.569
Bornmuellera_dieckii	--	1	0.361	0.213	0.050	0.148	0.574
Bornmuellera_tymphaea	8	1	0.359	0.211	0.050	0.148	0.571
Borodinia_baicalensis	--	0	2.373	1.932	0.400	0.442	4.305
Borodinia_macrophylla	7	0	2.373	1.932	0.400	0.442	4.305
Brassica_balearica	16	1	0.397	0.246	0.058	0.151	0.643
Brassica_barrelieri	9	0	0.279	0.122	0.109	0.157	0.401
Brassica_carinata	17	1	0.500	0.342	0.081	0.158	0.842
Brassica_cretica	10	0	0.279	0.122	0.109	0.157	0.401
Brassica_deflexa	7	0	0.279	0.122	0.109	0.157	0.401
Brassica_desnottesii	10	0	0.280	0.122	0.109	0.157	0.402
Brassica_elongata	11	0	0.279	0.122	0.109	0.157	0.401
Brassica_fruticulosa	8	0	0.279	0.122	0.109	0.157	0.401
Brassica_gravinae	10	0	0.279	0.122	0.109	0.157	0.401
Brassica_incana	9	0	0.279	0.122	0.109	0.157	0.401
Brassica_insularis	9	0	0.279	0.122	0.109	0.157	0.401
Brassica_juncea	16	1	0.403	0.252	0.060	0.151	0.655
Brassica_macrocarpa	9	0	0.279	0.122	0.109	0.157	0.401
Brassica_maurorum	--	0	0.279	0.122	0.109	0.157	0.401
Brassica_montana	9	0	0.279	0.122	0.109	0.157	0.401
Brassica_napus	19	1	0.402	0.251	0.059	0.151	0.654
Brassica_nigra	10	0	0.279	0.121	0.109	0.157	0.400
Brassica_oleracea	12	1	0.434	0.281	0.066	0.153	0.715
Brassica_oxyrrhina	9	0	0.279	0.122	0.109	0.157	0.401
Brassica_rapa	11	0	0.278	0.121	0.109	0.157	0.399
Brassica_repanda	11	0	0.280	0.122	0.109	0.157	0.402
Brassica_tournefortii	10	0	0.279	0.122	0.109	0.157	0.401
Brassica_villosa	9	0	0.279	0.122	0.109	0.157	0.401
Braya_alpina	16	1	1.004	0.809	0.191	0.195	1.812
Braya_brachycarpa	--	1	0.632	0.464	0.110	0.168	1.097
Braya_fernaldii	28	1	3.675	3.284	0.777	0.390	6.959
Braya_forrestii	--	1	0.359	0.211	0.050	0.148	0.570
Braya_gamosepala	--	1	0.775	0.596	0.141	0.178	1.371
Braya_glabella	28	1	0.496	0.338	0.080	0.158	0.835
Braya_humilis	25	1	3.461	3.086	0.730	0.375	6.547
Braya_linearis	21	1	3.461	3.086	0.730	0.375	6.547
Braya_longii	28	1	3.675	3.284	0.777	0.390	6.959
Braya_pilosa	14	1	2.718	2.397	0.567	0.320	5.115
Braya_rosea	21	1	1.104	0.902	0.213	0.202	2.006
Braya_scharnhorstii	--	1	0.375	0.226	0.053	0.149	0.601
Braya_siliquosa	--	1	1.004	0.809	0.191	0.195	1.812
Braya_thorild-wulffii	14	1	2.718	2.397	0.567	0.320	5.115
Bunias_orientalis	10	1	0.390	0.240	0.057	0.150	0.630
Cakile_arabica	9	0	0.279	0.122	0.109	0.157	0.401

Cakile_edentula	14	1	1.065	0.865	0.205	0.199	1.930
Cakile_lanceolata	9	0	1.242	0.954	0.243	0.288	2.196
Cakile_maritima	9	0	0.279	0.122	0.109	0.157	0.401
Calepina_irregularis	14	1	0.364	0.216	0.051	0.148	0.580
Calymmatium_draboides	--	0	0.279	0.122	0.109	0.157	0.401
Camelina_alyssum	21	1	3.347	2.981	0.705	0.366	6.328
Camelina_microcarpa	13	1	3.174	2.821	0.667	0.354	5.995
Camelina_rumelica	12	1	0.359	0.211	0.050	0.148	0.570
Camelina_sativa	14	1	3.347	2.981	0.705	0.366	6.328
Capsella_bursa-pastoris	10	1	1.876	1.617	0.382	0.259	3.492
Capsella_grandiflora	8	1	0.844	0.661	0.156	0.183	1.505
Capsella_orientalis	--	1	1.876	1.617	0.382	0.259	3.492
Capsella_rubella	7	1	0.844	0.661	0.156	0.183	1.505
Cardamine_adriatica	--	0	0.312	0.150	0.114	0.162	0.462
Cardamine_alpina	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_amara	28	1	0.486	0.329	0.078	0.157	0.815
Cardamine_amporitana	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_angustata	62	1	0.365	0.217	0.051	0.148	0.582
Cardamine_appendiculata	--	1	3.232	2.874	0.680	0.358	6.106
Cardamine_asarifolia	8	0	0.279	0.122	0.109	0.157	0.401
Cardamine_barbaraeoides	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_bellidifolia	8	0	0.280	0.123	0.109	0.157	0.403
Cardamine_blaisdellii	--	1	0.619	0.452	0.107	0.167	1.072
Cardamine_bonariensis	8	0	0.279	0.122	0.109	0.157	0.401
Cardamine_bradei	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_breweri	33	1	0.914	0.725	0.172	0.188	1.639
Cardamine_bulbosa	32	1	0.673	0.503	0.119	0.171	1.176
Cardamine_caldeirarum	--	1	0.486	0.329	0.078	0.157	0.815
Cardamine_carnosa	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_castellana	8	0	0.333	0.169	0.116	0.165	0.502
Cardamine_circaeoides	--	0	0.382	0.211	0.123	0.171	0.593
Cardamine_clematitis	--	1	0.628	0.461	0.109	0.168	1.089
Cardamine_concatenata	120	1	2.701	2.382	0.563	0.319	5.083
Cardamine_cordifolia	12	1	0.914	0.725	0.172	0.188	1.639
Cardamine_crassifolia	15	1	0.607	0.441	0.104	0.166	1.048
Cardamine_debilis	24	1	0.609	0.443	0.105	0.166	1.052
Cardamine_delavayi	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_dentipetala	--	0	0.480	0.296	0.137	0.185	0.776
Cardamine_digitata	20	1	0.388	0.238	0.056	0.150	0.626
Cardamine_diphylla	48	1	0.361	0.213	0.050	0.148	0.574
Cardamine_douglassii	--	1	0.673	0.503	0.119	0.171	1.176
Cardamine_ecuadorensis	--	0	0.283	0.125	0.109	0.158	0.408
Cardamine_enneaphyllos	26	1	0.377	0.228	0.054	0.149	0.605
Cardamine_fallax	--	0	0.453	0.272	0.133	0.181	0.724
Cardamine_fialae	--	0	0.305	0.144	0.113	0.161	0.450
Cardamine_flexuosa	15	1	1.289	1.073	0.254	0.216	2.361
Cardamine_fragariifolia	--	0	0.278	0.121	0.109	0.157	0.399
Cardamine_gallaecica	--	1	1.289	1.073	0.254	0.216	2.361
Cardamine_glanduligera	21	1	0.392	0.242	0.057	0.150	0.635

Cardamine_glauca	8	0	0.428	0.251	0.130	0.177	0.679
Cardamine_glechomifolia	--	0	0.382	0.211	0.123	0.171	0.593
Cardamine_graeca	8	0	0.279	0.122	0.109	0.157	0.401
Cardamine_griffithii	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_hirsuta	16	1	3.174	2.821	0.667	0.354	5.995
Cardamine_impatiens	12	1	0.382	0.232	0.055	0.150	0.614
Cardamine_laciniata	--	1	2.701	2.382	0.563	0.319	5.083
Cardamine_leucantha	8	0	0.271	0.115	0.108	0.156	0.387
Cardamine_lihengiana	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_limprichtiana	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_longifructus	--	0	0.484	0.299	0.137	0.185	0.784
Cardamine_lyallii	--	1	0.360	0.212	0.050	0.148	0.571
Cardamine_macrophylla	25	1	0.446	0.292	0.069	0.154	0.738
Cardamine_manshurica	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_maritima	--	0	0.305	0.144	0.113	0.161	0.450
Cardamine_matthioli	--	0	0.327	0.163	0.116	0.164	0.490
Cardamine_microphylla	24	1	0.446	0.292	0.069	0.154	0.738
Cardamine_microzyga	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_monteluccii	8	0	0.312	0.150	0.114	0.162	0.462
Cardamine_montenegrina	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_niigatensis	16	1	0.405	0.254	0.060	0.151	0.660
Cardamine_nipponica	--	0	0.280	0.123	0.109	0.157	0.403
Cardamine_nuttallii	--	1	0.628	0.461	0.109	0.168	1.089
Cardamine_occidentalis	32	1	0.448	0.294	0.069	0.154	0.742
Cardamine_oligosperma	8	0	0.283	0.125	0.109	0.158	0.408
Cardamine_ovata	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_pancicii	--	0	0.428	0.251	0.130	0.177	0.679
Cardamine_parviflora	14	1	0.424	0.271	0.064	0.153	0.696
Cardamine_pattersonii	--	0	0.283	0.125	0.109	0.158	0.408
Cardamine_paucijuga	--	0	0.453	0.272	0.133	0.181	0.724
Cardamine_pedata	15	1	0.619	0.452	0.107	0.167	1.072
Cardamine_pensylvanica	24	1	0.873	0.687	0.163	0.185	1.560
Cardamine_pentaphyllos	23	1	0.419	0.266	0.063	0.152	0.685
Cardamine_pratensis	24	1	0.405	0.254	0.060	0.151	0.659
Cardamine_purpurea	44	1	0.391	0.241	0.057	0.150	0.632
Cardamine_raphanifolia	24	1	0.593	0.428	0.101	0.165	1.022
Cardamine_regeliana	--	0	0.303	0.143	0.112	0.160	0.445
Cardamine_resedifolia	8	0	0.279	0.122	0.109	0.157	0.401
Cardamine_rhizomata	--	0	0.283	0.125	0.109	0.158	0.408
Cardamine_rupestris	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_rupicola	--	1	0.360	0.212	0.050	0.148	0.571
Cardamine_schulzii	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_scutata	16	1	0.516	0.356	0.084	0.159	0.872
Cardamine_serbica	--	0	0.279	0.122	0.109	0.157	0.401
Cardamine_sp._RS-2013	--	1	3.232	2.874	0.680	0.358	6.106
Cardamine_tanakae	--	0	0.484	0.299	0.137	0.185	0.784
Cardamine_tangutorum	21	1	0.446	0.292	0.069	0.154	0.738
Cardamine_trifolia	8	0	0.279	0.122	0.109	0.157	0.401
Cardamine_umbellata	--	1	0.609	0.443	0.105	0.166	1.052

Cardamine_victoris	14	1	0.390	0.240	0.057	0.150	0.629
Cardamine_yezoensis	30	1	0.361	0.213	0.050	0.148	0.574
Cardamine_yunnanensis	--	0	0.279	0.122	0.109	0.157	0.401
Carrichtera_annua	8	0	0.279	0.122	0.109	0.157	0.400
Catenulina_hedysaroides	--	0	0.279	0.122	0.109	0.157	0.401
Caulanthus_anceps	--	1	0.359	0.211	0.050	0.148	0.570
Caulanthus_coulteri	14	1	0.692	0.520	0.123	0.172	1.211
Caulanthus_crassicaulis	13	1	0.359	0.211	0.050	0.148	0.570
Caulanthus_flavescens	--	1	0.359	0.211	0.050	0.148	0.570
Caulanthus_glaucus	10	1	0.359	0.211	0.050	0.148	0.569
Caulanthus_hallii	--	1	0.359	0.211	0.050	0.148	0.569
Caulanthus_heterophyllus	14	1	0.359	0.211	0.050	0.148	0.569
Caulanthus_inflatus	14	1	0.359	0.211	0.050	0.148	0.571
Caulanthus_lasiophyllus	--	1	0.359	0.211	0.050	0.148	0.570
Caulanthus_lemmonii	--	1	0.692	0.520	0.123	0.172	1.211
Caulanthus_major	14	1	0.359	0.211	0.050	0.148	0.569
Caulanthus_pilosus	--	1	0.359	0.211	0.050	0.148	0.569
Caulanthus_simulans	16	1	0.359	0.211	0.050	0.148	0.569
Chalcanthus_renifolius	7	0	0.279	0.122	0.109	0.157	0.401
Chaunanthus_acuminatus	--	1	0.359	0.211	0.050	0.148	0.570
Chaunanthus_petiolatus	--	1	0.359	0.211	0.050	0.148	0.570
Chilocardamum_patagonicum	--	0	0.279	0.122	0.109	0.157	0.401
Chlorocrambe_hastata	--	1	0.359	0.211	0.050	0.148	0.569
Chorispora_bungeana	--	0	0.280	0.123	0.109	0.157	0.403
Chorispora_macropoda	7	0	0.279	0.122	0.109	0.157	0.401
Chorispora_persica	7	0	0.279	0.122	0.109	0.157	0.401
Chorispora_purpurascens	--	0	0.279	0.122	0.109	0.157	0.401
Chorispora_sabulosa	--	0	0.280	0.123	0.109	0.157	0.403
Chorispora_sibirica	--	0	0.280	0.123	0.109	0.157	0.402
Chorispora_songarica	--	0	0.280	0.123	0.109	0.157	0.402
Chorispora_tashkorganica	--	0	0.279	0.122	0.109	0.157	0.401
Chorispora_tenella	10	1	0.452	0.297	0.070	0.155	0.748
Christolea_crassifolia	7	0	0.279	0.122	0.109	0.157	0.401
Chrysochamela_velutina	10	1	0.360	0.212	0.050	0.148	0.571
Clastopus_vestitus	8	1	0.359	0.211	0.050	0.148	0.569
Clausia_agideliensis	--	1	3.008	2.666	0.631	0.342	5.674
Clausia_aprica	10	1	3.926	3.517	0.832	0.409	7.443
Clausia_kasakhorum	--	1	0.547	0.385	0.091	0.162	0.933
Clausia_robusta	--	1	3.926	3.517	0.832	0.409	7.443
Clausia_trichosepala	--	1	0.364	0.216	0.051	0.148	0.580
Clypeola_aspera	13	1	0.359	0.211	0.050	0.148	0.570
Clypeola_cyclodontea	--	1	0.359	0.211	0.050	0.148	0.570
Clypeola_dichotoma	7	1	0.359	0.211	0.050	0.148	0.570
Clypeola_jonthlaspi	14	1	0.359	0.211	0.050	0.148	0.570
Clypeola_lappacea	7	1	0.359	0.211	0.050	0.148	0.570
Coincya_monensis	11	0	0.279	0.122	0.109	0.157	0.401
Conringia_orientalis	7	0	0.279	0.122	0.109	0.157	0.401
Conringia_planisiliqua	8	0	0.279	0.122	0.109	0.157	0.401
Cordylocarpus_muricatus	8	0	0.279	0.122	0.109	0.157	0.401

Crambe_orientalis	15	1	0.384	0.234	0.055	0.150	0.619
Crucihimalaya_himalaica	8	0	0.288	0.130	0.110	0.158	0.418
Crucihimalaya_kneuckeri	--	0	0.426	0.249	0.129	0.177	0.675
Crucihimalaya_lasiocarpa	--	0	0.291	0.132	0.111	0.159	0.423
Crucihimalaya_mollissima	8	0	0.426	0.249	0.129	0.177	0.675
Crucihimalaya_mongolica	--	0	0.279	0.122	0.109	0.157	0.401
Crucihimalaya_stricta	7	0	0.288	0.130	0.110	0.158	0.418
Crucihimalaya_tenuisiliqua	--	0	0.291	0.132	0.111	0.159	0.423
Crucihimalaya_wallichii	8	0	0.294	0.135	0.111	0.159	0.429
Cryptospora_falcata	7	0	0.279	0.122	0.109	0.157	0.401
Cuphonotus_humistratus	--	0	0.279	0.122	0.109	0.157	0.401
Cusickiella_douglasii	--	0	0.279	0.122	0.109	0.157	0.401
Cusickiella_quadricostata	--	0	0.279	0.122	0.109	0.157	0.401
Cyphocardamum_aretioides	--	0	0.279	0.122	0.109	0.157	0.401
Degenia_velebitica	8	1	0.359	0.211	0.050	0.148	0.570
Delpinophytum_patagonicum	--	0	0.279	0.122	0.109	0.157	0.401
Dendroarabis_fruticulosa	8	1	0.360	0.212	0.050	0.148	0.573
Descurainia_adenophora	--	0	1.280	0.987	0.248	0.293	2.266
Descurainia_antarctica	--	0	0.556	0.361	0.147	0.195	0.917
Descurainia_appendiculata	--	0	4.941	4.150	0.756	0.791	9.091
Descurainia_argentina	--	0	0.621	0.418	0.156	0.204	1.039
Descurainia_artemisioides	7	0	0.318	0.156	0.114	0.163	0.474
Descurainia_athrocarpa	--	0	0.306	0.145	0.113	0.161	0.451
Descurainia_bourgeauana	7	0	0.993	0.738	0.208	0.254	1.731
Descurainia_brevisiliqua	--	0	0.616	0.413	0.156	0.203	1.029
Descurainia_californica	7	0	2.533	2.069	0.422	0.464	4.603
Descurainia_cumingiana_subsp._cumingiana	--	0	1.018	0.761	0.212	0.258	1.779
Descurainia_depressa	--	0	0.305	0.144	0.113	0.161	0.449
Descurainia_gilva	7	0	0.993	0.738	0.208	0.254	1.731
Descurainia_glaucescens	--	0	2.005	1.613	0.348	0.392	3.617
Descurainia_gonzalezii	8	0	2.390	1.946	0.402	0.444	4.336
Descurainia_heterotricha	--	0	1.018	0.761	0.212	0.258	1.779
Descurainia_impatiens	7	0	0.342	0.177	0.118	0.166	0.519
Descurainia_incana	10	0	3.620	3.009	0.573	0.611	6.628
Descurainia_incisa	--	0	3.620	3.009	0.573	0.611	6.628
Descurainia_kochii	--	0	0.279	0.122	0.109	0.157	0.401
Descurainia_lemsii	7	0	2.390	1.946	0.402	0.444	4.336
Descurainia_leptoclada	7	0	1.348	1.045	0.257	0.302	2.393
Descurainia_longipedicellata	--	0	0.639	0.433	0.159	0.206	1.073
Descurainia_millefolia	7	0	1.936	1.553	0.339	0.382	3.489
Descurainia_myriophylla	7	0	1.434	1.119	0.269	0.314	2.553
Descurainia_nelsonii	--	0	0.632	0.427	0.158	0.205	1.060
Descurainia_obtusa_subsp._obtusa	--	0	1.383	1.076	0.262	0.307	2.459
Descurainia_paradisa_subsp._nevadensis	--	0	0.639	0.433	0.159	0.206	1.073
Descurainia_pimpinellifolia	--	0	4.941	4.150	0.756	0.791	9.091
Descurainia_pinnata	14	1	1.183	0.975	0.231	0.208	2.158
Descurainia_preauxiana	7	0	1.485	1.164	0.276	0.321	2.649
Descurainia_sophia	8	0	0.279	0.122	0.109	0.157	0.401
Descurainia_sophioides	12	1	0.654	0.485	0.115	0.169	1.139

Descurainia_streptocarpa	14	1	1.141	0.936	0.221	0.205	2.077
Descurainia_stricta	--	0	2.259	1.833	0.384	0.426	4.091
Descurainia_tanacetifolia	--	0	0.284	0.126	0.110	0.158	0.410
Descurainia_virletii	14	1	0.521	0.361	0.085	0.160	0.883
Dichasianthus_subtilissimus	--	0	0.279	0.122	0.109	0.157	0.401
Didesmus_aegypticus	--	0	0.279	0.122	0.109	0.157	0.401
Didymophysa_aucheri	8	0	0.279	0.122	0.109	0.157	0.401
Didymophysa_fedtschenkoana	--	0	0.279	0.122	0.109	0.157	0.401
Dilophia_salsa	--	0	0.279	0.122	0.109	0.157	0.401
Dimorphocarpa_wislizeni	9	1	0.362	0.214	0.051	0.148	0.575
Diplotaxis_acris	11	0	0.279	0.122	0.109	0.157	0.401
Diplotaxis_catholica	9	0	0.279	0.122	0.109	0.157	0.401
Diplotaxis_erucoides	7	0	0.279	0.122	0.109	0.157	0.401
Diplotaxis_harra	13	0	0.279	0.122	0.109	0.157	0.401
Diplotaxis_tenuifolia	10	0	0.279	0.122	0.109	0.157	0.401
Dipoma_iberideum	--	0	0.279	0.122	0.109	0.157	0.401
Diptychocarpus_strictus	7	0	0.279	0.122	0.109	0.157	0.401
Dithyrea_californica	10	1	0.359	0.211	0.050	0.148	0.571
Dontostemon_crassifolius	7	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_dentatus	7	0	0.298	0.138	0.112	0.160	0.436
Dontostemon_elegans	--	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_glandulosus	--	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_gubanovii	--	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_hispidus	7	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_integrifolius	7	0	0.298	0.138	0.112	0.160	0.436
Dontostemon_intermedius	7	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_micranthus	--	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_perennis	--	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_pinnatifidus	7	0	0.279	0.122	0.109	0.157	0.401
Dontostemon_senilis	14	1	0.392	0.242	0.057	0.150	0.633
Dontostemon_tibeticus	--	0	0.279	0.122	0.109	0.157	0.401
Draba_affghanica	--	0	0.304	0.144	0.112	0.161	0.448
Draba_albertina	12	1	3.257	2.897	0.685	0.360	6.154
Draba_alpina	37	0	4.313	3.608	0.669	0.706	7.921
Draba_altaica	8	0	0.279	0.122	0.109	0.157	0.401
Draba_alyssoides	--	0	0.279	0.122	0.109	0.157	0.401
Draba_amplexicaulis	--	0	1.691	1.342	0.305	0.349	3.033
Draba_arabisans	48	0	0.609	0.407	0.155	0.202	1.016
Draba_arctica	--	1	0.942	0.752	0.178	0.191	1.694
Draba_aretioides	--	0	1.762	1.404	0.315	0.359	3.166
Draba_arseniewii	--	0	0.281	0.124	0.109	0.157	0.405
Draba_asprella	15	1	3.080	2.733	0.646	0.347	5.812
Draba_aurea	36	1	0.599	0.433	0.102	0.165	1.032
Draba_aureola	10	1	3.080	2.733	0.646	0.347	5.812
Draba_baicalensis	--	0	2.023	1.629	0.351	0.394	3.652
Draba_barbata	--	1	2.707	2.387	0.565	0.320	5.094
Draba_bellii	--	0	0.459	0.278	0.134	0.182	0.737
Draba_bifurcata	--	0	0.389	0.217	0.124	0.172	0.606
Draba_borealis	40	0	0.984	0.731	0.207	0.253	1.715

Draba_brachystylis	22	1	1.398	1.174	0.278	0.224	2.573
Draba_breweri	16	1	0.399	0.249	0.059	0.151	0.648
Draba_burkei	10	1	4.031	3.615	0.855	0.416	7.646
Draba_cana	16	0	1.263	0.972	0.246	0.291	2.236
Draba_cholaensis	--	0	0.289	0.131	0.110	0.159	0.420
Draba_cinerea	26	0	2.525	2.063	0.421	0.463	4.588
Draba_confusa	--	0	1.772	1.412	0.316	0.360	3.184
Draba_corrugata	--	1	0.786	0.607	0.144	0.179	1.393
Draba_corymbosa	60	1	0.658	0.488	0.115	0.170	1.146
Draba_crassa	18	1	0.542	0.381	0.090	0.161	0.922
Draba_crassifolia	26	1	3.257	2.897	0.685	0.360	6.154
Draba_cusickii	13	1	1.304	1.087	0.257	0.217	2.391
Draba_densifolia	18	1	0.786	0.607	0.144	0.179	1.393
Draba_doerfleri	--	0	2.115	1.708	0.364	0.407	3.823
Draba_elata	--	0	0.279	0.122	0.109	0.157	0.401
Draba_elegans	--	0	0.280	0.123	0.109	0.157	0.402
Draba_eriopoda	8	0	0.327	0.164	0.116	0.164	0.491
Draba_eschscholtzii	--	0	0.279	0.122	0.109	0.157	0.401
Draba_falconeri	--	0	0.987	0.733	0.207	0.253	1.720
Draba_fladnizensis	8	0	2.570	2.102	0.427	0.469	4.672
Draba_fuhaiensis	--	0	2.570	2.102	0.427	0.469	4.672
Draba_gilliesii	24	1	0.411	0.259	0.061	0.152	0.670
Draba_glabella	35	1	1.024	0.828	0.196	0.197	1.852
Draba_glacialis	8	0	1.251	0.962	0.244	0.289	2.213
Draba_globosa	--	1	4.031	3.615	0.855	0.416	7.646
Draba_gmelini	--	1	0.942	0.752	0.178	0.191	1.694
Draba_gracillima	--	0	0.327	0.164	0.116	0.164	0.491
Draba_groenlandica	--	0	1.507	1.183	0.279	0.324	2.691
Draba_helleriana	9	0	0.296	0.136	0.111	0.159	0.432
Draba_heterocoma	--	0	0.280	0.123	0.109	0.157	0.402
Draba_himalayensis	--	0	3.531	2.932	0.560	0.599	6.463
Draba_hirta	40	0	2.386	1.943	0.401	0.444	4.329
Draba_hitchcockii	27	0	0.420	0.244	0.129	0.176	0.664
Draba_incerta	56	1	0.512	0.352	0.083	0.159	0.864
Draba_involucrata	--	0	0.288	0.129	0.110	0.158	0.417
Draba_jaegeri	27	0	0.403	0.229	0.126	0.174	0.632
Draba_juniperina	--	1	4.142	3.718	0.879	0.424	7.859
Draba_juvenilis	32	0	3.531	2.932	0.560	0.599	6.463
Draba_kamtschatica	--	0	4.895	4.110	0.750	0.785	9.005
Draba_kananaskia	--	0	1.251	0.962	0.244	0.289	2.213
Draba_kassii	11	1	2.331	2.039	0.482	0.292	4.371
Draba_koeiei	--	0	0.772	0.547	0.177	0.224	1.319
Draba_korshinskyi	--	0	0.281	0.124	0.109	0.157	0.405
Draba_ladina	16	0	1.259	0.969	0.245	0.290	2.228
Draba_laurentiana	--	0	0.474	0.290	0.136	0.184	0.764
Draba_lichiangensis	--	0	0.741	0.521	0.173	0.220	1.261
Draba_lonchocarpa	10	0	0.569	0.372	0.149	0.197	0.941
Draba_longipes	--	0	2.608	2.135	0.432	0.474	4.743
Draba_luteola	--	0	0.411	0.236	0.127	0.175	0.647

Draba_macrocarpa	--	1	3.554	3.173	0.751	0.382	6.727
Draba_magellanica	32	1	3.554	3.173	0.751	0.382	6.727
Draba_matangensis	--	0	0.279	0.122	0.109	0.157	0.401
Draba_melanopus	16	1	0.426	0.273	0.065	0.153	0.699
Draba_micropetala	16	1	0.404	0.253	0.060	0.151	0.657
Draba_mogollonica	14	1	1.340	1.121	0.265	0.220	2.461
Draba_murrayi	19	0	0.308	0.147	0.113	0.161	0.455
Draba_nivalis	8	0	4.895	4.110	0.750	0.785	9.005
Draba_novolympica	--	0	0.821	0.590	0.184	0.231	1.411
Draba_nylamensis	--	0	1.259	0.969	0.245	0.290	2.228
Draba_oblongata	28	0	0.632	0.427	0.158	0.205	1.059
Draba_obovata	--	0	1.762	1.404	0.315	0.359	3.166
Draba_ochroleuca	40	0	4.270	3.570	0.663	0.700	7.840
Draba_odudiana	--	0	0.288	0.130	0.110	0.158	0.418
Draba_ogilviensis	8	1	0.899	0.711	0.168	0.187	1.610
Draba_olgae	6	0	0.772	0.547	0.177	0.224	1.319
Draba_oligosperma	30	0	1.051	0.789	0.216	0.262	1.839
Draba_oxycarpa	32	0	4.087	3.412	0.637	0.675	7.498
Draba_palanderiana	20	1	0.561	0.398	0.094	0.163	0.959
Draba_pauciflora	20	1	0.413	0.261	0.062	0.152	0.675
Draba_paysonii	21	1	0.674	0.503	0.119	0.171	1.177
Draba_pectinipila	11	1	4.142	3.718	0.879	0.424	7.859
Draba_pilosa	16	1	2.707	2.387	0.565	0.320	5.094
Draba_pohlei	--	0	4.313	3.608	0.669	0.706	7.921
Draba_polyphylla	--	0	0.279	0.122	0.109	0.157	0.401
Draba_porsildii	16	1	0.575	0.411	0.097	0.164	0.986
Draba_praealta	28	0	0.624	0.420	0.157	0.204	1.043
Draba_primuloides	--	0	1.845	1.475	0.326	0.370	3.321
Draba_prozorovskii	--	0	2.608	2.135	0.432	0.474	4.743
Draba_pterosperma	--	0	0.420	0.244	0.129	0.176	0.664
Draba_pycnosperma	--	0	0.828	0.596	0.185	0.232	1.424
Draba_pygmaea	--	0	2.600	2.127	0.431	0.473	4.728
Draba_ramosissima	8	0	0.293	0.134	0.111	0.159	0.428
Draba_ramulosa	--	0	0.279	0.122	0.109	0.157	0.401
Draba_rectifructa	12	1	1.280	1.065	0.252	0.215	2.344
Draba_reptans	15	1	1.409	1.184	0.280	0.225	2.594
Draba_rigida	--	0	0.281	0.123	0.109	0.157	0.404
Draba_ruaxes	36	1	0.491	0.333	0.079	0.158	0.824
Draba_rupestris	--	0	2.115	1.708	0.364	0.407	3.823
Draba_sachalinensis	32	0	2.534	2.070	0.422	0.464	4.604
Draba_scopulorum	--	0	0.279	0.122	0.109	0.157	0.401
Draba_sherriffii	--	0	0.281	0.123	0.109	0.157	0.404
Draba_sikkimensis	--	0	0.279	0.122	0.109	0.157	0.401
Draba_sobolifera	13	1	3.916	3.508	0.830	0.408	7.424
Draba_spectabilis	13	1	1.974	1.708	0.404	0.266	3.682
Draba_sphaerocarpa	10	0	0.716	0.499	0.170	0.217	1.215
Draba_sphaeroides	10	1	2.974	2.635	0.623	0.339	5.609
Draba_staintonii	--	0	0.279	0.122	0.109	0.157	0.401
Draba_stenopetala	12	1	1.486	1.256	0.297	0.230	2.742

Draba_streptobrachia	32	1	1.325	1.107	0.262	0.219	2.432
Draba_stylaris	8	0	0.294	0.135	0.111	0.159	0.428
Draba_subalpina	13	1	3.916	3.508	0.830	0.408	7.424
Draba_subamplexicaulis	24	0	0.284	0.126	0.110	0.158	0.410
Draba_subcapitata	8	0	0.631	0.426	0.158	0.205	1.058
Draba_supranivalis	8	0	0.570	0.374	0.149	0.197	0.944
Draba_surculosa	--	0	2.525	2.063	0.421	0.463	4.588
Draba_tibetica	--	0	0.987	0.733	0.207	0.253	1.720
Draba_tomentosa	8	0	0.570	0.374	0.149	0.197	0.944
Draba_turczaninovii	--	0	1.845	1.475	0.326	0.370	3.321
Draba_ussuriensis	12	0	1.757	1.399	0.314	0.358	3.156
Draba_ventosa	18	1	0.402	0.251	0.059	0.151	0.653
Draba_yunnanensis	--	0	0.286	0.127	0.110	0.158	0.413
Drabastrum_alpestre	--	0	0.279	0.122	0.109	0.157	0.401
Dryopetalon_viereckii	14	1	0.359	0.211	0.050	0.148	0.569
Elburzia_fenestrata	7	0	0.279	0.122	0.109	0.157	0.401
Englerocharis_pauciflora	--	1	0.359	0.211	0.050	0.148	0.569
Eremoblastus_caspicus	--	0	0.279	0.122	0.109	0.157	0.401
Eremophyton_chevallieri	--	0	0.279	0.122	0.109	0.157	0.401
Eruca_vesicaria_subsp._sativa	--	1	0.368	0.219	0.052	0.149	0.587
Erucaria_erucarioides	8	0	0.279	0.122	0.109	0.157	0.401
Erucastrum_gallicum	15	1	0.387	0.237	0.056	0.150	0.624
Erysimum_acrotonum	--	0	3.367	2.790	0.538	0.577	6.158
Erysimum_alaicum	--	0	0.494	0.307	0.139	0.186	0.801
Erysimum_amurense	--	0	0.737	0.517	0.172	0.219	1.254
Erysimum_angustatum	--	1	2.939	2.603	0.616	0.337	5.542
Erysimum_arbuscula	14	1	0.757	0.580	0.137	0.177	1.336
Erysimum_asperrimum	--	0	3.149	2.602	0.507	0.547	5.751
Erysimum_asperum	18	1	2.939	2.603	0.616	0.337	5.542
Erysimum_aucherianum	--	0	2.449	1.997	0.410	0.452	4.446
Erysimum_aureum	--	0	2.449	1.997	0.410	0.452	4.446
Erysimum_badghysi	--	0	0.614	0.411	0.155	0.203	1.025
Erysimum_baeticum	21	1	3.461	3.086	0.730	0.375	6.547
Erysimum_belvederense	--	0	0.337	0.172	0.117	0.165	0.509
Erysimum_bicolor	15	1	1.590	1.352	0.320	0.238	2.942
Erysimum_boreale	8	0	4.128	3.448	0.643	0.680	7.576
Erysimum_caboverdeanum	--	1	0.751	0.575	0.136	0.177	1.326
Erysimum_caespitosum	28	1	0.415	0.263	0.062	0.152	0.678
Erysimum_callicarpum	--	0	0.737	0.517	0.172	0.219	1.254
Erysimum_canum	--	0	2.996	2.469	0.486	0.526	5.465
Erysimum_capitatum	18	1	0.485	0.328	0.078	0.157	0.814
Erysimum_carniolicum	16	1	1.323	1.104	0.261	0.218	2.427
Erysimum_cazorlense	21	1	0.672	0.501	0.118	0.171	1.173
Erysimum_cheiranthoides	8	0	0.306	0.145	0.113	0.161	0.451
Erysimum_cheiri	--	0	0.314	0.152	0.114	0.162	0.465
Erysimum_collisparsum	--	0	0.838	0.605	0.186	0.233	1.442
Erysimum_comatum	7	0	0.285	0.127	0.110	0.158	0.413
Erysimum_crassicaule	24	1	0.579	0.415	0.098	0.164	0.994
Erysimum_crassipes	7	0	0.401	0.227	0.126	0.174	0.629

Erysimum_crepidifolium	7	0	0.387	0.215	0.124	0.172	0.602
Erysimum_cuspidatum	8	0	0.289	0.130	0.110	0.159	0.419
Erysimum_cyaneum	--	0	1.326	1.027	0.254	0.300	2.353
Erysimum_czernjajevi	--	0	1.326	1.027	0.254	0.300	2.353
Erysimum_deflexum	--	0	2.415	1.967	0.405	0.447	4.382
Erysimum_diffusum	18	1	0.426	0.273	0.065	0.153	0.699
Erysimum_duriaei	12	1	0.927	0.738	0.175	0.189	1.665
Erysimum_ehrendorferi	--	1	3.178	2.824	0.668	0.354	6.001
Erysimum_elbrusense	--	0	0.932	0.686	0.200	0.246	1.619
Erysimum_fitzii	--	0	1.006	0.750	0.210	0.256	1.755
Erysimum_gelidum	18	1	0.676	0.505	0.119	0.171	1.180
Erysimum_ghaznicum	--	0	3.367	2.790	0.538	0.577	6.158
Erysimum_gomez-campoi	--	0	1.397	1.088	0.264	0.309	2.484
Erysimum_gorbeanum	--	0	2.888	2.376	0.471	0.512	5.264
Erysimum_gramineum	--	1	1.403	1.179	0.279	0.224	2.583
Erysimum_griffithianum	--	0	0.317	0.155	0.114	0.162	0.472
Erysimum_griffithii	--	0	1.165	0.887	0.232	0.278	2.052
Erysimum_gypsaceum	--	0	0.289	0.131	0.110	0.159	0.420
Erysimum_handel-mazzettii	--	0	4.208	3.517	0.654	0.691	7.725
Erysimum_hieraciifolium	16	1	1.541	1.306	0.309	0.234	2.847
Erysimum_hirschfeldioides	--	0	1.022	0.764	0.212	0.258	1.787
Erysimum_humillimum	--	0	0.377	0.206	0.123	0.170	0.583
Erysimum_idae	--	0	0.401	0.227	0.126	0.174	0.629
Erysimum_inense	--	0	1.531	1.204	0.283	0.327	2.735
Erysimum_ischnostylum	20	1	0.699	0.526	0.124	0.173	1.225
Erysimum_jugicola	9	0	0.838	0.605	0.186	0.233	1.442
Erysimum_kamelinii	--	0	0.369	0.199	0.121	0.169	0.568
Erysimum_kerbabaevii	--	0	0.465	0.282	0.135	0.182	0.747
Erysimum_krendlii	7	0	0.594	0.394	0.153	0.200	0.989
Erysimum_kurdicum	8	0	0.389	0.216	0.124	0.172	0.605
Erysimum_lagascae	--	0	2.859	2.352	0.467	0.508	5.211
Erysimum_laxiflorum	--	0	0.328	0.165	0.116	0.164	0.493
Erysimum_lazistanicum	--	0	0.594	0.394	0.153	0.200	0.989
Erysimum_ledebourii	--	0	1.531	1.204	0.283	0.327	2.735
Erysimum_leptostylum	--	0	0.736	0.517	0.172	0.219	1.253
Erysimum_leucanthemum	6	0	3.191	2.638	0.513	0.553	5.829
Erysimum_lilacinum	--	0	0.620	0.416	0.156	0.203	1.036
Erysimum_linariifolium	12	1	0.995	0.800	0.189	0.194	1.795
Erysimum_linifolium	7	0	1.156	0.880	0.231	0.276	2.036
Erysimum_lycaonicum	--	0	0.401	0.227	0.126	0.174	0.628
Erysimum_macrostigma	--	0	0.736	0.517	0.172	0.219	1.253
Erysimum_mediohispanicum	--	1	3.461	3.086	0.730	0.375	6.547
Erysimum_merxmuelleri	--	1	3.145	2.794	0.661	0.352	5.939
Erysimum_metlesicsii	7	0	0.349	0.182	0.119	0.167	0.531
Erysimum_mongolicum	--	0	4.186	3.497	0.651	0.688	7.683
Erysimum_myriophyllum	10	0	0.981	0.728	0.206	0.253	1.709
Erysimum_nasturtioides	--	0	0.932	0.686	0.200	0.246	1.619
Erysimum_naxense	9	0	0.461	0.279	0.134	0.182	0.741
Erysimum_nervosum	--	1	3.178	2.824	0.668	0.354	6.001

Erysimum_nevadense	7	0	1.118	0.846	0.225	0.271	1.964
Erysimum_ochroleucum	16	1	1.106	0.904	0.214	0.203	2.010
Erysimum_odoratum	10	0	0.301	0.141	0.112	0.160	0.442
Erysimum_oleifolium	--	0	1.022	0.764	0.212	0.258	1.787
Erysimum_pachycarpum	9	0	2.415	1.967	0.405	0.447	4.382
Erysimum_pallasii	--	1	3.148	2.796	0.661	0.352	5.944
Erysimum_passgalense	--	0	3.203	2.648	0.515	0.555	5.851
Erysimum_pectinatum	6	0	0.389	0.217	0.124	0.172	0.606
Erysimum_penyalarense	19	1	3.145	2.794	0.661	0.352	5.939
Erysimum_perofskianum	9	0	0.458	0.276	0.134	0.181	0.734
Erysimum_popovii	14	1	2.794	2.468	0.584	0.326	5.261
Erysimum_pseudopurpureum	--	0	0.355	0.188	0.119	0.168	0.543
Erysimum_pulchellum	28	1	0.531	0.370	0.088	0.160	0.901
Erysimum_purpureum	20	1	0.449	0.295	0.070	0.154	0.744
Erysimum_quadrangulum	--	0	2.847	2.341	0.465	0.506	5.188
Erysimum_redowskii	14	1	3.148	2.796	0.661	0.352	5.944
Erysimum_repandum	8	0	0.349	0.182	0.119	0.167	0.531
Erysimum_rhodium	8	0	0.465	0.283	0.135	0.182	0.748
Erysimum_rondae	--	0	1.006	0.750	0.210	0.256	1.755
Erysimum_roseum	--	0	4.208	3.517	0.654	0.691	7.725
Erysimum_ruscinonense	--	0	2.888	2.376	0.471	0.512	5.264
Erysimum_salangense	35	1	0.592	0.427	0.101	0.165	1.020
Erysimum_scabrum	14	1	0.531	0.371	0.088	0.160	0.902
Erysimum_scoparium	14	1	1.590	1.352	0.320	0.238	2.942
Erysimum_seipkae	--	0	1.413	1.102	0.266	0.311	2.515
Erysimum_semperflorens	7	0	0.648	0.440	0.160	0.207	1.088
Erysimum_senoneri	8	0	0.465	0.283	0.135	0.182	0.748
Erysimum_siliculosum	7	0	4.186	3.497	0.651	0.688	7.683
Erysimum_sintenisianum	--	1	0.427	0.274	0.065	0.153	0.701
Erysimum_sisymbrioides	10	0	0.327	0.163	0.116	0.164	0.490
Erysimum_smyrnaeum	7	0	0.289	0.131	0.110	0.159	0.420
Erysimum_spetae	--	0	3.203	2.648	0.515	0.555	5.851
Erysimum_stenophyllum	7	0	1.564	1.232	0.287	0.332	2.797
Erysimum_subulatum	14	1	0.473	0.317	0.075	0.156	0.790
Erysimum_thomsonii	--	0	1.295	0.999	0.250	0.295	2.294
Erysimum_uncinatifolium	--	0	0.644	0.438	0.160	0.207	1.082
Erysimum_virescens	--	1	0.757	0.580	0.137	0.177	1.336
Erysimum_virgatum	16	1	1.491	1.260	0.298	0.231	2.750
Erysimum_vitellinum	--	0	1.256	0.966	0.245	0.290	2.222
Erysimum_witmannii	7	0	3.070	2.534	0.496	0.537	5.604
Euclidium_syriacum	7	0	0.279	0.122	0.109	0.157	0.401
Eutrema_altaicum	--	0	0.279	0.122	0.109	0.157	0.401
Eutrema_botschantzevii	--	0	3.052	2.518	0.494	0.534	5.570
Eutrema_edwardsii	16	1	0.556	0.394	0.093	0.162	0.951
Eutrema_halophilum	7	0	3.052	2.518	0.494	0.534	5.570
Eutrema_heterophyllum	10	0	0.279	0.121	0.109	0.157	0.400
Eutrema_japonicum	14	1	0.399	0.248	0.059	0.151	0.647
Eutrema_penlandii	--	1	0.556	0.394	0.093	0.162	0.951
Eutrema_salsugineum	7	0	0.698	0.484	0.167	0.214	1.182

Eutrema_verticillatum	--	0	0.279	0.122	0.109	0.157	0.401
Exhalimolobos_berlandieri	--	0	0.356	0.188	0.120	0.168	0.544
Exhalimolobos_hispidulus	--	1	1.594	1.356	0.321	0.238	2.949
Exhalimolobos_palmeri	--	1	1.655	1.412	0.334	0.243	3.067
Exhalimolobos_parryi	12	1	0.510	0.351	0.083	0.159	0.862
Exhalimolobos_weddellii	16	1	1.655	1.412	0.334	0.243	3.067
Fezia_pterocarpa	11	0	0.279	0.122	0.109	0.157	0.400
Fibigia_clypeata	8	1	0.412	0.260	0.061	0.152	0.671
Fibigia_eriocarpa	8	1	0.412	0.260	0.061	0.152	0.671
Fibigia_lunarioides	8	1	0.359	0.211	0.050	0.148	0.570
Fibigia_macrocarpa	8	1	0.371	0.222	0.053	0.149	0.593
Fibigia_spathulata	8	1	0.359	0.211	0.050	0.148	0.570
Fibigia_suffruticosa	8	1	0.359	0.211	0.050	0.148	0.569
Fibigia_triquetra	8	1	0.359	0.211	0.050	0.148	0.570
Fibigia_umbellata	8	1	0.359	0.211	0.050	0.148	0.570
Fortuynia_garcini	--	0	0.279	0.122	0.109	0.157	0.401
Galitzkya_macrocarpa	8	1	0.363	0.215	0.051	0.148	0.578
Galitzkya_potaninii	--	1	0.363	0.215	0.051	0.148	0.578
Galitzkya_spathulata	8	1	0.359	0.211	0.050	0.148	0.569
Goldbachia_laevigata	14	1	0.360	0.212	0.050	0.148	0.572
Goldbachia_sabulosa	--	1	0.360	0.212	0.050	0.148	0.572
Halimolobos_adpressus	--	0	0.443	0.264	0.132	0.179	0.707
Halimolobos_diffusus	--	0	0.389	0.217	0.124	0.172	0.607
Halimolobos_elatus	--	0	0.550	0.356	0.147	0.194	0.906
Halimolobos_henricksonii	8	0	0.560	0.365	0.148	0.195	0.925
Halimolobos_jaegeri	--	0	0.301	0.141	0.112	0.160	0.443
Halimolobos_lasiolobus	8	0	0.560	0.365	0.148	0.195	0.925
Halimolobos_minutiflorus	--	0	0.443	0.264	0.132	0.179	0.707
Harmsiodoxa_blennodioides	--	0	0.279	0.122	0.109	0.157	0.401
Hesperidanthus_jaegeri	--	0	0.279	0.122	0.109	0.157	0.400
Hesperis_dinarica	14	1	0.363	0.215	0.051	0.148	0.578
Hesperis_laciniata	6	0	0.279	0.122	0.109	0.157	0.401
Hesperis_matronalis	12	1	0.473	0.317	0.075	0.156	0.789
Hesperis_rechingeri	--	0	0.279	0.122	0.109	0.157	0.401
Hesperis_sibirica	--	0	0.279	0.122	0.109	0.157	0.401
Hesperis_voronovii	--	1	0.473	0.317	0.075	0.156	0.789
Hirschfeldia_incana	8	0	0.279	0.122	0.109	0.157	0.401
Hormathophylla_baetica	--	1	1.379	1.157	0.274	0.222	2.536
Hormathophylla_cadevalliana	--	1	0.359	0.211	0.050	0.148	0.570
Hormathophylla_cochleata	--	1	1.379	1.157	0.274	0.222	2.536
Hormathophylla_halimifolia	16	1	0.373	0.224	0.053	0.149	0.597
Hormathophylla_lapeyrousiana	--	1	0.363	0.215	0.051	0.148	0.577
Hormathophylla_longicaulis	--	1	0.799	0.619	0.146	0.180	1.417
Hormathophylla_macrocarpa	--	1	0.373	0.224	0.053	0.149	0.597
Hormathophylla_purpurea	--	1	0.364	0.216	0.051	0.148	0.579
Hormathophylla_reverchonii	--	1	0.799	0.619	0.146	0.180	1.417
Hormathophylla_spinosa	--	1	0.361	0.213	0.050	0.148	0.575
Hornungia_alpina	6	0	0.308	0.147	0.113	0.161	0.456
Hornungia_petraea	6	0	0.279	0.122	0.109	0.157	0.401

Ianhedgea_minutiflora	14	1	0.398	0.247	0.058	0.151	0.644
Iodanthus_pinnatifidus	--	0	0.279	0.122	0.109	0.157	0.401
Irenepharsus_magicus	--	0	0.279	0.122	0.109	0.157	0.401
Isatis_armena	--	0	2.381	1.938	0.401	0.443	4.319
Isatis_brevipes	--	0	0.279	0.122	0.109	0.157	0.401
Isatis_buschiana	7	0	0.284	0.126	0.110	0.158	0.409
Isatis_cappadocica_subsp._besseri	--	1	0.402	0.251	0.059	0.151	0.653
Isatis_elegans	--	0	2.381	1.938	0.401	0.443	4.319
Isatis_emarginata	--	1	2.629	2.315	0.548	0.314	4.944
Isatis_gaubae	7	0	0.630	0.425	0.158	0.205	1.056
Isatis_gymnocarpa	--	0	0.279	0.122	0.109	0.157	0.401
Isatis_koeiei	--	0	0.283	0.125	0.109	0.158	0.407
Isatis_koelzii	--	0	0.630	0.425	0.158	0.205	1.056
Isatis_kotschyana	14	1	0.402	0.251	0.059	0.151	0.653
Isatis_leuconeura	7	0	0.284	0.126	0.110	0.158	0.409
Isatis_lusitanica	7	0	0.279	0.122	0.109	0.157	0.401
Isatis_microcarpa	7	0	0.279	0.122	0.109	0.157	0.401
Isatis_minima	21	1	2.578	2.268	0.536	0.310	4.846
Isatis_multicaulis	--	0	0.279	0.122	0.109	0.157	0.400
Isatis_pachycarpa	--	1	0.360	0.212	0.050	0.148	0.573
Isatis_quadrialata	--	0	0.279	0.122	0.109	0.157	0.401
Isatis_raphanifolia	7	0	0.283	0.125	0.109	0.158	0.407
Isatis_stocksii	14	1	2.608	2.296	0.543	0.312	4.904
Isatis_tinctoria	13	1	0.360	0.212	0.050	0.148	0.573
Isatis_trachycarpa	--	1	2.608	2.296	0.543	0.312	4.904
Isatis_violascens	--	1	2.629	2.315	0.548	0.314	4.944
Isatis_zarrei	--	0	0.279	0.122	0.109	0.157	0.401
Iskandera_alaica	--	0	0.279	0.122	0.109	0.157	0.401
Iskandera_hissarica	--	0	0.279	0.122	0.109	0.157	0.401
Leavenworthia_alabamica	11	1	3.374	3.005	0.711	0.368	6.379
Leavenworthia_crassa	11	1	3.374	3.005	0.711	0.368	6.379
Leavenworthia_torulosa	15	1	0.868	0.682	0.161	0.185	1.550
Leiospora_eriocalyx	7	0	2.412	1.965	0.405	0.447	4.377
Leiospora_exscapa	--	0	0.279	0.122	0.109	0.157	0.401
Leiospora_pamirica	--	0	2.412	1.965	0.405	0.447	4.377
Lepidium_aegrum	--	1	2.469	2.167	0.513	0.302	4.637
Lepidium_africanum	12	1	0.375	0.226	0.053	0.149	0.601
Lepidium_alyssoides	16	1	0.371	0.222	0.052	0.149	0.592
Lepidium_angustissimum	--	0	0.276	0.120	0.109	0.157	0.396
Lepidium_apetalum	16	1	0.381	0.232	0.055	0.150	0.613
Lepidium_aucheri	8	0	0.279	0.121	0.109	0.157	0.400
Lepidium_banksii	--	1	2.477	2.174	0.514	0.303	4.651
Lepidium_bonariense	24	1	0.365	0.217	0.051	0.148	0.582
Lepidium_campestre	8	0	0.280	0.122	0.109	0.157	0.402
Lepidium_chalepense	--	0	0.279	0.122	0.109	0.157	0.401
Lepidium_crassum	--	1	2.431	2.132	0.504	0.299	4.563
Lepidium_davisii	16	1	0.359	0.211	0.050	0.148	0.570
Lepidium_densiflorum	14	1	0.359	0.211	0.050	0.148	0.570
Lepidium_desvauxii	--	1	0.680	0.508	0.120	0.171	1.188

Lepidium_didymum	12	1	2.740	2.418	0.572	0.322	5.158
Lepidium_draba	33	1	0.458	0.303	0.072	0.155	0.761
Lepidium_flexicaule	--	1	2.403	2.105	0.498	0.297	4.508
Lepidium_foliosum	--	1	0.669	0.498	0.118	0.171	1.167
Lepidium_graminifolium	8	0	0.276	0.119	0.109	0.157	0.395
Lepidium_heterophyllum	16	1	0.554	0.392	0.093	0.162	0.947
Lepidium_hirtum	8	0	0.279	0.122	0.109	0.157	0.401
Lepidium_juvencum	--	1	2.418	2.120	0.501	0.298	4.537
Lepidium_lacerum	--	1	2.584	2.274	0.538	0.311	4.858
Lepidium_limenophylax	--	1	2.740	2.418	0.572	0.322	5.158
Lepidium_meyenii	32	1	0.359	0.211	0.050	0.148	0.569
Lepidium_montanum	16	1	2.703	2.383	0.564	0.319	5.086
Lepidium_naufragorum	72	1	0.359	0.211	0.050	0.148	0.570
Lepidium_navasii	16	1	0.359	0.211	0.050	0.148	0.569
Lepidium_nesophilum	--	1	0.686	0.514	0.122	0.172	1.200
Lepidium_obtusatum	--	1	2.326	2.034	0.481	0.292	4.360
Lepidium_oleraceum	36	1	2.384	2.088	0.494	0.296	4.472
Lepidium_oligodontum	--	1	2.442	2.142	0.507	0.300	4.584
Lepidium_panniforme	--	1	2.461	2.160	0.511	0.302	4.621
Lepidium_papilliferum	--	1	2.703	2.383	0.564	0.319	5.086
Lepidium_perfoliatum	8	0	0.279	0.122	0.109	0.157	0.401
Lepidium_phlebopetalum	--	0	0.279	0.122	0.109	0.157	0.401
Lepidium_rekohuense	--	1	2.360	2.066	0.489	0.294	4.426
Lepidium_rubtzovii	--	1	3.889	3.483	0.824	0.406	7.373
Lepidium_ruderale	13	1	3.889	3.483	0.824	0.406	7.373
Lepidium_sativum	11	1	0.359	0.211	0.050	0.148	0.570
Lepidium_seditiosum	--	1	2.452	2.151	0.509	0.301	4.604
Lepidium_sisymbrioides	--	1	0.387	0.237	0.056	0.150	0.625
Lepidium_solandri	--	1	0.387	0.237	0.056	0.150	0.625
Lepidium_squamatum	--	0	0.279	0.122	0.109	0.157	0.401
Lepidium_subcordatum	--	1	0.370	0.221	0.052	0.149	0.591
Lepidium_virginicum	12	1	0.371	0.222	0.052	0.149	0.592
Lepidostemon_glaricola	--	1	0.360	0.212	0.050	0.148	0.572
Leptaleum_filifolium	7	0	0.279	0.122	0.109	0.157	0.401
Litwinowia_tenuissima	7	0	0.279	0.122	0.109	0.157	0.401
Lyrocarpa_coulteri	20	1	0.359	0.211	0.050	0.148	0.569
Mancoa_bracteata	--	0	0.283	0.125	0.109	0.158	0.408
Mancoa_foliosa	--	0	0.283	0.125	0.109	0.158	0.408
Mathewsia_auriculata	--	1	0.360	0.212	0.050	0.148	0.573
Mathewsia_collina	--	1	0.395	0.244	0.058	0.151	0.639
Mathewsia_densifolia	--	1	0.370	0.221	0.052	0.149	0.591
Mathewsia_foliosa	--	1	0.360	0.212	0.050	0.148	0.573
Mathewsia_incana	--	1	0.395	0.244	0.058	0.151	0.639
Mathewsia_nivea	--	1	0.359	0.211	0.050	0.148	0.570
Matthiola_bucharica	--	0	0.387	0.215	0.124	0.172	0.601
Matthiola_capiomontiana	--	0	0.279	0.122	0.109	0.157	0.401
Matthiola_farinosa	6	0	0.279	0.122	0.109	0.157	0.401
Matthiola_fruticulosa	6	0	0.290	0.132	0.110	0.159	0.422
Matthiola_incana	6	0	0.914	0.671	0.197	0.244	1.585

Matthiola_longipetala	7	0	0.279	0.122	0.109	0.157	0.401
Matthiola_maderensis	7	0	0.285	0.127	0.110	0.158	0.413
Matthiola_oxyceras	--	0	0.279	0.122	0.109	0.157	0.401
Matthiola_parviflora	7	0	0.290	0.132	0.110	0.159	0.422
Matthiola_pulchella	--	0	0.285	0.127	0.110	0.158	0.413
Matthiola_rupestris	--	0	0.914	0.671	0.197	0.244	1.585
Matthiola_stoddartii	6	0	0.387	0.215	0.124	0.172	0.601
Menkea_sphaerocarpa	--	0	0.279	0.122	0.109	0.157	0.401
Microlepidium_pilosulum	--	0	0.279	0.122	0.109	0.157	0.401
Microstigma_brachycarpum	--	0	0.279	0.122	0.109	0.157	0.401
Moricandia_arvensis	12	1	2.583	2.272	0.537	0.310	4.855
Moricandia_foetida	14	1	0.359	0.211	0.050	0.148	0.570
Moricandia_foleyi	11	1	0.368	0.219	0.052	0.149	0.587
Moricandia_moricandioides	14	1	0.359	0.211	0.050	0.148	0.570
Moricandia_nitens	14	1	0.359	0.211	0.050	0.148	0.569
Moricandia_sinaica	14	1	0.359	0.211	0.050	0.148	0.570
Moricandia_spinosa	28	1	3.696	3.304	0.782	0.392	6.999
Moricandia_suffruticosa	10	1	3.696	3.304	0.782	0.392	6.999
Mostacillastrum_andinum	--	0	0.279	0.122	0.109	0.157	0.401
Mostacillastrum_elongatum	--	0	0.279	0.122	0.109	0.157	0.401
Mostacillastrum_gracile	--	0	0.279	0.122	0.109	0.157	0.401
Mostacillastrum_stenophyllum	--	0	0.279	0.122	0.109	0.157	0.401
Myagrum_perfoliatum	7	0	0.279	0.122	0.109	0.157	0.401
Nasturtiopsis_coronopifolia	7	0	0.279	0.122	0.109	0.157	0.400
Nasturtium_microphyllum	30	1	2.843	2.514	0.595	0.330	5.357
Nasturtium_officinale	16	1	2.843	2.514	0.595	0.330	5.357
Neotorularia_contortuplicata	7	0	0.304	0.143	0.112	0.161	0.447
Neotorularia_dentata	7	0	0.279	0.122	0.109	0.157	0.401
Neotorularia_korolkowii	--	0	0.279	0.122	0.109	0.157	0.401
Neotorularia_tetracmoides	7	0	0.279	0.122	0.109	0.157	0.401
Neotorularia_torulosa	10	1	0.640	0.472	0.112	0.168	1.113
Nerisyrenia_johnstonii	10	1	0.366	0.218	0.051	0.148	0.583
Nerisyrenia_linearifolia	10	1	0.366	0.218	0.051	0.148	0.583
Neslia_paniculata	10	1	0.359	0.211	0.050	0.148	0.571
Neuontobotrys_frutescens	--	0	0.279	0.122	0.109	0.157	0.401
Neuontobotrys_intricatissima	--	0	0.290	0.132	0.110	0.159	0.422
Neuontobotrys_lanata	--	0	2.513	2.052	0.419	0.461	4.564
Neuontobotrys_tarapacana	--	0	2.513	2.052	0.419	0.461	4.564
Nevada_holmgrenii	7	0	0.279	0.122	0.109	0.157	0.401
Octoceras_lehmannianum	7	0	0.279	0.122	0.109	0.157	0.401
Olimarabidopsis_cabulica	24	1	0.501	0.343	0.081	0.158	0.844
Olimarabidopsis_pumila	15	1	0.501	0.343	0.081	0.158	0.844
Olimarabidopsis_umbrosa	--	0	0.279	0.122	0.109	0.157	0.401
Ornithocarpa_torulosa	24	1	0.383	0.234	0.055	0.150	0.617
Orychophragmus_diffusus	--	0	0.279	0.122	0.109	0.157	0.401
Orychophragmus_hupehensis	--	0	0.280	0.123	0.109	0.157	0.402
Orychophragmus_taibaiensis	--	0	0.279	0.122	0.109	0.157	0.401
Orychophragmus_violaceus	24	1	0.393	0.243	0.057	0.150	0.636
Orychophragmus_ziguiensis	--	0	0.280	0.123	0.109	0.157	0.402

Pachycladon_cheesemanii	--	0	0.353	0.186	0.119	0.167	0.538
Pachycladon_enysii	--	0	1.317	1.019	0.253	0.298	2.336
Pachycladon_exile	--	0	0.353	0.186	0.119	0.167	0.538
Pachycladon_fastigiatum	--	0	1.317	1.019	0.253	0.298	2.336
Pachycladon_latisiliquum	--	0	0.279	0.122	0.109	0.157	0.401
Pachycladon_novaezelandiae	--	0	0.279	0.122	0.109	0.157	0.401
Pachycladon_radicatum	--	0	0.279	0.122	0.109	0.157	0.401
Pachycladon_stellatum	--	0	0.279	0.122	0.109	0.157	0.401
Pachycladon_wallii	--	0	0.279	0.122	0.109	0.157	0.401
Pachymitus_cardaminoides	--	0	0.279	0.122	0.109	0.157	0.401
Parlatoria_rostrata	7	0	0.279	0.122	0.109	0.157	0.401
Parrya_ajanensis	--	0	0.292	0.133	0.111	0.159	0.425
Parrya_alba	--	0	0.299	0.139	0.112	0.160	0.439
Parrya_albida	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_angrenica	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_arctica	8	0	2.437	1.987	0.408	0.451	4.424
Parrya_asperrima	--	0	0.281	0.123	0.109	0.157	0.404
Parrya_australis	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_darvazica	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_fruticulosa	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_kuramensis	--	0	0.546	0.353	0.146	0.194	0.899
Parrya_lancifolia	--	0	0.413	0.238	0.128	0.175	0.651
Parrya_longicarpa	--	0	0.488	0.302	0.138	0.186	0.790
Parrya_maidantalica	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_minjanensis	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_nauruaq	--	0	2.437	1.987	0.408	0.451	4.424
Parrya_nudicaulis	10	1	0.462	0.307	0.073	0.155	0.769
Parrya_nuratensis	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_pavlovii	--	0	0.281	0.123	0.109	0.157	0.404
Parrya_pinnatifida	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_popovii	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_pulvinata	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_runcinata	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_rydbergii	--	0	0.281	0.123	0.109	0.157	0.404
Parrya_saurica	--	0	0.413	0.238	0.128	0.175	0.651
Parrya_saxifraga	--	0	0.546	0.353	0.146	0.194	0.899
Parrya_schugnana	10	1	0.399	0.248	0.059	0.151	0.647
Parrya_simulatrix	--	0	0.285	0.127	0.110	0.158	0.412
Parrya_stenocarpa	--	0	0.298	0.139	0.112	0.160	0.437
Parrya_stenophylla	--	0	0.279	0.122	0.109	0.157	0.401
Parrya_subsiliquosa	--	0	0.488	0.302	0.138	0.186	0.790
Parrya_tianschanica	--	0	0.299	0.139	0.112	0.160	0.439
Parrya_turkestanica	7	0	0.281	0.123	0.109	0.157	0.404
Parrya_villosula	--	0	0.279	0.122	0.109	0.157	0.401
Paysonia_auriculata	8	1	0.365	0.216	0.051	0.148	0.581
Paysonia_densipila	8	1	2.627	2.314	0.547	0.314	4.941
Paysonia_grandiflora	9	1	0.359	0.211	0.050	0.148	0.570
Paysonia_lasiocarpa	7	1	0.363	0.214	0.051	0.148	0.577
Paysonia_lescurii	8	1	2.627	2.314	0.547	0.314	4.941

Paysonia_stonensis	8	1	2.168	1.888	0.447	0.280	4.055
Pegaeophyton_scapiflorum	--	0	0.279	0.122	0.109	0.157	0.401
Peltaria_alliacea	14	1	0.394	0.243	0.058	0.150	0.637
Pennellia_longifolia	8	0	0.279	0.122	0.109	0.157	0.401
Pennellia_micrantha	--	0	0.279	0.122	0.109	0.157	0.401
Petiniotia_purpurascens	--	0	0.279	0.122	0.109	0.157	0.401
Phaeonychium_kashgaricum	--	0	0.279	0.122	0.109	0.157	0.401
Phaeonychium_villosum	--	0	0.279	0.122	0.109	0.157	0.401
Phlegmatospermum_eremaeum	--	0	0.279	0.122	0.109	0.157	0.401
Phoenicaulis_cheiranthoides	14	1	0.441	0.287	0.068	0.154	0.728
Physaria_acutifolia	7	0	2.983	2.459	0.484	0.525	5.442
Physaria_argyraea	10	1	1.111	0.909	0.215	0.203	2.020
Physaria_bellii	4	0	3.067	2.531	0.496	0.536	5.597
Physaria_eriocarpa	--	0	0.289	0.130	0.110	0.159	0.419
Physaria_fendleri	7	0	1.427	1.114	0.268	0.313	2.541
Physaria_filiformis	7	0	0.279	0.122	0.109	0.157	0.401
Physaria_goodrichii	--	0	0.280	0.122	0.109	0.157	0.402
Physaria_gracilis	6	0	0.388	0.216	0.124	0.172	0.604
Physaria_hemiphysaria	--	0	0.280	0.123	0.109	0.157	0.403
Physaria_humilis	--	0	0.280	0.122	0.109	0.157	0.402
Physaria_intermedia	10	1	0.451	0.296	0.070	0.155	0.747
Physaria_johnstonii	--	0	0.279	0.122	0.109	0.157	0.401
Physaria_ludoviciana	--	0	0.279	0.122	0.109	0.157	0.401
Physaria_nelsonii	--	0	0.284	0.126	0.110	0.158	0.411
Physaria_newberryi	8	1	1.332	1.113	0.263	0.219	2.445
Physaria_occidentalis	5	0	0.279	0.122	0.109	0.157	0.401
Physaria_pallida	6	0	0.388	0.216	0.124	0.172	0.604
Physaria_pruinosa	--	0	0.279	0.122	0.109	0.157	0.401
Physaria_pycnantha	--	0	0.361	0.193	0.120	0.168	0.555
Physaria_rosei	--	0	0.279	0.122	0.109	0.157	0.401
Physaria_spatulata	5	0	0.361	0.193	0.120	0.168	0.555
Physaria_subumbellata	5	0	0.303	0.142	0.112	0.160	0.445
Physocardamum_davisii	--	1	0.359	0.211	0.050	0.148	0.569
Physoptychis_caspica	8	1	0.359	0.211	0.050	0.148	0.569
Planodes_virginica	--	0	0.279	0.122	0.109	0.157	0.400
Polyctenium_fremontii	--	0	0.279	0.122	0.109	0.157	0.401
Polypsecadium_grandiflorum	--	0	0.279	0.122	0.109	0.157	0.401
Polypsecadium_harmsianum	--	0	0.279	0.122	0.109	0.157	0.402
Polypsecadium_rusbyi	--	0	0.279	0.122	0.109	0.157	0.402
Pringlea_antiscorbutica	12	0	0.279	0.122	0.109	0.157	0.401
Pritzelago_alpina	6	0	0.308	0.147	0.113	0.161	0.456
Pseudocamelina_glaucophylla	7	0	0.279	0.122	0.109	0.157	0.401
Pseudoclausia_gracillima	--	0	0.279	0.122	0.109	0.157	0.401
Pseudoclausia_hispida	--	0	0.279	0.122	0.109	0.157	0.401
Pseudoclausia_mollissima	--	0	0.281	0.124	0.109	0.157	0.404
Pseudoclausia_olgae	--	0	0.279	0.122	0.109	0.157	0.401
Pseudoclausia_papillosa	--	0	0.279	0.122	0.109	0.157	0.401
Pseudoclausia_sarawschanica	--	0	0.281	0.124	0.109	0.157	0.404
Pseudoclausia_turkestanica	7	0	0.279	0.122	0.109	0.157	0.401

Pseudovesicaria_digitata	5	0	0.279	0.122	0.109	0.157	0.401
Psychine_stylosa	15	1	0.386	0.236	0.056	0.150	0.623
Raphanus_raphanistrum	9	0	0.279	0.122	0.109	0.157	0.401
Raphanus_sativus	--	0	0.279	0.122	0.109	0.157	0.401
Rapistrum_rugosum	7	0	0.279	0.122	0.109	0.157	0.401
Rhammatophyllum_afghanicum	--	0	0.279	0.122	0.109	0.157	0.401
Rhammatophyllum_frutex	--	0	0.282	0.124	0.109	0.158	0.406
Rhammatophyllum_gaudanense	--	0	0.282	0.124	0.109	0.158	0.406
Rhammatophyllum_ghoranum	--	0	0.280	0.123	0.109	0.157	0.403
Rhammatophyllum_kamelinii	--	0	0.279	0.122	0.109	0.157	0.401
Rhammatophyllum_pachyrhizum	--	0	0.279	0.122	0.109	0.157	0.401
Robeschia_schimperii	--	0	0.279	0.122	0.109	0.157	0.401
Rorippa_amphibia	15	1	4.070	3.651	0.864	0.419	7.721
Rorippa_austriaca	8	0	0.281	0.124	0.109	0.157	0.404
Rorippa_cantoniensis	8	0	0.334	0.170	0.117	0.165	0.504
Rorippa_indica	16	1	0.664	0.494	0.117	0.170	1.159
Rorippa_islandica	8	0	0.281	0.124	0.109	0.157	0.404
Rorippa_palustris	12	1	4.070	3.651	0.864	0.419	7.721
Rorippa_sylvestris	20	1	3.958	3.547	0.839	0.411	7.505
Rytidocarpus_moricandioides	14	1	0.360	0.212	0.050	0.148	0.573
Sandbergia_perplexa	7	0	0.279	0.122	0.109	0.157	0.401
Sandbergia_whitedii	--	0	0.279	0.122	0.109	0.157	0.401
Sarcodraba_dusenii	--	0	0.279	0.122	0.109	0.157	0.401
Savignya_parviflora	15	1	0.383	0.233	0.055	0.150	0.616
Scambopus_curvipes	--	0	0.279	0.122	0.109	0.157	0.401
Schimpera_arabica	7	0	0.279	0.122	0.109	0.157	0.401
Schizopetalon_arcuatum	--	1	0.359	0.211	0.050	0.148	0.569
Schizopetalon_bipinnatifidum	--	1	1.584	1.346	0.318	0.237	2.930
Schizopetalon_biseriatum	--	1	3.832	3.430	0.811	0.402	7.262
Schizopetalon_brachycarpum	--	1	1.947	1.683	0.398	0.264	3.629
Schizopetalon_dentatum	--	1	0.359	0.211	0.050	0.148	0.570
Schizopetalon_maritimum	--	1	0.408	0.256	0.061	0.151	0.664
Schizopetalon_rupestre	--	1	0.359	0.211	0.050	0.148	0.569
Schizopetalon_tenuifolium	--	1	3.832	3.430	0.811	0.402	7.262
Schizopetalon_walkeri	10	1	0.408	0.256	0.061	0.151	0.664
Schoenocrambe_linifolia	--	0	0.279	0.122	0.109	0.157	0.401
Schouwia_purpurea	18	1	0.376	0.227	0.054	0.149	0.602
Selenia_aurea	46	1	0.383	0.234	0.055	0.150	0.617
Selenia_dissecta	7	0	0.277	0.120	0.109	0.157	0.396
Selenia_jonesii	12	1	0.401	0.250	0.059	0.151	0.652
Sibara_angelorum	14	1	0.359	0.211	0.050	0.148	0.570
Sibara_deserti	14	1	0.359	0.211	0.050	0.148	0.570
Sibara_laxa	14	1	0.359	0.211	0.050	0.148	0.570
Sibaropsis_hammittii	14	1	0.359	0.211	0.050	0.148	0.570
Sinapidendron_frutescens	10	0	0.279	0.122	0.109	0.157	0.401
Sinapis_alba	12	0	0.279	0.122	0.109	0.157	0.401
Sinapis_arvensis	9	0	0.279	0.122	0.109	0.157	0.401
Sisymbrella_aspera	8	0	0.279	0.122	0.109	0.157	0.401
Sisymbriopsis_mollipila	--	0	0.279	0.122	0.109	0.157	0.401

Sisymbriopsis_yechengnica	--	0	0.279	0.122	0.109	0.157	0.401
Sisymbrium_aculeolatum	--	0	0.279	0.122	0.109	0.157	0.401
Sisymbrium_altissimum	7	0	0.279	0.122	0.109	0.157	0.401
Sisymbrium_austriacum	7	0	0.279	0.122	0.109	0.157	0.401
Sisymbrium_irio	9	1	0.416	0.264	0.062	0.152	0.679
Sisymbrium_loeselii	7	0	0.279	0.122	0.109	0.157	0.401
Sisymbrium_officinale	7	0	0.279	0.122	0.109	0.157	0.401
Sisymbrium_orientale	7	0	0.279	0.122	0.109	0.157	0.401
Sisymbrium_polymorphum	--	0	0.279	0.122	0.109	0.157	0.401
Smelowskia_alba	6	0	0.279	0.122	0.109	0.157	0.401
Smelowskia_americana	8	0	0.280	0.123	0.109	0.157	0.403
Smelowskia_annua	--	0	0.314	0.152	0.114	0.162	0.465
Smelowskia_bartholomewii	--	1	0.365	0.216	0.051	0.148	0.581
Smelowskia_bifurcata	6	0	0.279	0.122	0.109	0.157	0.401
Smelowskia_borealis	6	0	0.424	0.247	0.129	0.177	0.671
Smelowskia_calycina	8	0	0.280	0.123	0.109	0.157	0.403
Smelowskia_flavissima	--	0	0.279	0.122	0.109	0.157	0.401
Smelowskia_inopinata	--	0	0.279	0.122	0.109	0.157	0.401
Smelowskia_jacutica	12	1	0.397	0.246	0.058	0.151	0.642
Smelowskia_johnsonii	6	0	0.279	0.122	0.109	0.157	0.401
Smelowskia_media	8	0	0.424	0.247	0.129	0.177	0.671
Smelowskia_parryoides	9	1	0.363	0.215	0.051	0.148	0.578
Smelowskia_porsildii	11	1	0.411	0.259	0.061	0.152	0.670
Smelowskia_pyriformis	6	0	0.279	0.122	0.109	0.157	0.401
Smelowskia_sisymbrioides	--	0	0.314	0.152	0.114	0.162	0.465
Smelowskia_sophiifolia	10	1	0.363	0.215	0.051	0.148	0.578
Smelowskia_tibetica	12	1	0.365	0.216	0.051	0.148	0.581
Sobolewskia_caucasica	8	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_baiogoinensis	--	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_eurycarpa	7	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_flabellata	--	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_himalayensis	--	0	0.359	0.191	0.120	0.168	0.550
Solms-laubachia_jafrii	--	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_lanata	7	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_linearifolia	7	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_linearis	--	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_minor	7	0	0.281	0.123	0.109	0.157	0.404
Solms-laubachia_platycarpa	7	0	0.279	0.122	0.109	0.157	0.401
Solms-laubachia_pulcherrima	7	0	0.285	0.127	0.110	0.158	0.412
Solms-laubachia_retropilosa	10	1	0.404	0.253	0.060	0.151	0.657
Solms-laubachia_stewartii	--	0	0.359	0.191	0.120	0.168	0.550
Solms-laubachia_xerophyta	7	0	0.281	0.123	0.109	0.157	0.404
Solms-laubachia_zhongdianensis	--	0	0.285	0.127	0.110	0.158	0.412
Sphaerocardamum_compressum	--	0	0.279	0.122	0.109	0.157	0.401
Sphaerocardamum_divaricatum	--	0	0.319	0.157	0.115	0.163	0.476
Sphaerocardamum_fruticulosum	--	0	3.236	2.677	0.519	0.559	5.912
Sphaerocardamum_macropetalum	8	0	0.383	0.211	0.123	0.171	0.594
Sphaerocardamum_macrum	--	0	1.039	0.778	0.214	0.260	1.817
Sphaerocardamum_nesliiforme	--	0	0.279	0.122	0.109	0.157	0.401

Sphaerocardamum_ramosum	--	0	1.039	0.778	0.214	0.260	1.817
Sphaerocardamum_stellatum	8	0	3.236	2.677	0.519	0.559	5.912
Spryginia_falcata	--	0	0.279	0.122	0.109	0.157	0.401
Spryginia_winkleri	--	0	0.279	0.122	0.109	0.157	0.401
Stanleya_albescens	--	1	0.359	0.211	0.050	0.148	0.569
Stanleya_bipinnata	13	1	0.359	0.211	0.050	0.148	0.570
Stanleya_confertiflora	--	1	0.359	0.211	0.050	0.148	0.570
Stanleya_elata	12	1	0.359	0.211	0.050	0.148	0.569
Stanleya_pinnata	19	1	0.359	0.211	0.050	0.148	0.569
Stanleya_tomentosa	--	1	0.359	0.211	0.050	0.148	0.570
Stanleya_viridiflora	12	1	0.359	0.211	0.050	0.148	0.570
Stenopetalum_nutans	--	0	0.279	0.122	0.109	0.157	0.401
Sterigmostemum_acanthocarpum	7	0	0.279	0.122	0.109	0.157	0.401
Sterigmostemum_eglandulosum	--	0	4.263	3.564	0.662	0.699	7.827
Sterigmostemum_fuhaiense	--	0	0.279	0.122	0.109	0.157	0.401
Sterigmostemum_grandiflorum	--	0	1.971	1.584	0.344	0.387	3.556
Sterigmostemum_incanum	7	0	4.263	3.564	0.662	0.699	7.827
Sterigmostemum_longistylum	--	0	0.279	0.122	0.109	0.157	0.401
Sterigmostemum_matthioloides	--	0	0.279	0.122	0.109	0.157	0.401
Sterigmostemum_ramosissimum	7	0	0.279	0.122	0.109	0.157	0.401
Sterigmostemum_sulphureum	7	0	0.456	0.275	0.134	0.181	0.732
Sterigmostemum_tomentosum	--	0	0.279	0.122	0.109	0.157	0.401
Sterigmostemum_violaceum	--	0	0.456	0.275	0.134	0.181	0.732
Streptanthella_longirostris	10	1	0.359	0.211	0.050	0.148	0.570
Streptanthus_barbatus	21	1	0.359	0.211	0.050	0.148	0.570
Streptanthus_barbiger	14	1	0.368	0.219	0.052	0.149	0.588
Streptanthus_batrachopus	14	1	0.369	0.220	0.052	0.149	0.589
Streptanthus_bernardinus	10	1	0.376	0.227	0.054	0.149	0.602
Streptanthus_brachiatus	14	1	2.013	1.744	0.413	0.269	3.757
Streptanthus_bracteatus	--	1	0.364	0.216	0.051	0.148	0.580
Streptanthus_breweri	14	1	0.467	0.311	0.074	0.156	0.778
Streptanthus_callistus	14	1	0.367	0.219	0.052	0.148	0.586
Streptanthus_campestris	--	1	0.376	0.227	0.054	0.149	0.602
Streptanthus_carinatus	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_cooperi	--	1	0.359	0.211	0.050	0.148	0.570
Streptanthus_cordatus	14	1	0.359	0.211	0.050	0.148	0.570
Streptanthus_cutleri	14	1	0.364	0.216	0.051	0.148	0.580
Streptanthus_diversifolius	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_drepanoides	14	1	0.467	0.311	0.074	0.156	0.778
Streptanthus_farnsworthianus	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_fenestratus	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_glandulosus	14	1	0.360	0.212	0.050	0.148	0.572
Streptanthus_hesperidis	14	1	0.360	0.212	0.050	0.148	0.572
Streptanthus_hispidus	14	1	0.367	0.219	0.052	0.148	0.586
Streptanthus_howellii	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_hyacinthoides	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_longisiliquus	--	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_maculatus	--	1	0.359	0.211	0.050	0.148	0.570
Streptanthus_morrisonii	14	1	3.609	3.223	0.763	0.386	6.832

Streptanthus_petiolaris	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_platycarpus	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_polygaloides	14	1	0.359	0.211	0.050	0.148	0.570
Streptanthus_tortuosus	14	1	0.359	0.211	0.050	0.148	0.569
Streptanthus_vernalis	--	1	3.609	3.223	0.763	0.386	6.832
Succowia_balearica	17	1	0.375	0.226	0.054	0.149	0.602
Synstemon_petrovii	--	0	0.286	0.128	0.110	0.158	0.414
Synthlipsis_greggii	10	1	0.359	0.211	0.050	0.148	0.570
Tchihatchewia_isatidea	--	0	0.279	0.122	0.109	0.157	0.401
Tetracme_contorta	--	0	0.279	0.122	0.109	0.157	0.401
Tetracme_quadricornis	7	0	0.279	0.122	0.109	0.157	0.401
Tetracme_secunda	--	0	0.279	0.122	0.109	0.157	0.401
Thelypodiopsis_ambigua	11	1	0.359	0.211	0.050	0.148	0.569
Thelypodiopsis_elegans	--	1	0.359	0.211	0.050	0.148	0.569
Thelypodiopsis_vaseyi	10	1	0.359	0.211	0.050	0.148	0.570
Thelypodium_crispum	13	1	0.359	0.211	0.050	0.148	0.569
Thelypodium_flexuosum	13	1	0.359	0.211	0.050	0.148	0.570
Thelypodium_integrifolium	13	1	0.426	0.273	0.065	0.153	0.699
Thelypodium_laciniatum	13	1	0.359	0.211	0.050	0.148	0.570
Thelypodium_sagittatum	13	1	0.426	0.273	0.065	0.153	0.699
Thlaspi_alpinum	--	0	0.367	0.198	0.121	0.169	0.565
Thlaspi_arvense	7	0	0.279	0.122	0.109	0.157	0.401
Thlaspi_bulbosum	7	0	0.279	0.122	0.109	0.157	0.401
Thlaspi_calaminare	--	0	0.361	0.193	0.120	0.168	0.554
Thlaspi_cepaeifolium	--	0	0.367	0.198	0.121	0.169	0.565
Thlaspi_densiflorum	--	0	0.279	0.122	0.109	0.157	0.401
Thlaspi_erraticum	--	1	0.367	0.218	0.052	0.148	0.585
Thlaspi_goesingense	16	1	0.748	0.571	0.135	0.176	1.319
Thlaspi_jankae	12	1	0.748	0.571	0.135	0.176	1.319
Thlaspi_montanum	10	1	0.402	0.251	0.059	0.151	0.653
Thlaspi_nevadense	14	1	0.421	0.269	0.064	0.152	0.690
Thlaspi_perfoliatum	17	1	0.367	0.218	0.052	0.148	0.585
Thlaspi_praecox	4	0	0.286	0.128	0.110	0.158	0.413
Thysanocarpus_conchuliferus	--	1	0.359	0.211	0.050	0.148	0.570
Thysanocarpus_curvipes	14	1	0.361	0.213	0.050	0.148	0.573
Thysanocarpus_erectus	--	1	0.359	0.211	0.050	0.148	0.570
Thysanocarpus_laciniatus	--	1	0.361	0.213	0.050	0.148	0.573
Thysanocarpus_radians	--	1	0.359	0.211	0.050	0.148	0.570
Thysanocarpus_rigidus	--	1	0.359	0.211	0.050	0.148	0.570
Tropidocarpum_gracile	8	0	0.279	0.122	0.109	0.157	0.401
Turritis_glabra	8	0	0.279	0.122	0.109	0.157	0.401
Turritis_laxa	6	0	0.279	0.122	0.109	0.157	0.401
Vella_anremerica	17	1	0.359	0.211	0.050	0.148	0.569
Vella_aspera	--	1	0.359	0.211	0.050	0.148	0.569
Vella_bourgaeana	17	1	0.359	0.211	0.050	0.148	0.570
Vella_castrilensis	34	1	0.359	0.211	0.050	0.148	0.569
Vella_lucentina	17	1	0.359	0.211	0.050	0.148	0.569
Vella_mairei	34	1	0.359	0.211	0.050	0.148	0.569
Vella_pseudocytisus_subsp._glabrata	--	1	0.359	0.211	0.050	0.148	0.569

Vella_spinosa	17	1	0.360	0.212	0.050	0.148	0.572
Warea_cuneifolia	--	1	0.359	0.211	0.050	0.148	0.570
Weberbauera_herzogii	--	1	0.359	0.211	0.050	0.148	0.569
Weberbauera_peruviana	--	1	0.359	0.211	0.050	0.148	0.569
Weberbauera_rosulans	--	1	0.359	0.211	0.050	0.148	0.569
Werdermannia_macrostachya	--	0	0.279	0.122	0.109	0.157	0.401
Werdermannia_mendocina	--	0	0.279	0.122	0.109	0.157	0.401
Yinshania_acutangula_subsp._acutangula	--	0	0.284	0.126	0.110	0.158	0.409
Yinshania_henryi	6	0	2.331	1.894	0.394	0.436	4.225
Yinshania_zayuensis	--	0	2.331	1.894	0.394	0.436	4.225
Zerdana_anchonioides	7	0	0.279	0.122	0.109	0.157	0.401
Zilla_spinosa_subsp._macroptera	--	0	0.279	0.122	0.109	0.157	0.401
Zuvanda_crenulata	--	0	0.319	0.156	0.114	0.163	0.475
Zuvanda_exacoides	--	0	0.319	0.156	0.114	0.163	0.475

Table S3.3 Summary of 12 different trait-dependent diversification models (both BiSSE and HiSSE)

MODEL	HIDDEN STATES	τ	ε	q	lnLik	AIC	ΔAIC	WEIGHTS
BiSSE_1	Absent	Equal	Equal	Equal	-3868.186	7742.371	1130.222	3.733E-246
BiSSE_2	Absent	Free	Free	Equal	-3868.158	7744.317	1132.168	1.411E-246
BiSSE_3	Absent	Equal	Equal	Free	-3867.771	7743.541	1131.392	2.080E-246
BiSSE_4	Absent	Free	Free	Free	-3867.516	7745.033	1132.884	9.867E-247
HiSSE_1	Present for diploids and polyploids	Free	Free	Equal	-3644.154	7306.307	694.158	1.829E-151
HiSSE_2	Present for diploids	Free	Free	Equal	-3609.434	7232.869	620.720	1.619E-135
HiSSE_3	Present for diploids	Free	Free	Equal	-3544.090	7102.180	490.031	3.872E-107
HiSSE_4	Present for diploids and polyploids	Free	Free	Free	-3286.074	6612.149	0.000	9.926E-01
HiSSE_5	Present for diploids	Free	Free	Free	-3458.089	6936.177	324.028	4.315E-71
HiSSE_6	Present for polyploids	Free	Free	Free	-3793.601	7607.203	995.054	8.386E-217
HiSSE-CID2	Present for diploids and polyploids	Equal	Equal	Equal	-3298.967	6621.934	9.786	7.445E-03
HiSSE-CID4	Present for diploids and polyploids	Equal	Equal	Equal within observed and hidden	-3490.705	6999.409	387.260	8.021E-85

Table S3.4 Summary statistics for macroevolutionary parameters associated with observed (diploid [D] and polyploid [P]) and hidden (A and B) states.

PARAMETER	STATES		Mean	Interquartile	
				25%	75%
SPECIATION	OBSERVED	DIPLOID (D)	0.715	0.279	0.609
		POLYPLOID (P)	1.063	0.360	1.325
	HIDDEN	D-A	0.147	0.143	0.150
		D-B	4.672	4.452	4.740
		P-A	0.166	0.150	0.177
		P-B	6.478	6.003	6.868
EXTINCTION	OBSERVED	DIPLOID (D)	0.499	0.122	0.407
		POLYPLOID (P)	0.864	0.212	1.106
	HIDDEN	D-A	0.016	0.015	0.017
		D-B	3.398	3.162	3.573
		P-A	0.000	0.000	0.000
		P-B	6.576	6.015	7.219
NET DIVERSIFICATION	OBSERVED	DIPLOID (D)	0.216	0.152	0.202
		POLYPLOID (P)	0.199	0.148	0.218
	HIDDEN	D-A	0.130	0.128	0.133
		D-B	1.274	1.289	1.168
		P-A	0.166	0.150	0.177
		P-B	-0.098	-0.012	-0.351
TURNOVER	OBSERVED	DIPLOID (D)	1.214	0.401	1.015
		POLYPLOID (P)	1.927	0.573	2.431
	HIDDEN	D-A	0.112	0.105	0.115
		D-B	0.727	0.710	0.754
		P-A	0.001	0.001	0.001
		P-B	1.015	1.002	1.051

Table S3.5 Summary of polyploid richness within each clade including clade age, richness, diversification rates, and proportion of polyploids.

GENUS	STEM AGE	CROWN AGE	SPECIES TREE	RICHNESS	S0	S0.5	S0.9	C0	C0.5	C0.9	DR MEAN	SUBTREE	TOTAL RICHNESS	RAW RICHNESS
Aethionema	33.514	12.010	5	57	0.121	0.100	0.056	0.279	0.256	0.153	0.084	0.000	0.000	0.000
Alliaria	14.741	14.724	2	2	0.047	0.028	0.006	0.000	0.000	0.000	0.062	0.405	0.405	0.527
Alyssoides	4.362	4.345	2	2	0.159	0.093	0.022	0.000	0.000	0.000	0.187	0.405	0.405	0.527
Alyssopsis	3.362	3.331	2	2	0.206	0.121	0.028	0.000	0.000	0.000	0.201	0.405	0.405	0.527
Alyssum	24.049	23.879	107	195	0.219	0.191	0.125	0.192	0.180	0.124	0.447	0.693	0.437	1.737
Ammosperma	21.983	-	1	2	0.032	0.018	0.004	-	-	-	0.044	0.000	0.000	0.000
Anastatica	5.743	-	1	1	0.000	0.000	0.000	-	-	-	0.083	0.000	0.000	0.000
Anelsonia	5.921	-	1	1	0.000	0.000	0.000	-	-	-	0.145	0.000	0.000	0.000
Arabidella	13.474	-	1	7	0.144	0.103	0.035	-	-	-	0.070	0.693	0.134	0.527
Arabidopsis	13.119	11.910	14	14	0.201	0.154	0.063	0.163	0.144	0.065	0.348	0.654	0.619	1.271
Arabis	18.195	18.186	81	112	0.259	0.222	0.137	0.221	0.206	0.134	1.062	0.674	0.529	1.681
Arcyosperma	4.681	-	1	1	0.000	0.000	0.000	-	-	-	0.073	0.000	0.000	0.000
Armoracia	15.141	-	1	3	0.073	0.046	0.012	-	-	-	0.056	0.693	0.288	0.527
Aschersoniodoxa	8.561	7.811	2	3	0.128	0.081	0.021	0.052	0.045	0.015	0.091	0.000	0.000	0.000
Asperuginoides	26.491	-	1	1	0.000	0.000	0.000	-	-	-	0.037	0.693	0.693	0.527
Athysanus	6.894	4.501	2	24	0.461	0.366	0.173	0.552	0.496	0.254	0.137	0.000	0.000	0.000
Aubrieta	18.288	2.989	2	12	0.136	0.102	0.041	0.599	0.527	0.230	0.089	0.000	0.000	0.000
Aurinia	15.131	15.118	8	9	0.145	0.106	0.039	0.099	0.087	0.035	0.261	0.693	0.636	1.162
Baimashania	4.362	4.329	2	2	0.159	0.093	0.022	0.000	0.000	0.000	0.149	0.000	0.000	0.000
Barbarea	10.581	2.431	3	27	0.311	0.249	0.121	1.071	0.966	0.505	0.190	0.000	0.000	0.000
Berteroa	11.008	1.108	4	5	0.146	0.100	0.031	0.827	0.707	0.252	0.315	0.693	0.588	0.959
Biscutella	21.427	9.322	8	53	0.185	0.154	0.085	0.352	0.322	0.190	0.150	0.000	0.000	0.000
Bivonaea	25.251	-	1	1	0.000	0.000	0.000	-	-	-	0.039	0.000	0.000	0.000
Blennodia	6.258	4.324	2	2	0.111	0.065	0.015	0.000	0.000	0.000	0.157	0.405	0.405	0.527
Boechera	5.921	5.910	64	110	0.794	0.678	0.418	0.678	0.631	0.410	0.842	0.172	0.104	1.271
Bornmuellera	4.825	4.808	4	7	0.403	0.287	0.097	0.261	0.225	0.086	0.197	0.693	0.452	0.959
Borodinia	10.686	0.018	2	2	0.065	0.038	0.009	0.000	0.000	0.000	0.153	0.000	0.000	0.000
Botschantzevia	4.362	-	1	1	0.000	0.000	0.000	-	-	-	0.110	0.000	0.000	0.000
Brassica	21.850	21.832	23	39	0.168	0.137	0.072	0.136	0.124	0.069	0.130	0.197	0.121	1.027
Braya	3.911	3.640	14	14	0.675	0.515	0.213	0.535	0.472	0.214	0.967	0.693	0.693	1.311
Bunias	18.701	-	1	3	0.059	0.037	0.010	-	-	-	0.049	0.693	0.288	0.527
Cakile	10.160	4.449	4	6	0.176	0.123	0.040	0.247	0.212	0.078	0.241	0.223	0.154	0.527
Calepina	15.196	-	1	1	0.000	0.000	0.000	-	-	-	0.048	0.693	0.693	0.527
Callothlaspi	11.377	-	1	1	0.000	0.000	0.000	-	-	-	0.070	0.000	0.000	0.000
Calymmatium	4.411	-	1	2	0.157	0.092	0.022	-	-	-	0.101	0.000	0.000	0.000
Camelina	8.544	2.848	4	11	0.281	0.210	0.081	0.599	0.524	0.224	0.404	0.693	0.310	0.959
Capsella	9.346	1.631	4	5	0.172	0.118	0.036	0.562	0.481	0.171	0.326	0.693	0.588	0.959
Cardamine	13.281	13.267	93	203	0.400	0.348	0.230	0.348	0.327	0.226	0.350	0.390	0.188	1.560
Carrichtera	13.648	-	1	1	0.000	0.000	0.000	-	-	-	0.055	0.000	0.000	0.000
Catenulina	6.406	-	1	1	0.000	0.000	0.000	-	-	-	0.122	0.000	0.000	0.000
Catolobus	9.964	-	1	1	0.000	0.000	0.000	-	-	-	0.092	0.000	0.000	0.000
Caulanthus	7.789	7.150	13	17	0.364	0.282	0.123	0.299	0.266	0.126	0.262	0.693	0.568	1.292
Chalcanthus	15.044	-	1	1	0.000	0.000	0.000	-	-	-	0.048	0.000	0.000	0.000
Chaunanthus	6.083	5.550	2	4	0.228	0.151	0.043	0.125	0.107	0.036	0.166	0.693	0.405	0.741
Chilocardamum	2.368	-	1	4	0.585	0.387	0.111	-	-	-	0.237	0.000	0.000	0.000
Chlorocrambe	3.966	-	1	1	0.000	0.000	0.000	-	-	-	0.187	0.693	0.693	0.527

Chorispora	14.889	14.880	9	11	0.161	0.120	0.047	0.115	0.100	0.043	0.218	0.105	0.087	0.527
Christolea	5.209	-	1	2	0.133	0.078	0.018	-	-	-	0.129	0.000	0.000	0.000
Chrysochamela	9.346	-	1	3	0.118	0.074	0.020	-	-	-	0.099	0.693	0.288	0.527
Cithareloma	3.264	-	1	3	0.337	0.212	0.056	-	-	-	0.122	0.000	0.000	0.000
Clastopus	3.322	-	1	2	0.209	0.122	0.029	-	-	-	0.171	0.693	0.405	0.527
Clausia	10.238	3.267	5	5	0.157	0.107	0.033	0.280	0.240	0.085	0.395	0.693	0.693	1.027
Clypeola	19.344	12.278	5	9	0.114	0.083	0.030	0.123	0.107	0.043	0.096	0.693	0.442	1.027
Cochlearia	14.556	14.548	10	18	0.199	0.155	0.068	0.151	0.135	0.065	0.422	0.000	0.000	0.000
Coincya	21.004	-	1	6	0.085	0.060	0.019	-	-	-	0.046	0.000	0.000	0.000
Conringia	19.659	18.542	2	6	0.091	0.064	0.021	0.059	0.051	0.019	0.050	0.000	0.000	0.000
Cordylocarpus	16.581	-	1	1	0.000	0.000	0.000	-	-	-	0.056	0.000	0.000	0.000
Crambe	21.398	-	1	9	0.103	0.075	0.027	-	-	-	0.045	0.693	0.105	0.527
Crucihimalaya	14.627	5.157	8	9	0.150	0.110	0.040	0.292	0.254	0.103	0.359	0.000	0.000	0.000
Cryptospora	6.406	-	1	5	0.251	0.172	0.053	-	-	-	0.122	0.000	0.000	0.000
Cuphonotus	4.042	-	1	2	0.171	0.100	0.024	-	-	-	0.113	0.000	0.000	0.000
Cusickiella	9.138	9.125	2	2	0.076	0.044	0.010	0.000	0.000	0.000	0.103	0.000	0.000	0.000
Cyphocardamum	16.616	-	1	1	0.000	0.000	0.000	-	-	-	0.049	0.000	0.000	0.000
Dactylocardamum	3.727	-	1	1	0.000	0.000	0.000	-	-	-	0.156	0.000	0.000	0.000
Degenia	7.456	-	1	1	0.000	0.000	0.000	-	-	-	0.081	0.693	0.693	0.527
Delpinophytum	23.409	-	1	1	0.000	0.000	0.000	-	-	-	0.041	0.000	0.000	0.000
Dendroarabis	18.195	-	1	1	0.000	0.000	0.000	-	-	-	0.051	0.693	0.693	0.527
Descurainia	14.007	8.527	36	52	0.282	0.234	0.129	0.382	0.350	0.206	1.065	0.105	0.074	0.959
Diceratella	8.965	-	1	11	0.267	0.200	0.077	-	-	-	0.087	0.000	0.000	0.000
Dichasianthus	10.060	-	1	1	0.000	0.000	0.000	-	-	-	0.076	0.000	0.000	0.000
Didesmus	10.160	-	1	2	0.068	0.040	0.009	-	-	-	0.073	0.000	0.000	0.000
Didymophysa	4.568	4.072	2	2	0.152	0.089	0.021	0.000	0.000	0.000	0.152	0.000	0.000	0.000
Dilophia	9.538	-	1	1	0.000	0.000	0.000	-	-	-	0.097	0.000	0.000	0.000
Dimorphocarpa	8.701	-	1	4	0.159	0.105	0.030	-	-	-	0.076	0.693	0.223	0.527
Diplotaxis	22.378	22.324	5	32	0.155	0.125	0.063	0.124	0.113	0.061	0.052	0.000	0.000	0.000
Dipoma	14.619	-	1	1	0.000	0.000	0.000	-	-	-	0.066	0.000	0.000	0.000
Diptychocarpus	13.119	-	1	1	0.000	0.000	0.000	-	-	-	0.061	0.000	0.000	0.000
Dithyrea	7.731	-	1	2	0.090	0.052	0.012	-	-	-	0.095	0.693	0.405	0.527
Dontostemon	10.238	7.766	13	13	0.251	0.190	0.077	0.241	0.212	0.095	0.182	0.074	0.074	0.527
Draba	8.860	8.853	243	376	0.669	0.591	0.412	0.592	0.559	0.407	1.259	0.293	0.111	1.570
Drabastrum	2.711	-	1	1	0.000	0.000	0.000	-	-	-	0.151	0.000	0.000	0.000
Dryopetalon	3.966	-	1	8	0.524	0.379	0.134	-	-	-	0.187	0.693	0.118	0.527
Elburzia	4.568	-	1	1	0.000	0.000	0.000	-	-	-	0.110	0.000	0.000	0.000
Englerocharis	4.492	-	1	2	0.154	0.090	0.021	-	-	-	0.141	0.693	0.405	0.527
Eremoblastus	11.928	-	1	1	0.000	0.000	0.000	-	-	-	0.070	0.000	0.000	0.000
Eremophyton	17.703	-	1	1	0.000	0.000	0.000	-	-	-	0.049	0.000	0.000	0.000
Erophila	11.285	2.388	3	3	0.097	0.061	0.016	0.170	0.147	0.049	0.160	0.000	0.000	0.000
Eruca	1.607	-	1	4	0.863	0.570	0.163	-	-	-	0.120	0.693	0.223	0.527
Erucaria	13.782	-	1	10	0.167	0.124	0.047	-	-	-	0.058	0.000	0.000	0.000
Erucastrum	20.234	-	1	25	0.159	0.127	0.060	-	-	-	0.047	0.693	0.039	0.527
Erysimum	13.933	2.001	134	226	0.389	0.340	0.227	2.362	2.221	1.552	1.328	0.270	0.148	1.528
Euclidium	8.638	-	1	1	0.000	0.000	0.000	-	-	-	0.100	0.000	0.000	0.000
Eutrema	11.577	11.562	9	27	0.285	0.228	0.111	0.225	0.203	0.106	0.187	0.288	0.105	0.870
Exhalimolobos	8.760	1.135	5	9	0.251	0.184	0.067	1.325	1.153	0.470	0.391	0.588	0.368	0.959
Farsetia	18.484	12.387	7	27	0.178	0.143	0.069	0.210	0.189	0.099	0.150	0.000	0.000	0.000

Fezia	18.284	-	1	1	0.000	0.000	0.000	-	-	-	0.052	0.000	0.000	0.000
Fibigia	4.362	4.347	8	13	0.588	0.446	0.181	0.431	0.379	0.169	0.311	0.693	0.480	1.162
Fortuynia	4.212	-	1	2	0.165	0.096	0.023	-	-	-	0.078	0.000	0.000	0.000
Galitzkya	11.008	4.266	3	3	0.100	0.063	0.017	0.095	0.082	0.028	0.153	0.693	0.693	0.870
Goldbachia	15.196	7.576	2	5	0.106	0.072	0.022	0.121	0.103	0.037	0.071	0.693	0.336	0.741
Halimolobos	5.425	5.391	7	8	0.383	0.277	0.098	0.257	0.223	0.088	0.492	0.000	0.000	0.000
Harmsiodoxa	10.120	-	1	3	0.109	0.068	0.018	-	-	-	0.095	0.000	0.000	0.000
Heldreichia	16.723	2.581	4	4	0.083	0.055	0.016	0.269	0.230	0.078	0.168	0.000	0.000	0.000
Hesperidanthus	9.562	-	1	5	0.168	0.115	0.035	-	-	-	0.086	0.000	0.000	0.000
Hesperis	5.172	5.158	6	47	0.744	0.615	0.333	0.612	0.560	0.324	0.235	0.405	0.062	0.870
Hilliella	24.390	18.022	10	10	0.094	0.070	0.026	0.089	0.078	0.033	0.264	0.000	0.000	0.000
Hirschfeldia	18.270	-	1	1	0.000	0.000	0.000	-	-	-	0.050	0.000	0.000	0.000
Hormathophylla	14.168	3.248	10	10	0.163	0.120	0.045	0.496	0.433	0.181	0.352	0.693	0.693	1.223
Ianhedgea	14.987	-	1	1	0.000	0.000	0.000	-	-	-	0.056	0.693	0.693	0.527
Iberis	24.116	8.790	5	27	0.137	0.109	0.053	0.296	0.267	0.140	0.158	0.000	0.000	0.000
Iodanthus	13.281	-	1	1	0.000	0.000	0.000	-	-	-	0.064	0.000	0.000	0.000
Ionopsidium	14.556	14.495	6	6	0.123	0.086	0.028	0.076	0.065	0.024	0.093	0.000	0.000	0.000
Irenepharsus	11.514	-	1	3	0.095	0.060	0.016	-	-	-	0.082	0.000	0.000	0.000
Isatis	12.722	12.703	24	79	0.343	0.290	0.171	0.289	0.268	0.167	0.309	0.318	0.108	1.195
Iskandera	14.568	12.934	2	2	0.048	0.028	0.007	0.000	0.000	0.000	0.068	0.000	0.000	0.000
Kernera	4.894	0.693	2	2	0.142	0.083	0.019	0.000	0.000	0.000	0.128	0.000	0.000	0.000
Lachnocapsa	10.050	-	1	1	0.000	0.000	0.000	-	-	-	0.071	0.000	0.000	0.000
Leavenworthia	11.831	0.631	8	8	0.176	0.127	0.045	2.197	1.903	0.754	0.932	0.693	0.318	0.870
Leiospora	10.060	2.504	3	6	0.178	0.125	0.040	0.439	0.377	0.139	0.211	0.000	0.000	0.000
Lepidium	16.616	16.605	46	232	0.328	0.286	0.192	0.286	0.269	0.189	1.002	0.590	0.148	1.534
Lepidostemon	3.911	-	1	6	0.458	0.320	0.104	-	-	-	0.133	0.693	0.154	0.527
Leptaleum	11.889	-	1	1	0.000	0.000	0.000	-	-	-	0.071	0.000	0.000	0.000
Litwinowia	9.425	-	1	1	0.000	0.000	0.000	-	-	-	0.088	0.000	0.000	0.000
Lobularia	15.943	6.223	10	10	0.144	0.107	0.040	0.259	0.226	0.094	0.451	0.000	0.000	0.000
Lunaria	23.946	23.048	2	3	0.046	0.029	0.008	0.018	0.015	0.005	0.041	0.000	0.000	0.000
Lyrocarpa	4.158	-	1	3	0.264	0.167	0.044	-	-	-	0.158	0.693	0.288	0.527
Macropodium	18.666	7.036	2	2	0.037	0.022	0.005	0.000	0.000	0.000	0.068	0.000	0.000	0.000
Malcolmia	27.642	27.631	9	31	0.124	0.100	0.050	0.099	0.090	0.048	0.096	0.000	0.000	0.000
Mancoa	8.760	1.248	2	8	0.237	0.172	0.061	1.111	0.962	0.381	0.166	0.000	0.000	0.000
Maresia	13.704	-	1	3	0.080	0.051	0.013	-	-	-	0.057	0.000	0.000	0.000
Mathewsia	5.494	5.362	6	10	0.419	0.310	0.117	0.300	0.262	0.110	0.287	0.693	0.470	1.080
Matthiola	17.036	17.028	12	49	0.228	0.189	0.103	0.188	0.172	0.100	0.184	0.000	0.000	0.000
Megacarpaea	14.674	-	1	9	0.150	0.110	0.040	-	-	-	0.049	0.000	0.000	0.000
Megadenia	16.723	-	1	1	0.000	0.000	0.000	-	-	-	0.050	0.000	0.000	0.000
Menkea	4.042	-	1	6	0.443	0.310	0.100	-	-	-	0.113	0.000	0.000	0.000
Menonvillea	22.277	21.175	16	24	0.143	0.113	0.054	0.117	0.105	0.054	0.204	0.000	0.000	0.000
Microlepidium	10.120	-	1	2	0.068	0.040	0.009	-	-	-	0.095	0.000	0.000	0.000
Microstigma	16.404	-	1	3	0.067	0.042	0.011	-	-	-	0.055	0.000	0.000	0.000
Microthlaspi	18.682	18.667	5	5	0.086	0.059	0.018	0.049	0.042	0.015	0.109	0.000	0.000	0.000
Morettia	8.965	8.953	3	3	0.123	0.077	0.020	0.045	0.039	0.013	0.148	0.000	0.000	0.000
Mostacillastrum	3.335	3.324	4	17	0.849	0.659	0.286	0.644	0.572	0.272	0.290	0.000	0.000	0.000
Myagrum	14.721	-	1	1	0.000	0.000	0.000	-	-	-	0.053	0.000	0.000	0.000
Nasturtiopsis	18.299	-	1	2	0.038	0.022	0.005	-	-	-	0.050	0.000	0.000	0.000
Nasturtium	15.177	0.014	2	10	0.152	0.112	0.042	117.787	102.819	43.017	0.112	0.693	0.182	0.741

Neotorularia	9.414	9.260	5	11	0.255	0.190	0.074	0.184	0.161	0.069	0.149	0.182	0.087	0.527
Nerisyrenia	4.158	1.682	2	8	0.500	0.362	0.128	0.824	0.714	0.283	0.250	0.693	0.223	0.741
Neslia	8.544	-	1	1	0.000	0.000	0.000	-	-	-	0.099	0.693	0.693	0.527
Neuontobotrys	3.356	3.285	4	11	0.715	0.534	0.207	0.519	0.455	0.195	0.466	0.000	0.000	0.000
Nevada	6.410	-	1	1	0.000	0.000	0.000	-	-	-	0.123	0.000	0.000	0.000
Noccaea	11.377	7.142	19	80	0.385	0.325	0.192	0.516	0.478	0.299	0.458	0.000	0.000	0.000
Notoceras	15.943	-	1	1	0.000	0.000	0.000	-	-	-	0.053	0.000	0.000	0.000
Octoceras	7.031	-	1	1	0.000	0.000	0.000	-	-	-	0.115	0.000	0.000	0.000
Olimarabidopsis	3.362	3.342	3	3	0.327	0.206	0.054	0.121	0.105	0.035	0.297	0.511	0.511	0.741
Onuris	10.268	7.109	6	6	0.175	0.122	0.039	0.155	0.133	0.049	0.554	0.000	0.000	0.000
Oreophyton	11.629	-	1	1	0.000	0.000	0.000	-	-	-	0.074	0.000	0.000	0.000
Ornithocarpa	14.513	-	1	2	0.048	0.028	0.007	-	-	-	0.065	0.693	0.405	0.527
Orychophragmus	24.819	16.409	5	5	0.065	0.044	0.014	0.056	0.048	0.017	0.115	0.182	0.182	0.527
Pachycladon	5.898	4.730	9	10	0.390	0.289	0.109	0.340	0.297	0.124	0.388	0.000	0.000	0.000
Pachymitus	2.711	-	1	1	0.000	0.000	0.000	-	-	-	0.151	0.000	0.000	0.000
Pachyneurum	8.860	-	1	1	0.000	0.000	0.000	-	-	-	0.099	0.000	0.000	0.000
Parlatoria	6.312	-	1	2	0.110	0.064	0.015	-	-	-	0.103	0.000	0.000	0.000
Parolinia	5.743	-	1	5	0.280	0.191	0.059	-	-	-	0.083	0.000	0.000	0.000
Parrya	9.425	7.163	33	36	0.380	0.310	0.160	0.404	0.367	0.203	0.376	0.059	0.054	0.741
Paysonia	12.172	6.551	6	8	0.171	0.124	0.044	0.212	0.183	0.073	0.382	0.693	0.560	1.080
Pegaeophyton	11.577	-	1	7	0.168	0.120	0.041	-	-	-	0.062	0.000	0.000	0.000
Peltaria	16.689	-	1	4	0.083	0.055	0.016	-	-	-	0.048	0.693	0.223	0.527
Pennellia	5.425	5.230	2	10	0.424	0.314	0.118	0.308	0.269	0.112	0.155	0.000	0.000	0.000
Petiniotia	11.928	-	1	1	0.000	0.000	0.000	-	-	-	0.070	0.000	0.000	0.000
Phaeonychium	5.209	2.696	2	6	0.344	0.241	0.078	0.407	0.350	0.130	0.191	0.000	0.000	0.000
Phlegmatospermum	10.436	-	1	4	0.133	0.088	0.025	-	-	-	0.091	0.000	0.000	0.000
Phoenicaulis	6.410	-	1	1	0.000	0.000	0.000	-	-	-	0.123	0.693	0.693	0.527
Physaria	12.172	6.637	22	106	0.383	0.327	0.201	0.598	0.556	0.360	0.488	0.128	0.028	0.870
Physocardamum	4.825	-	1	1	0.000	0.000	0.000	-	-	-	0.079	0.693	0.693	0.527
Physoptychis	3.322	-	1	3	0.331	0.209	0.055	-	-	-	0.171	0.693	0.288	0.527
Planodes	13.734	-	1	1	0.000	0.000	0.000	-	-	-	0.069	0.000	0.000	0.000
Polyctenium	9.138	-	1	1	0.000	0.000	0.000	-	-	-	0.097	0.000	0.000	0.000
Polypsecadium	3.335	3.118	3	15	0.812	0.623	0.262	0.646	0.572	0.264	0.312	0.000	0.000	0.000
Pringlea	2.368	-	1	1	0.000	0.000	0.000	-	-	-	0.237	0.000	0.000	0.000
Pritzelago	0.798	-	1	1	0.000	0.000	0.000	-	-	-	0.141	0.000	0.000	0.000
Pseudoarabidopsis	11.081	-	1	1	0.000	0.000	0.000	-	-	-	0.079	0.000	0.000	0.000
Pseudocamelina	11.675	-	1	3	0.094	0.059	0.016	-	-	-	0.073	0.000	0.000	0.000
Pseudoclausia	10.089	9.563	7	7	0.193	0.137	0.047	0.131	0.113	0.043	0.244	0.000	0.000	0.000
Pseudovesicaria	10.550	-	1	1	0.000	0.000	0.000	-	-	-	0.077	0.000	0.000	0.000
Psychine	20.389	-	1	1	0.000	0.000	0.000	-	-	-	0.045	0.693	0.693	0.527
Pugionium	14.674	0.358	2	3	0.075	0.047	0.012	1.133	0.983	0.329	0.096	0.000	0.000	0.000
Raphanus	13.806	13.769	2	3	0.080	0.050	0.013	0.029	0.026	0.009	0.064	0.000	0.000	0.000
Rapistrum	13.806	-	1	2	0.050	0.029	0.007	-	-	-	0.057	0.000	0.000	0.000
Rhammatophyllum	5.604	3.578	6	10	0.411	0.304	0.115	0.450	0.393	0.164	0.333	0.000	0.000	0.000
Rhizobotrya	4.894	-	1	1	0.000	0.000	0.000	-	-	-	0.067	0.000	0.000	0.000
Ricotia	26.586	-	1	9	0.083	0.061	0.022	-	-	-	0.037	0.000	0.000	0.000
Robeschia	14.007	-	1	1	0.000	0.000	0.000	-	-	-	0.063	0.000	0.000	0.000
Rorippa	9.949	9.909	8	87	0.449	0.380	0.227	0.381	0.353	0.223	0.362	0.452	0.045	0.959
Rytidocarpus	12.945	-	1	1	0.000	0.000	0.000	-	-	-	0.058	0.693	0.693	0.527

Sandbergia	5.957	2.833	2	2	0.116	0.068	0.016	0.000	0.000	0.000	0.187	0.000	0.000	0.000
Sarcodraba	2.404	-	1	4	0.577	0.381	0.109	-	-	-	0.165	0.000	0.000	0.000
Savignya	18.284	-	1	1	0.000	0.000	0.000	-	-	-	0.052	0.693	0.693	0.527
Scambopus	6.258	-	1	1	0.000	0.000	0.000	-	-	-	0.119	0.000	0.000	0.000
Schimpera	12.722	-	1	1	0.000	0.000	0.000	-	-	-	0.063	0.000	0.000	0.000
Schivereckia	9.482	0.994	2	3	0.116	0.073	0.019	0.408	0.354	0.118	0.162	0.000	0.000	0.000
Schizopetalon	5.494	4.258	9	10	0.419	0.310	0.117	0.378	0.330	0.138	0.540	0.693	0.642	1.195
Schoenocrambe	11.781	-	1	1	0.000	0.000	0.000	-	-	-	0.059	0.000	0.000	0.000
Schouwia	23.753	-	1	1	0.000	0.000	0.000	-	-	-	0.041	0.693	0.693	0.527
Selenia	11.831	9.993	5	5	0.136	0.093	0.028	0.092	0.078	0.028	0.167	0.511	0.336	0.741
Sibara	8.944	7.664	3	6	0.200	0.140	0.045	0.143	0.123	0.046	0.137	0.693	0.405	0.870
Sibaropsis	7.136	-	1	1	0.000	0.000	0.000	-	-	-	0.111	0.693	0.693	0.527
Sinapidendron	18.249	-	1	4	0.076	0.050	0.014	-	-	-	0.052	0.000	0.000	0.000
Sinapis	16.581	16.567	2	5	0.097	0.066	0.020	0.055	0.047	0.017	0.058	0.000	0.000	0.000
Sisymbrella	9.949	-	1	2	0.070	0.041	0.010	-	-	-	0.086	0.000	0.000	0.000
Sisymbriopsis	6.431	6.419	2	5	0.250	0.171	0.052	0.143	0.122	0.043	0.136	0.000	0.000	0.000
Sisymbrium	11.781	11.765	8	48	0.329	0.272	0.148	0.270	0.247	0.144	0.101	0.118	0.021	0.527
Smelowskia	16.615	10.872	18	25	0.194	0.154	0.074	0.232	0.209	0.108	0.247	0.288	0.215	1.080
Sobolewskia	6.312	-	1	4	0.220	0.145	0.042	-	-	-	0.103	0.000	0.000	0.000
Solms-laubachia	5.604	5.583	15	26	0.581	0.464	0.224	0.459	0.414	0.215	0.312	0.065	0.038	0.527
Sphaerocardamum	6.867	3.656	8	8	0.303	0.219	0.077	0.379	0.328	0.130	0.650	0.000	0.000	0.000
Spryginia	14.492	4.912	2	7	0.134	0.096	0.032	0.255	0.220	0.084	0.083	0.000	0.000	0.000
Stanleya	4.838	4.818	7	7	0.402	0.287	0.097	0.260	0.224	0.086	0.234	0.693	0.693	1.125
Stenopetalum	5.898	-	1	10	0.390	0.289	0.109	-	-	-	0.106	0.000	0.000	0.000
Stevenia	18.666	14.573	3	3	0.059	0.037	0.010	0.028	0.024	0.008	0.060	0.000	0.000	0.000
Streptanthella	7.136	-	1	1	0.000	0.000	0.000	-	-	-	0.111	0.693	0.693	0.527
Streptanthus	6.772	6.733	30	35	0.525	0.427	0.219	0.425	0.386	0.212	0.338	0.693	0.619	1.489
Succowia	24.472	-	1	1	0.000	0.000	0.000	-	-	-	0.040	0.693	0.693	0.527
Synstemon	1.117	-	1	2	0.621	0.363	0.085	-	-	-	0.129	0.000	0.000	0.000
Synthlipsis	6.513	-	1	2	0.106	0.062	0.015	-	-	-	0.118	0.693	0.405	0.527
Tchihatchewia	5.172	-	1	1	0.000	0.000	0.000	-	-	-	0.078	0.000	0.000	0.000
Teesdalia	24.116	-	1	3	0.046	0.029	0.008	-	-	-	0.041	0.000	0.000	0.000
Tetracme	7.031	7.020	3	10	0.328	0.242	0.091	0.229	0.200	0.084	0.143	0.000	0.000	0.000
Thelypodiopsis	6.283	6.228	3	14	0.420	0.321	0.133	0.312	0.276	0.125	0.186	0.693	0.194	0.870
Thelypodium	5.635	5.616	5	17	0.503	0.390	0.170	0.381	0.339	0.161	0.276	0.693	0.258	1.027
Thlaspi	23.821	23.029	13	53	0.167	0.138	0.077	0.142	0.131	0.077	0.347	0.379	0.107	1.080
Thysanocarpus	8.944	8.521	6	6	0.200	0.140	0.045	0.129	0.111	0.041	0.178	0.693	0.693	1.080
Tomostima	6.894	1.502	3	3	0.159	0.101	0.026	0.270	0.234	0.078	0.255	0.000	0.000	0.000
Tropidocarpum	14.524	-	1	4	0.095	0.063	0.018	-	-	-	0.057	0.000	0.000	0.000
Turritis	11.629	3.621	2	2	0.060	0.035	0.008	0.000	0.000	0.000	0.117	0.000	0.000	0.000
Vania	12.221	-	1	1	0.000	0.000	0.000	-	-	-	0.058	0.000	0.000	0.000
Vella	13.648	6.230	8	8	0.152	0.110	0.039	0.223	0.193	0.076	0.160	0.693	0.693	1.162
Warea	5.635	-	1	4	0.246	0.163	0.047	-	-	-	0.164	0.693	0.223	0.527
Weberbauera	4.492	4.469	3	21	0.678	0.534	0.245	0.526	0.471	0.234	0.190	0.693	0.134	0.870
Werdermannia	12.912	4.110	2	5	0.125	0.085	0.026	0.223	0.191	0.068	0.104	0.000	0.000	0.000
Xerodraba	10.268	5.109	3	7	0.190	0.135	0.046	0.245	0.211	0.081	0.161	0.000	0.000	0.000
Yinshania	16.615	1.256	3	13	0.154	0.117	0.047	1.490	1.313	0.585	0.156	0.000	0.000	0.000
Zerdana	9.146	-	1	1	0.000	0.000	0.000	-	-	-	0.085	0.000	0.000	0.000
Zilla	4.212	-	1	2	0.165	0.096	0.023	-	-	-	0.078	0.000	0.000	0.000
Zuvanda	19.659	0.731	2	3	0.056	0.035	0.009	0.555	0.481	0.161	0.091	0.000	0.000	0.000

Table S3.6 Phylogenetic generalized least squares (PGLS) models testing whether polyploid richness influences species richness through diversification rates

POLYPLOIDY RICHNESS	METHOD	GROUP	e	SLOPE	R^2	P
Absolute	MS	Crown	0	0.216	0.001	0.806
			0.5	0.194	0.001	0.801
			0.9	0.104	0.000	0.746
		Stem	0	0.085	0.166	**<0.001**
			0.5	0.073	0.207	**<0.001**
			0.9	0.444	0.304	**<0.001**
Proportion tree		Crown	0	3.665	0.021	0.115
			0.5	3.197	0.021	0.115
			0.9	1.333	0.021	0.116
		Stem	0	0.057	0.016	**0.046**
			0.5	0.044	0.017	**0.044**
			0.9	0.057	0.016	**0.046**
Proportion total richness		Crown	0	-0.203	<0.001	0.948
			0.5	-0.183	<0.001	0.946
			0.9	-0.095	<0.001	0.933
		Stem	0	-0.031	0.003	0.403
			0.5	-0.020	0.002	0.474
			0.9	-0.007	0.001	0.641
Absolute	DR		-	0.011	0.458	**<0.001**
Proportion tree			-	0.083	0.031	0.006
Proportion total richness			-	0.085	0.019	0.032

Table S3.7 Phylogenetic path regression models testing whether polyploid richness has indirectly shaped present-day patterns of species richness among clades through diversification.

METHOD	GROUP	e	POLYPLOIDY	k	q	C	p	CICc	delta_CICc	l	w
MS	Stem *(n=243)*	0.9	*	12	9	2107.492	0.000	2126.264	0.000	1.000	1.000
		0.9	-	13	8	2261.086	0.000	2277.702	151.438	0.000	0.000
		0.5	*	12	9	2284.479	0.000	2303.252	176.988	0.000	0.000
		0.5	-	13	8	2411.309	0.000	2427.925	301.661	0.000	0.000
		0	*	12	9	2414.687	0.000	2433.460	307.196	0.000	0.000
		0	-	13	8	2519.595	0.000	2536.211	409.947	0.000	0.000
	Crown *(n=124)*	0.9	-	13	8	3575.756	0.000	3593.065	0.000	1.000	0.609
		0.5	-	13	8	3578.077	0.000	3595.387	2.321	0.313	0.191
		0	-	13	8	3578.429	0.000	3595.738	2.673	0.263	0.160
		0.5	*	12	9	3580.245	0.000	3599.897	6.831	0.033	0.020
		0	*	12	9	3580.681	0.000	3600.332	7.267	0.026	0.016
		0.9	*	12	9	3583.826	0.000	3603.477	10.412	0.005	0.003
DR *(n=243)*		-	*	3	7	21.308	0.002	36.317	0.000	1.000	1.000
			-	4	6	68.440	0.000	81.190	44.872	0.000	0.000

Table S3.8 List of DR (Species-Specific Diversification Rate) statistic estimated for 1,667 Brassicaceae species.

SPECIES	DR
Streptanthus_glandulosus	0.228
Streptanthus_callistus	0.321
Streptanthus_hispidus	0.321
Streptanthus_cutleri	0.318
Streptanthus_bracteatus	0.318
Streptanthus_platycarpus	0.222
Streptanthus_carinatus	0.182
Streptanthus_vernalis	1.410
Streptanthus_morrisonii	1.410
Streptanthus_brachiatus	0.726
Streptanthus_batrachopus	0.414
Streptanthus_barbiger	0.354
Streptanthus_hesperidis	0.277
Streptanthus_drepanoides	0.366
Streptanthus_breweri	0.366
Streptanthus_polygaloides	0.168
Streptanthus_cooperi	0.168
Streptanthus_cordatus	0.160
Streptanthus_howellii	0.176
Streptanthus_longisiliquus	0.176
Streptanthus_barbatus	0.160
Streptanthus_diversifolius	0.229
Streptanthus_tortuosus	0.229
Streptanthus_bernardinus	0.287
Streptanthus_campestris	0.287
Streptanthus_fenestratus	0.192
Streptanthus_farnsworthianus	0.192
Streptanthus_maculatus	0.144
Streptanthus_petiolaris	0.165
Streptanthus_hyacinthoides	0.165
Thelypodium_sagittatum	0.389
Thelypodium_integrifolium	0.389
Thelypodium_flexuosum	0.240
Thelypodium_crispum	0.192
Thelypodium_laciniatum	0.171
Warea_cuneifolia	0.164
Chaunanthus_acuminatus	0.166
Chaunanthus_petiolatus	0.166
Thelypodiopsis_elegans	0.203
Thelypodiopsis_ambigua	0.203
Thelypodiopsis_vaseyi	0.151
Stanleya_confertiflora	0.259
Stanleya_bipinnata	0.259
Stanleya_pinnata	0.225
Stanleya_albescens	0.193
Stanleya_viridiflora	0.255
Stanleya_tomentosa	0.255

Stanleya_elata	0.189
Dryopetalon_viereckii	0.187
Chlorocrambe_hastata	0.187
Thysanocarpus_curvipes	0.224
Thysanocarpus_laciniatus	0.224
Thysanocarpus_radians	0.146
Thysanocarpus_rigidus	0.181
Thysanocarpus_conchuliferus	0.181
Thysanocarpus_erectus	0.112
Sibara_angelorum	0.146
Sibara_laxa	0.146
Sibara_deserti	0.118
Weberbauera_peruviana	0.198
Weberbauera_rosulans	0.198
Weberbauera_herzogii	0.173
Englerocharis_pauciflora	0.141
Hesperidanthus_jaegeri	0.086
Mostacillastrum_elongatum	0.296
Mostacillastrum_andinum	0.296
Mostacillastrum_gracile	0.283
Mostacillastrum_stenophyllum	0.283
Polypsecadium_harmsianum	0.344
Polypsecadium_rusbyi	0.344
Polypsecadium_grandiflorum	0.248
Neuontobotrys_tarapacana	0.663
Neuontobotrys_lanata	0.663
Neuontobotrys_intricatissima	0.333
Neuontobotrys_frutescens	0.203
Pringlea_antiscorbutica	0.237
Chilocardamum_patagonicum	0.237
Sarcodraba_dusenii	0.165
Caulanthus_coulteri	0.506
Caulanthus_lemmonii	0.506
Caulanthus_inflatus	0.290
Caulanthus_heterophyllus	0.229
Caulanthus_simulans	0.207
Caulanthus_glaucus	0.209
Caulanthus_hallii	0.209
Caulanthus_pilosus	0.166
Caulanthus_flavescens	0.280
Caulanthus_lasiophyllus	0.280
Caulanthus_anceps	0.235
Caulanthus_major	0.179
Caulanthus_crassicaulis	0.111
Streptanthella_longirostris	0.111
Sibaropsis_hammittii	0.111
Schizopetalon_biseriatum	1.293
Schizopetalon_tenuifolium	1.293
Schizopetalon_brachycarpum	0.663

Schizopetalon_bipinnatifidum	0.384
Schizopetalon_rupestre	0.212
Schizopetalon_arcuatum	0.178
Schizopetalon_maritimum	0.322
Schizopetalon_walkeri	0.322
Schizopetalon_dentatum	0.195
Mathewsia_collina	0.394
Mathewsia_incana	0.394
Mathewsia_densifolia	0.276
Mathewsia_foliosa	0.262
Mathewsia_auriculata	0.262
Mathewsia_nivea	0.132
Werdermannia_macrostachya	0.104
Werdermannia_mendocina	0.104
Sisymbrium_orientale	0.140
Sisymbrium_officinale	0.140
Sisymbrium_irio	0.093
Sisymbrium_austriacum	0.084
Sisymbrium_aculeolatum	0.078
Sisymbrium_loeselii	0.094
Sisymbrium_polymorphum	0.094
Sisymbrium_altissimum	0.082
Schoenocrambe_linifolia	0.059
Brassica_rapa	0.233
Brassica_juncea	0.233
Brassica_napus	0.198
Brassica_incana	0.277
Brassica_oleracea	0.277
Brassica_montana	0.237
Brassica_cretica	0.196
Brassica_insularis	0.125
Brassica_macrocarpa	0.095
Brassica_villosa	0.071
Brassica_barrelieri	0.069
Brassica_oxyrrhina	0.069
Brassica_deflexa	0.058
Brassica_balearica	0.058
Brassica_repanda	0.108
Brassica_desnottesii	0.108
Brassica_gravinae	0.059
Brassica_elongata	0.052
Brassica_maurorum	0.095
Brassica_tournefortii	0.095
Brassica_fruticulosa	0.075
Brassica_carinata	0.099
Brassica_nigra	0.099
Raphanus_sativus	0.064
Raphanus_raphanistrum	0.064
Rapistrum_rugosum	0.057

Erucastrum_gallicum	0.047
Diplotaxis_acris	0.058
Diplotaxis_tenuifolia	0.058
Diplotaxis_harra	0.052
Diplotaxis_erucoides	0.045
Diplotaxis_catholica	0.044
Moricandia_suffruticosa	0.478
Moricandia_spinosa	0.478
Moricandia_arvensis	0.242
Moricandia_nitens	0.124
Moricandia_sinaica	0.118
Moricandia_foetida	0.118
Moricandia_moricandioides	0.097
Eruca_vesicaria_subsp._sativa	0.120
Moricandia_foleyi	0.120
Rytidocarpus_moricandioides	0.058
Zilla_spinosa_subsp._macroptera	0.078
Fortuynia_garcini	0.078
Sinapis_alba	0.058
Sinapis_arvensis	0.058
Cordylocarpus_muricatus	0.056
Sinapidendron_frutescens	0.052
Hirschfeldia_incana	0.050
Coincya_monensis	0.046
Crambe_orientalis	0.045
Cakile_edentula	0.335
Cakile_lanceolata	0.335
Cakile_maritima	0.182
Cakile_arabica	0.110
Didesmus_aegypticus	0.073
Erucaria_erucarioides	0.058
Eremophyton_chevallieri	0.049
Vella_pseudocytisus_subsp._glabrata	0.177
Vella_aspera	0.177
Vella_mairei	0.192
Vella_anremerica	0.192
Vella_lucentina	0.175
Vella_castrilensis	0.175
Vella_bourgaeana	0.111
Vella_spinosa	0.082
Carrichtera_annua	0.055
Ammosperma_cinerea	0.044
Savignya_parviflora	0.052
Fezia_pterocarpa	0.052
Nasturtiopsis_coronopifolia	0.050
Psychine_stylosa	0.045
Schouwia_purpurea	0.041
Succowia_balearica	0.040
Orychophragmus_hupehensis	0.179

Orychophragmus_ziguiensis	0.179
Orychophragmus_taibaiensis	0.104
Orychophragmus_diffusus	0.063
Orychophragmus_violaceus	0.048
Bivonaea_lutea	0.039
Isatis_cappadocica_subsp._besseri	0.351
Isatis_kotschyana	0.351
Isatis_pachycarpa	0.278
Isatis_tinctoria	0.278
Isatis_microcarpa	0.280
Isatis_lusitanica	0.280
Isatis_raphanifolia	0.314
Isatis_koeiei	0.314
Isatis_koelzii	0.441
Isatis_gaubae	0.441
Isatis_leuconeura	0.366
Isatis_buschiana	0.366
Isatis_elegans	0.352
Isatis_armena	0.352
Isatis_quadrialata	0.155
Isatis_zarrei	0.111
Isatis_violascens	0.582
Isatis_emarginata	0.582
Isatis_minima	0.314
Isatis_trachycarpa	0.325
Isatis_stocksii	0.325
Isatis_multicaulis	0.111
Isatis_brevipes	0.086
Isatis_gymnocarpa	0.070
Schimpera_arabica	0.063
Myagrum_perfoliatum	0.053
Conringia_orientalis	0.050
Conringia_planisiliqua	0.050
Zuvanda_crenulata	0.091
Zuvanda_exacoides	0.091
Eutrema_penlandii	0.253
Eutrema_edwardsii	0.253
Eutrema_heterophyllum	0.140
Eutrema_verticillatum	0.098
Eutrema_japonicum	0.087
Eutrema_botschantzevii	0.308
Eutrema_halophilum	0.308
Eutrema_salsugineum	0.155
Eutrema_altaicum	0.081
Pegaeophyton_scapiflorum	0.062
Chalcanthus_renifolius	0.048
Thlaspi_cepaeifolium	0.689
Thlaspi_alpinum	0.689
Thlaspi_calaminare	0.550

Thlaspi_praecox	0.473
Thlaspi_nevadense	0.473
Thlaspi_bulbosum	0.298
Thlaspi_goesingense	0.409
Thlaspi_jankae	0.409
Thlaspi_montanum	0.159
Thlaspi_densiflorum	0.102
Thlaspi_erraticum	0.108
Thlaspi_perfoliatum	0.108
Thlaspi_arvense	0.042
Didymophysa_fedtschenkoana	0.152
Didymophysa_aucheri	0.152
Elburzia_fenestrata	0.110
Pseudocamelina_glaucophylla	0.073
Sobolewskia_caucasica	0.103
Parlatoria_rostrata	0.103
Pseudovesicaria_digitata	0.077
Alliaria_petiolata	0.062
Alliaria_grandifolia	0.062
Peltaria_alliacea	0.048
Goldbachia_laevigata	0.071
Goldbachia_sabulosa	0.071
Calepina_irregularis	0.048
Brayopsis_colombiana	0.474
Eudema_nubigena_subsp._nubigena	0.474
Eudema_nubigena_subsp._remyana	0.326
Brayopsis_gamosepala	0.201
Brayopsis_calycina	0.352
Brayopsis_monimocalyx	0.352
Brayopsis_diapensioides	0.195
Eudema_nubigena	0.198
Eudema_rupestris	0.198
Dactylocardamum_imbricatifolium	0.156
Aschersoniodoxa_cachensis	0.091
Aschersoniodoxa_peruviana	0.091
Onuris_papillosa	1.107
Onuris_hatcheriana	1.107
Onuris_spegazziniana	0.564
Onuris_alismatifolia	0.296
Onuris_graminifolia	0.159
Onuris_hauthalii	0.091
Xerodraba_pycnophylloides	0.192
Xerodraba_patagonica	0.192
Xerodraba_pectinata	0.100
Menonvillea_rigida	0.245
Menonvillea_nordenskjoeldii	0.245
Menonvillea_spathulata	0.162
Menonvillea_cicatricosa	0.112
Menonvillea_cuneata	0.077

Menonvillea_scapigera_subsp._scapigera	0.091
Menonvillea_scapigera_subsp._longipes	0.091
Menonvillea_flexuosa	0.353
Menonvillea_litoralis	0.353
Menonvillea_filifolia_subsp._filifolia	0.421
Menonvillea_pinnatifida	0.421
Menonvillea_orbiculata	0.225
Menonvillea_chilensis	0.225
Menonvillea_minima	0.069
Menonvillea_scapigera	0.088
Menonvillea_hookeri	0.088
Kernera_saxatilis_subsp._saxatilis	0.128
Kernera_saxatilis_subsp._boissieri	0.128
Rhizobotrya_alpina	0.067
Noccaea_occitanica	1.141
Noccaea_caerulescens	1.141
Noccaea_caerulescens_subsp._caerulescens	0.703
Noccaea_brachypetala	0.399
Noccaea_rotundifolia	0.275
Noccaea_virens	0.264
Noccaea_papyracea	0.264
Noccaea_oppositifolia	0.178
Noccaea_stylosa	0.166
Noccaea_crantzii	0.147
Noccaea_fendleri_subsp._glauca	0.642
Noccaea_fendleri_subsp._siskiyouensis	0.642
Noccaea_fendleri_subsp._idahoensis	0.368
Noccaea_fendleri	0.252
Noccaea_goesingensis	0.522
Noccaea_banatica	0.522
Noccaea_kovatsii	0.490
Noccaea_tymphaea	0.490
Noccaea_cochleariformis	0.093
Callothlaspi_lilacinum	0.070
Vania_trinervia	0.058
Microthlaspi_natolicum_subsp._gaillardotii	0.177
Microthlaspi_natolicum_subsp._sporadium	0.177
Microthlaspi_mediterraneo-orientale	0.089
Microthlaspi_granatense	0.052
Microthlaspi_umbellatum	0.049
Cochlearia_danica	1.031
Cochlearia_pyrenaica	1.031
Cochlearia_excelsa	0.519
Cochlearia_aestuaria	0.261
Cochlearia_tatrae	0.471
Cochlearia_officinalis	0.471
Cochlearia_anglica	0.244
Cochlearia_sempervivum	0.069
Cochlearia_aragonensis	0.063

Cochlearia_glastifolia	0.058
Ionopsidium_savianum	0.137
Ionopsidium_abulense	0.137
Ionopsidium_prolongoi	0.075
Ionopsidium_albiflorum	0.077
Ionopsidium_acaule	0.077
Ionopsidium_megalospermum	0.058
Hilliella_rupicola_subsp._rupicola	0.603
Hilliella_shuangpaiensis	0.603
Hilliella_hui	0.303
Hilliella_hunanensis	0.188
Hilliella_sinuata	0.191
Hilliella_rivulorum	0.191
Hilliella_lichuanensis	0.200
Hilliella_paradoxa	0.200
Hilliella_yixianensis	0.112
Hilliella_fumarioides	0.047
Iberis_amara	0.245
Iberis_spathulata	0.245
Iberis_saxatilis	0.150
Iberis_umbellata	0.089
Iberis_sempervirens	0.060
Teesdalia_nudicaulis	0.041
Pugionium_dolabratum	0.096
Pugionium_cornutum	0.096
Megacarpaea_delavayi	0.049
Draba_alpina	5.681
Draba_pohlei	5.681
Draba_ochroleuca	4.756
Draba_oxycarpa	3.648
Draba_pygmaea	2.611
Draba_sachalinensis	2.273
Draba_himalayensis	3.034
Draba_juvenilis	3.034
Draba_hirta	2.226
Draba_oligosperma	1.477
Draba_pycnosperma	1.336
Draba_kananaskia	1.499
Draba_glacialis	1.499
Draba_praealta	1.129
Draba_tibetica	1.342
Draba_falconeri	1.342
Draba_arabisans	1.123
Draba_laurentiana	0.909
Draba_confusa	1.728
Draba_glabella	1.728
Draba_borealis	1.401
Draba_prozorovskii	1.866
Draba_longipes	1.866

Draba_fuhaiensis	1.619
Draba_fladnizensis	1.619
Draba_incerta	0.620
Draba_nivalis	2.983
Draba_kamtschatica	2.983
Draba_ussuriensis	1.566
Draba_lichiangensis	1.194
Draba_nylamensis	1.429
Draba_ladina	1.429
Draba_porsildii	1.029
Draba_bellii	0.991
Draba_palanderiana	0.930
Draba_tomentosa	1.049
Draba_supranivalis	1.049
Draba_jaegeri	0.904
Draba_magellanica	2.186
Draba_macrocarpa	2.186
Draba_cana	1.133
Draba_ruaxes	0.764
Draba_barbata	1.587
Draba_pilosa	1.587
Draba_lonchocarpa	0.878
Draba_primuloides	1.305
Draba_turczaninovii	1.305
Draba_oblongata	0.819
Draba_doerfleri	1.741
Draba_rupestris	1.741
Draba_baicalensis	1.315
Draba_cinerea	1.782
Draba_surculosa	1.782
Draba_groenlandica	1.242
Draba_pterosperma	0.849
Draba_hitchcockii	0.849
Draba_murrayi	0.684
Draba_stylaris	0.636
Draba_ramosissima	0.615
Draba_subamplexicaulis	0.518
Draba_lactea	0.476
Draba_kotschyi	1.037
Draba_incana	1.037
Draba_norvegica	0.621
Draba_subcapitata	0.852
Draba_paysonii	0.852
Draba_corymbosa	0.637
Draba_dubia	0.389
Draba_glomerata	0.737
Draba_oreades	0.737
Draba_stenobotrys	0.891
Draba_kusnetzowii	0.891

Draba_lasiophylla	0.460
Draba_altaica	0.460
Draba_amoena	0.448
Draba_staintonii	0.448
Draba_elata	0.375
Draba_sikkimensis	0.337
Draba_ramulosa	0.267
Draba_scopulorum	0.421
Draba_subumbellata	0.421
Draba_tucumanensis	0.345
Draba_zangbeiensis	0.498
Draba_ladyginii	0.498
Draba_gilliesii	0.469
Draba_arseniewii	0.469
Draba_sherriffii	0.436
Draba_rigida	0.385
Draba_hyperborea	0.341
Draba_alyssoides	0.341
Draba_breweri	0.291
Draba_winterbottomii	0.542
Draba_trinervis	0.542
Draba_elegans	0.348
Draba_heterocoma	0.348
Draba_streptocarpa	2.498
Draba_exunguiculata	2.498
Draba_heilii	1.268
Draba_bifurcata	0.768
Draba_crassa	0.768
Draba_corrugata	1.194
Draba_densifolia	1.194
Draba_novolympica	0.992
Draba_sphaerocarpa	0.753
Draba_gmelini	0.728
Draba_arctica	0.728
Draba_aurea	0.694
Draba_luteola	0.694
Draba_helleriana	0.528
Draba_stylosa	0.417
Draba_obovata	1.331
Draba_aretioides	1.331
Draba_amplexicaulis	0.866
Draba_yunnanensis	0.513
Draba_eschscholtzii	0.395
Draba_ventosa	0.385
Draba_setosa	1.191
Draba_radicans	1.191
Draba_korshinskyi	1.507
Draba_cachemirica	1.507
Draba_macbeathiana	0.645

Draba_gracillima	0.671
Draba_eriopoda	0.671
Draba_alberti	0.344
Draba_micropetala	0.351
Draba_matangensis	0.351
Draba_burkei	5.497
Draba_globosa	5.497
Draba_juniperina	5.861
Draba_pectinipila	5.861
Draba_kassii	2.170
Draba_reptans	1.727
Draba_sobolifera	3.448
Draba_subalpina	3.448
Draba_stenopetala	1.764
Draba_asprella	3.618
Draba_aureola	3.618
Draba_sphaeroides	2.877
Draba_spectabilis	2.124
Draba_albertina	2.965
Draba_crassifolia	2.965
Draba_brachystylis	1.698
Draba_mogollonica	1.583
Draba_streptobrachia	1.484
Draba_cusickii	1.329
Draba_rectifructa	1.108
Draba_ogilviensis	0.837
Draba_koeiei	1.088
Draba_olgae	1.088
Draba_affghanica	0.670
Draba_stenocarpa	0.820
Draba_bhutanica	0.820
Draba_aubrietioides	0.695
Draba_cholaensis	0.593
Draba_melanopus	0.565
Draba_odudiana	0.518
Draba_involucrata	0.447
Draba_pauciflora	0.352
Draba_polyphylla	0.213
Draba_bellardii	1.931
Draba_cuatrecasana	1.931
Draba_cryophila	1.437
Draba_aizoides	1.031
Draba_parnassica	0.893
Draba_scardica	0.893
Draba_dedeana	0.800
Draba_cretica	0.800
Draba_athoa	0.731
Draba_acaulis	0.749
Draba_lacaitae	0.749

Draba_hispanica	0.611
Draba_cappadocica	0.369
Draba_bruniifolia	0.318
Draba_araratica	0.261
Draba_lasiocarpa	0.402
Draba_olympica	0.402
Draba_oreadum	0.298
Draba_incompta	0.365
Draba_aucheri	0.365
Draba_rosularis	0.243
Draba_kongboiana	0.470
Draba_ellipsoidea	0.470
Draba_huetii	0.573
Draba_lutescens	0.573
Draba_ossetica	0.235
Draba_jucunda	0.204
Draba_lutea	0.385
Draba_nemorosa	0.385
Draba_hispida	0.208
Draba_nuda	0.197
Draba_sibirica	0.184
Draba_longisiliqua	0.160
Draba_funiculosa	0.126
Draba_hederifolia	0.126
Draba_pusilla	1.801
Draba_rositae	1.801
Draba_schusteri	1.661
Draba_hallii	1.453
Draba_peruviana	2.200
Draba_pickeringii	2.200
Draba_ritacuvana	2.069
Draba_pseudocheiranthoides	2.069
Draba_violacea	2.899
Draba_confertifolia	2.899
Draba_depressa	2.194
Draba_pycnophylla	1.545
Draba_barclayana	1.981
Draba_boyacana	1.981
Draba_standleyi	1.732
Draba_splendens	1.420
Draba_cryptantha	1.623
Draba_wurdackii	1.623
Draba_litamo	1.542
Draba_hidalgensis	1.411
Draba_solitaria	1.407
Draba_sericea	1.403
Draba_pennell-hazenii	1.398
Draba_hammenii	1.395
Draba_nivicola	1.391

Draba_chionophila	1.387
Draba_soratensis	1.382
Draba_farsetioides	1.378
Draba_spruceana	1.372
Draba_hemsleyana	1.365
Draba_funckeana	1.354
Draba_extensa	1.336
Draba_lindenii	1.307
Draba_lapaziana	1.257
Draba_pulvinata_subsp._berryi	1.311
Draba_pulvinata_subsp._pulvinata	1.311
Draba_macleanii	1.039
Draba_matthioloides	0.850
Draba_cruciata	0.807
Draba_jorullensis	0.734
Draba_mexicana	0.700
Draba_cuzcoensis	0.643
Draba_hookeri	0.553
Draba_inquisiviana	0.434
Draba_matthioloides_subsp._saundersii	0.304
Draba_beltranii	0.191
Draba_lemmonii	0.305
Draba_maguirei	0.305
Draba_stenoloba	0.187
Pachyneurum_grandiflorum	0.099
Schivereckia_podolica	0.162
Schivereckia_monticola	0.162
Tomostima_platycarpa	0.296
Tomostima_araboides	0.296
Tomostima_cuneifolia	0.173
Athysanus_pusillus	0.137
Athysanus_unilateralis	0.137
Erophila_verna	0.184
Erophila_verna_subsp._praecox	0.184
Erophila_verna_subsp._spathulata	0.112
Aubrieta_deltoidea	0.089
Aubrieta_parviflora	0.089
Arabis_eschscholtziana	3.771
Arabis_nipponica	3.771
Arabis_olympica	2.005
Arabis_borealis	2.667
Arabis_pycnocarpa	2.667
Arabis_flagellosa	0.844
Arabis_bijuga	5.090
Arabis_pangiensis	5.090
Arabis_amplexicaulis	2.680
Arabis_nuristanica	1.423
Arabis_paniculata	0.841
Arabis_pterosperma	0.614

Arabis_stelleri	0.901
Arabis_serrata	0.901
Arabis_blepharophylla	2.148
Arabis_furcata	2.148
Arabis_georgiana	2.017
Arabis_oregana	1.819
Arabis_aculeolata	1.537
Arabis_modesta	1.182
Arabis_macdonaldiana	0.817
Arabis_nuttallii	0.932
Arabis_crucisetosa	0.932
Arabis_stenocarpa	2.961
Arabis_planisiliqua	2.961
Arabis_juressi	1.504
Arabis_beirana	0.883
Arabis_scabra	0.566
Arabis_doumetii	0.991
Arabis_erubescens	0.991
Arabis_vochinensis	0.534
Arabis_serpyllifolia	0.534
Arabis_ciliata	0.561
Arabis_allionii	0.561
Arabis_sudetica	3.707
Arabis_abietina	3.707
Arabis_planisiliqua_subsp._planisiliqua	1.934
Arabis_sadina	1.023
Arabis_sagittata	0.900
Arabis_hirsuta	0.905
Arabis_takesimana	0.905
Arabis_pumila	1.432
Arabis_soyeri	1.432
Arabis_surculosa	0.722
Arabis_cretica	0.512
Arabis_androsacea	0.417
Arabis_pubescens	0.337
Arabis_scopoliana	0.283
Arabis_procurrens	0.371
Arabis_ferdinandi-coburgii	0.371
Arabis_stellulata	0.281
Arabis_collina	0.276
Arabis_rosea	0.276
Arabis_bryoides	0.143
Arabis_carduchorum	0.154
Arabis_armena	0.154
Arabis_karategina	0.628
Arabis_ariana	0.628
Arabis_kamelinii	0.361
Arabis_alaschanica	0.195
Arabis_setosifolia	0.218

Arabis_axilliflora	0.218
Arabis_kokanica	0.172
Arabis_caerulea	0.085
Arabis_brachycarpa	0.477
Arabis_graellsiiformis	0.477
Arabis_christianii	0.240
Arabis_nordmanniana	0.123
Arabis_montbretiana	0.416
Arabis_auriculata	0.416
Arabis_erikii	0.220
Arabis_nova	0.115
Arabis_alpina	0.070
Arabis_josiae	0.146
Arabis_conringioides	0.146
Arabis_ottonis-schulzii	0.075
Arabis_kennedyae	0.118
Arabis_subflava	0.118
Arabis_axillaris	0.065
Arabis_parvula	0.105
Arabis_aucheri	0.105
Dendroarabis_fruticulosa	0.051
Baimashania_pulvinata	0.149
Baimashania_wangii	0.149
Botschantzevia_karatavica	0.110
Arcyosperma_primulifolium	0.073
Stevenia_cheiranthoides	0.063
Stevenia_canescens	0.063
Stevenia_maximowiczii	0.054
Macropodium_nivale	0.068
Macropodium_pterospermum	0.068
Biscutella_algeriensis	0.251
Biscutella_maritima	0.251
Biscutella_didyma	0.179
Biscutella_baetica	0.121
Biscutella_laevigata	0.109
Biscutella_lyrata	0.109
Biscutella_cichoriifolia	0.090
Biscutella_auriculata	0.090
Heldreichia_bupleurifolia_subsp._bourgaei	0.220
Heldreichia_bupleurifolia_subsp._bupleurifolia	0.220
Heldreichia_bupleurifolia_subsp._rotundifolia	0.145
Heldreichia_bupleurifolia_subsp._polymorpha	0.088
Megadenia_pygmaea	0.050
Lunaria_annua	0.041
Lunaria_rediviva	0.041
Ricotia_lunaria	0.037
Alyssum_sp._JZL-2014	1.227
Alyssum_fastigiatum	1.227
Alyssum_nevadense	1.136

Alyssum_densistellatum	1.000
Alyssum_ovirense	1.799
Alyssum_wulfenianum_subsp._wulfenianum	1.799
Alyssum_montanum	0.779
Alyssum_sp._BF-2014	0.645
Alyssum_cuneifolium	0.893
Alyssum_flexicaule	0.893
Alyssum_loiseleurii	0.692
Alyssum_orophilum	0.478
Alyssum_diffusum	0.400
Alyssum_repens_subsp._transsilvanicum	0.318
Alyssum_stribryni	0.226
Alyssum_turkestanicum	0.257
Alyssum_desertorum	0.257
Alyssum_simplex	0.364
Alyssum_minutum	0.364
Alyssum_marginatum	0.250
Alyssum_stapfii	0.287
Alyssum_antilibanoticum	0.287
Alyssum_minus	0.350
Alyssum_siculum	0.350
Alyssum_alyssoides	0.243
Alyssum_granatense	0.151
Alyssum_hirsutum	0.155
Alyssum_xanthocarpum	0.155
Alyssum_umbellatum	0.176
Alyssum_strigosum	0.176
Alyssum_harputicum	2.404
Alyssum_paphlagonicum	2.404
Alyssum_thymops	2.445
Alyssum_lepidoto-stellatum	2.445
Alyssum_corningii	1.170
Alyssum_tetrastemon	1.170
Alyssum_baumgartnerianum	0.530
Alyssum_dasycarpum	0.384
Alyssum_montis-stellae	0.508
Alyssum_lenense	0.508
Alyssum_lepidotum	0.403
Alyssum_niveum	0.302
Alyssum_persicum	0.250
Alyssum_sulphureum	0.195
Alyssum_misirdalianum	0.417
Alyssum_praecox	0.417
Alyssum_aurantiacum	0.241
Alyssum_iranicum	0.246
Alyssum_caespitosum	0.246
Alyssum_doerfleri	0.152
Alyssum_fallacinum	0.559
Alyssum_tenium	0.559

Alyssum_argenteum	0.487
Alyssum_chalcidicum	0.457
Alyssum_samariferum	0.608
Alyssum_floribundum	0.608
Alyssum_kavadarcense	0.439
Alyssum_gevgelicense	0.418
Alyssum_serpentinum	0.383
Alyssum_markgrafii	0.327
Alyssum_murale	0.266
Alyssum_skopjense	0.194
Alyssum_pintodasilvae	0.537
Alyssum_serpyllifolium	0.537
Alyssum_alpestre	0.292
Alyssum_robertianum	0.203
Alyssum_bracteatum	0.237
Alyssum_filiforme	0.237
Alyssum_polycladum	0.129
Alyssum_inflatum	0.123
Alyssum_baldaccii	0.112
Alyssum_euboeum	0.166
Alyssum_fragillimum	0.166
Alyssum_giosnanum	0.153
Alyssum_corymbosoides	0.153
Alyssum_caricum	0.120
Alyssum_anatolicum	0.120
Alyssum_virgatum	0.132
Alyssum_nebrodense	0.132
Alyssum_peltarioides	0.194
Alyssum_pterocarpum	0.194
Alyssum_obovatum	0.110
Alyssum_bertolonii	0.454
Alyssum_tavolarae	0.454
Alyssum_heldreichii	0.266
Alyssum_smolikanum	0.179
Alyssum_condensatum	0.312
Alyssum_biovulatum	0.312
Alyssum_oxycarpum	0.232
Alyssum_huber-morathii	0.169
Alyssum_lesbiacum	0.138
Alyssum_sibiricum	0.138
Alyssum_corsicum	0.125
Alyssum_cypricum	0.119
Alyssum_pinifolium	0.113
Alyssum_masmenaeum	0.104
Alyssum_borzaeanum	0.166
Alyssum_davisianum	0.166
Alyssum_tortuosum	0.211
Alyssum_americanum	0.211
Alyssum_pateri	0.089

Alyssum_linifolium	0.062
Alyssum_meniocoides	0.082
Alyssum_aureum	0.082
Alyssum_tenuifolium	0.042
Alyssum_homalocarpum	0.062
Alyssum_antiatlanticum	0.062
Fibigia_clypeata	0.448
Fibigia_eriocarpa	0.448
Fibigia_macrocarpa	0.316
Fibigia_umbellata	0.258
Fibigia_spathulata	0.258
Fibigia_triquetra	0.269
Fibigia_lunarioides	0.269
Fibigia_suffruticosa	0.226
Alyssoides_cretica	0.187
Alyssoides_utriculata	0.187
Physoptychis_caspica	0.171
Clastopus_vestitus	0.171
Degenia_velebitica	0.081
Hormathophylla_baetica	0.666
Hormathophylla_cochleata	0.666
Hormathophylla_purpurea	0.360
Hormathophylla_lapeyrousiana	0.301
Hormathophylla_macrocarpa	0.323
Hormathophylla_halimifolia	0.323
Hormathophylla_spinosa	0.158
Hormathophylla_longicaulis	0.286
Hormathophylla_reverchonii	0.286
Hormathophylla_cadevalliana	0.153
Bornmuellera_baldaccii	0.249
Bornmuellera_dieckii	0.249
Bornmuellera_tymphaea	0.176
Bornmuellera_cappadocica	0.115
Physocardamum_davisii	0.079
Aurinia_gionae	0.445
Aurinia_saxatilis	0.445
Aurinia_moreana	0.348
Aurinia_sinuata	0.249
Aurinia_leucadea_subsp._diomedea	0.169
Aurinia_corymbosa	0.186
Aurinia_petraea	0.186
Aurinia_rupestris	0.060
Berteroa_orbiculata	0.444
Berteroa_obliqua	0.444
Berteroa_incana	0.243
Berteroa_mutabilis	0.127
Galitzkya_macrocarpa	0.177
Galitzkya_potaninii	0.177
Galitzkya_spathulata	0.106

Clypeola_lappacea	0.126
Clypeola_aspera	0.126
Clypeola_dichotoma	0.078
Clypeola_cyclodontea	0.075
Clypeola_jonthlaspi	0.075
Asperuginoides_axillaris	0.037
Solms-laubachia_pulcherrima	0.487
Solms-laubachia_zhongdianensis	0.487
Solms-laubachia_minor	0.405
Solms-laubachia_xerophyta	0.333
Solms-laubachia_eurycarpa	0.270
Solms-laubachia_linearifolia	0.270
Solms-laubachia_retropilosa	0.218
Solms-laubachia_lanata	0.238
Solms-laubachia_baiogoinensis	0.238
Solms-laubachia_platycarpa	0.205
Solms-laubachia_jafrii	0.174
Solms-laubachia_himalayensis	0.447
Solms-laubachia_stewartii	0.447
Solms-laubachia_linearis	0.256
Solms-laubachia_flabellata	0.207
Rhammatophyllum_frutex	0.453
Rhammatophyllum_gaudanense	0.453
Rhammatophyllum_ghoranum	0.372
Rhammatophyllum_kamelinii	0.296
Rhammatophyllum_afghanicum	0.236
Rhammatophyllum_pachyrhizum	0.191
Sisymbriopsis_mollipila	0.136
Sisymbriopsis_yechengnica	0.136
Euclidium_syriacum	0.100
Neotorularia_contortuplicata	0.203
Neotorularia_torulosa	0.203
Neotorularia_korolkowii	0.116
Neotorularia_dentata	0.112
Neotorularia_tetracmoides	0.112
Cryptospora_falcata	0.122
Catenulina_hedysaroides	0.122
Tetracme_contorta	0.151
Tetracme_secunda	0.151
Tetracme_quadricornis	0.127
Octoceras_lehmannianum	0.115
Braya_alpina	1.144
Braya_siliquosa	1.144
Braya_gamosepala	0.964
Braya_humilis	1.612
Braya_linearis	1.612
Braya_brachycarpa	0.645
Braya_fernaldii	1.705
Braya_longii	1.705

Braya_rosea	0.867
Braya_glabella	0.603
Braya_scharnhorstii	0.346
Braya_pilosa	0.507
Braya_thorild-wulffii	0.507
Braya_forrestii	0.180
Lepidostemon_glaricola	0.133
Phaeonychium_villosum	0.191
Phaeonychium_kashgaricum	0.191
Christolea_crassifolia	0.129
Dilophia_salsa	0.097
Leptaleum_filifolium	0.071
Leiospora_pamirica	0.254
Leiospora_eriocalyx	0.254
Leiospora_exscapa	0.127
Dichasianthus_subtilissimus	0.076
Spryginia_winkleri	0.083
Spryginia_falcata	0.083
Sterigmostemum_eglandulosum	1.171
Sterigmostemum_incanum	1.171
Sterigmostemum_grandiflorum	0.590
Sterigmostemum_sulphureum	0.561
Sterigmostemum_violaceum	0.561
Sterigmostemum_matthioloides	0.206
Sterigmostemum_tomentosum	0.189
Sterigmostemum_fuhaiense	0.189
Sterigmostemum_acanthocarpum	0.131
Anchonium_elichrysifolium_subsp._canescens	0.110
Sterigmostemum_longistylum	0.112
Sterigmostemum_ramosissimum	0.112
Zerdana_anchonioides	0.085
Anchonium_billardierei	0.129
Synstemon_petrovii	0.129
Microstigma_brachycarpum	0.055
Matthiola_incana	0.286
Matthiola_rupestris	0.286
Matthiola_pulchella	0.252
Matthiola_maderensis	0.252
Matthiola_fruticulosa	0.235
Matthiola_parviflora	0.235
Matthiola_capiomontiana	0.134
Matthiola_oxyceras	0.072
Matthiola_stoddartii	0.157
Matthiola_bucharica	0.157
Matthiola_farinosa	0.082
Matthiola_longipetala	0.058
Eremoblastus_caspicus	0.070
Petiniotia_purpurascens	0.070
Iskandera_alaica	0.068

Iskandera_hissarica	0.068
Hesperis_voronovii	0.332
Hesperis_matronalis	0.332
Hesperis_dinarica	0.192
Hesperis_rechingeri	0.222
Hesperis_laciniata	0.222
Hesperis_sibirica	0.111
Tchihatchewia_isatidea	0.078
Bunias_orientalis	0.049
Parrya_pavlovii	0.426
Parrya_asperrima	0.426
Parrya_darvazica	0.313
Parrya_maidantalica	0.279
Parrya_saxifraga	0.483
Parrya_kuramensis	0.483
Parrya_schugnana	0.263
Parrya_ajanensis	0.486
Parrya_nudicaulis	0.486
Parrya_arctica	0.767
Parrya_nauruaq	0.767
Parrya_turkestanica	0.387
Parrya_rydbergii	0.387
Parrya_albida	0.214
Parrya_subsiliquosa	0.471
Parrya_longicarpa	0.471
Parrya_australis	0.259
Parrya_popovii	0.226
Parrya_pinnatifida	0.226
Parrya_nuratensis	0.264
Parrya_fruticulosa	0.264
Parrya_tianschanica	0.585
Parrya_alba	0.585
Parrya_stenocarpa	0.497
Parrya_simulatrix	0.384
Parrya_stenophylla	0.282
Parrya_saurica	0.410
Parrya_lancifolia	0.410
Parrya_runcinata	0.224
Parrya_minjanensis	0.224
Parrya_pulvinata	0.135
Parrya_villosula	0.156
Parrya_angrenica	0.156
Litwinowia_tenuissima	0.088
Pseudoclausia_mollissima	0.350
Pseudoclausia_sarawschanica	0.350
Pseudoclausia_hispida	0.305
Pseudoclausia_olgae	0.305
Pseudoclausia_turkestanica	0.181
Pseudoclausia_gracillima	0.131

Pseudoclausia_papillosa	0.088
Diptychocarpus_strictus	0.061
Chorispora_sabulosa	0.362
Chorispora_bungeana	0.362
Chorispora_macropoda	0.253
Chorispora_songarica	0.277
Chorispora_sibirica	0.277
Chorispora_tashkorganica	0.131
Chorispora_tenella	0.088
Chorispora_purpurascens	0.105
Chorispora_persica	0.105
Dontostemon_integrifolius	0.269
Dontostemon_dentatus	0.269
Dontostemon_tibeticus	0.153
Dontostemon_perennis	0.145
Dontostemon_gubanovii	0.218
Dontostemon_crassifolius	0.218
Dontostemon_elegans	0.129
Dontostemon_senilis	0.118
Dontostemon_micranthus	0.214
Dontostemon_intermedius	0.214
Dontostemon_hispidus	0.144
Dontostemon_glandulosus	0.137
Dontostemon_pinnatifidus	0.137
Clausia_robusta	0.680
Clausia_aprica	0.680
Clausia_agideliensis	0.343
Clausia_kasakhorum	0.177
Clausia_trichosepala	0.097
Erysimum_mediohispanicum	3.054
Erysimum_baeticum	3.054
Erysimum_popovii	1.877
Erysimum_semperflorens	1.212
Erysimum_gorbeanum	1.928
Erysimum_ruscinonense	1.928
Erysimum_penyalarense	3.652
Erysimum_merxmuelleri	3.652
Erysimum_lagascae	2.334
Erysimum_ochroleucum	1.778
Erysimum_gomez-campoi	1.363
Erysimum_seipkae	1.645
Erysimum_duriaei	1.645
Erysimum_linifolium	1.423
Erysimum_nevadense	1.204
Erysimum_rondae	1.408
Erysimum_fitzii	1.408
Erysimum_myriophyllum	1.246
Erysimum_cazorlense	1.023
Erysimum_belvederense	0.773

Erysimum_virescens	1.083
Erysimum_arbuscula	1.083
Erysimum_caboverdeanum	1.033
Erysimum_bicolor	1.328
Erysimum_scoparium	1.328
Erysimum_ehrendorferi	1.963
Erysimum_nervosum	1.963
Erysimum_gramineum	1.132
Erysimum_ghaznicum	2.520
Erysimum_acrotonum	2.520
Erysimum_leucanthemum	1.768
Erysimum_badghysi	1.133
Erysimum_salangense	1.036
Erysimum_alaicum	0.970
Erysimum_cyaneum	1.731
Erysimum_czernjajevi	1.731
Erysimum_thomsonii	1.603
Erysimum_vitellinum	1.413
Erysimum_griffithii	1.155
Erysimum_laxiflorum	0.778
Erysimum_subulatum	0.752
Erysimum_kerbabaevii	0.908
Erysimum_crassicaule	0.908
Erysimum_pseudopurpureum	0.788
Erysimum_purpureum	0.715
Erysimum_oleifolium	1.168
Erysimum_hirschfeldioides	1.168
Erysimum_scabrum	0.805
Erysimum_spetae	2.260
Erysimum_passgalense	2.260
Erysimum_asperrimum	1.564
Erysimum_lilacinum	0.974
Erysimum_kurdicum	0.791
Erysimum_carniolicum	2.387
Erysimum_witmannii	2.387
Erysimum_canum	1.765
Erysimum_quadrangulum	1.172
Erysimum_metlesicsii	0.782
Erysimum_repandum	0.782
Erysimum_leptostylum	1.257
Erysimum_macrostigma	1.257
Erysimum_ischnostylum	1.160
Erysimum_inense	1.451
Erysimum_ledebourii	1.451
Erysimum_roseum	2.111
Erysimum_handel-mazzettii	2.111
Erysimum_pachycarpum	1.708
Erysimum_deflexum	1.708
Erysimum_humillimum	0.915

Erysimum_callicarpum	1.149
Erysimum_amurense	1.149
Erysimum_kamelinii	0.887
Erysimum_pallasii	1.716
Erysimum_redowskii	1.716
Erysimum_rhodium	1.031
Erysimum_senoneri	1.031
Erysimum_naxense	0.996
Erysimum_perofskianum	0.937
Erysimum_siliculosum	4.419
Erysimum_mongolicum	4.419
Erysimum_boreale	3.358
Erysimum_hieraciifolium	2.301
Erysimum_virgatum	1.431
Erysimum_collisparsum	1.172
Erysimum_jugicola	1.172
Erysimum_sisymbrioides	0.760
Erysimum_cheiri	0.724
Erysimum_cheiranthoides	0.693
Erysimum_odoratum	0.665
Erysimum_idae	0.939
Erysimum_crassipes	0.939
Erysimum_pulchellum	0.912
Erysimum_lazistanicum	1.069
Erysimum_krendlii	1.069
Erysimum_lycaonicum	0.914
Erysimum_crepidifolium	0.795
Erysimum_stenophyllum	1.185
Erysimum_linariifolium	1.185
Erysimum_pectinatum	0.823
Erysimum_griffithianum	0.726
Erysimum_sintenisianum	0.625
Erysimum_aureum	1.228
Erysimum_aucherianum	1.228
Erysimum_smyrnaeum	0.617
Erysimum_gypsaceum	0.609
Erysimum_diffusum	0.594
Erysimum_cuspidatum	0.567
Erysimum_asperum	1.288
Erysimum_angustatum	1.288
Erysimum_capitatum	0.658
Erysimum_comatum	0.458
Erysimum_nasturtioides	1.427
Erysimum_elbrusense	1.427
Erysimum_szowitsianum	1.295
Erysimum_gelidum	1.101
Erysimum_hajastanicum	1.149
Erysimum_leptophyllum	1.149
Erysimum_uncinatifolium	0.756

Erysimum_elymaiticum	0.536
Erysimum_caespitosum	0.397
Erysimum_wilczekianum	0.397
Erysimum_etnense_subsp._etnense	1.430
Erysimum_pusillum	1.430
Erysimum_bonannianum	0.948
Erysimum_rhaeticum	1.282
Erysimum_crassistylum	1.282
Erysimum_sylvestre	0.727
Erysimum_incanum	0.421
Erysimum_majellense	0.830
Erysimum_pseudorhaeticum	0.830
Erysimum_serpentinicum	0.546
Erysimum_echinellum	0.407
Erysimum_ibericum	0.187
Erysimum_gabrielianiae	0.187
Olimarabidopsis_cabulica	0.345
Olimarabidopsis_pumila	0.345
Olimarabidopsis_umbrosa	0.200
Alyssopsis_mollis	0.201
Alyssopsis_trinervis	0.201
Calymmatium_draboides	0.101
Arabidopsis_kamchatica	0.399
Arabidopsis_lyrata	0.399
Arabidopsis_petraea_subsp._umbrosa	0.605
Arabidopsis_arenicola	0.605
Arabidopsis_croatica	0.305
Arabidopsis_arenosa_subsp._arenosa	0.419
Arabidopsis_neglecta	0.419
Arabidopsis_halleri	0.356
Arabidopsis_umezawana	0.356
Arabidopsis_pedemontana	0.295
Arabidopsis_cebennensis	0.295
Arabidopsis_suecica	0.171
Arabidopsis_thaliana	0.171
Arabidopsis_arenosa	0.077
Capsella_orientalis	0.334
Capsella_bursa-pastoris	0.334
Capsella_rubella	0.317
Capsella_grandiflora	0.317
Chrysochamela_velutina	0.099
Catolobus_pendulus	0.092
Camelina_alyssum	0.580
Camelina_sativa	0.580
Camelina_microcarpa	0.301
Camelina_rumelica	0.154
Neslia_paniculata	0.099
Pseudoarabidopsis_toxophylla	0.079
Turritis_glabra	0.117

Turritis_laxa	0.117
Oreophyton_falcatum	0.074
Boechera_selbyi	2.155
Boechera_pallidifolia	2.155
Boechera_paupercula	1.293
Boechera_villosa	0.985
Boechera_falcifructa	0.720
Boechera_cobrensis	0.720
Boechera_formosa	0.688
Boechera_macounii	0.789
Boechera_lemmonii	0.789
Boechera_yorkii	0.797
Boechera_subpinnatifida	0.797
Boechera_williamsii	0.709
Boechera_falcata	0.660
Boechera_polyantha	0.660
Boechera_platysperma	1.152
Boechera_howellii	1.152
Boechera_arcuata	0.738
Boechera_rectissima	0.738
Boechera_dispar	1.273
Boechera_serpenticola	1.273
Boechera_retrofracta	1.119
Boechera_pygmaea	0.919
Boechera_lignifera	0.728
Boechera_lincolnensis	0.747
Boechera_glaucovalvula	0.747
Boechera_davidsonii	0.613
Boechera_collinsii	0.594
Boechera_evadens	0.562
Boechera_constancei	0.912
Boechera_suffrutescens	0.912
Boechera_rollei	0.711
Boechera_tiehmii	0.579
Boechera_lasiocarpa	0.477
Boechera_crandallii	0.812
Boechera_texana	0.812
Boechera_parishii	0.848
Boechera_johnstonii	0.848
Boechera_oxylobula	1.017
Boechera_demissa	1.017
Boechera_spatifolia	1.256
Boechera_gracilipes	1.256
Boechera_nevadensis	0.891
Boechera_perennans	0.750
Boechera_shockleyi	1.407
Boechera_inyoensis	1.407
Boechera_fendleri	0.854
Boechera_pendulocarpa	0.579

Boechera_bodiensis	1.022
Boechera_cusickii	1.022
Boechera_koehleri	0.996
Boechera_puberula	0.996
Boechera_schistacea	0.516
Boechera_stricta	0.757
Boechera_grahamii	0.757
Boechera_divaricarpa	0.556
Boechera_lyallii	0.389
Boechera_serotina	0.751
Boechera_missouriensis	0.751
Boechera_laevigata	0.461
Boechera_perstellata	0.402
Boechera_shortii	0.402
Boechera_canadensis	0.172
Boechera_gunnisoniana	0.172
Boechera_repanda	0.165
Anelsonia_eurycarpa	0.145
Sandbergia_whitedii	0.187
Sandbergia_perplexa	0.187
Phoenicaulis_cheiranthoides	0.123
Nevada_holmgrenii	0.123
Cusickiella_douglasii	0.103
Cusickiella_quadricostata	0.103
Polyctenium_fremontii	0.097
Borodinia_baicalensis	0.153
Borodinia_macrophylla	0.153
Halimolobos_lasiolobus	0.804
Halimolobos_henricksonii	0.804
Halimolobos_elatus	0.602
Halimolobos_diffusus	0.402
Halimolobos_jaegeri	0.254
Halimolobos_minutiflorus	0.288
Halimolobos_adpressus	0.288
Pennellia_longifolia	0.155
Pennellia_micrantha	0.155
Sphaerocardamum_fruticulosum	1.262
Sphaerocardamum_stellatum	1.262
Sphaerocardamum_macropetalum	0.636
Sphaerocardamum_divaricatum	0.463
Sphaerocardamum_ramosum	0.607
Sphaerocardamum_macrum	0.607
Sphaerocardamum_nesliiforme	0.213
Sphaerocardamum_compressum	0.148
Exhalimolobos_weddellii	0.540
Exhalimolobos_palmeri	0.540
Exhalimolobos_hispidulus	0.310
Exhalimolobos_berlandieri	0.282
Exhalimolobos_parryi	0.282

Mancoa_bracteata	0.166
Mancoa_foliosa	0.166
Pachycladon_enysii	0.672
Pachycladon_fastigiatum	0.672
Pachycladon_stellatum	0.350
Pachycladon_latisiliquum	0.287
Pachycladon_wallii	0.237
Pachycladon_cheesemanii	0.441
Pachycladon_exile	0.441
Pachycladon_novaezelandiae	0.254
Pachycladon_radicatum	0.141
Stenopetalum_nutans	0.106
Blennodia_pterosperma	0.157
Blennodia_canescens	0.157
Scambopus_curvipes	0.119
Pachymitus_cardaminoides	0.151
Drabastrum_alpestre	0.151
Microlepidium_pilosulum	0.095
Harmsiodoxa_blennodioides	0.095
Phlegmatospermum_eremaeum	0.091
Irenepharsus_magicus	0.082
Cuphonotus_humistratus	0.113
Menkea_sphaerocarpa	0.113
Arabidella_trisecta	0.070
Dipoma_iberideum	0.066
Crucihimalaya_mollissima	0.581
Crucihimalaya_kneuckeri	0.581
Crucihimalaya_wallichii	0.369
Crucihimalaya_stricta	0.361
Crucihimalaya_himalaica	0.361
Crucihimalaya_tenuisiliqua	0.261
Crucihimalaya_lasiocarpa	0.261
Crucihimalaya_mongolica	0.095
Physaria_spatulata	0.765
Physaria_pycnantha	0.765
Physaria_eriocarpa	0.589
Physaria_subumbellata	0.626
Physaria_intermedia	0.626
Physaria_nelsonii	0.513
Physaria_bellii	1.347
Physaria_newberryi	1.347
Physaria_acutifolia	0.822
Physaria_hemiphysaria	0.392
Physaria_occidentalis	0.334
Physaria_ludoviciana	0.287
Physaria_humilis	0.329
Physaria_goodrichii	0.329
Physaria_pallida	0.331
Physaria_gracilis	0.331

Physaria_filiformis	0.162
Physaria_pruinosa	0.181
Physaria_rosei	0.181
Physaria_johnstonii	0.119
Physaria_argyraea	0.178
Physaria_fendleri	0.178
Paysonia_lescurii	0.729
Paysonia_densipila	0.729
Paysonia_stonensis	0.398
Paysonia_auriculata	0.213
Paysonia_grandiflora	0.132
Paysonia_lasiocarpa	0.093
Nerisyrenia_linearifolia	0.250
Nerisyrenia_johnstonii	0.250
Lyrocarpa_coulteri	0.158
Synthlipsis_greggii	0.118
Dithyrea_californica	0.095
Dimorphocarpa_wislizeni	0.076
Cardamine_raphanifolia	0.550
Cardamine_matthioli	0.550
Cardamine_crassifolia	0.555
Cardamine_castellana	0.555
Cardamine_pratensis	0.368
Cardamine_schulzii	0.314
Cardamine_caldeirarum	0.437
Cardamine_amara	0.437
Cardamine_barbaraeoides	0.239
Cardamine_amporitana	0.219
Cardamine_longifructus	0.843
Cardamine_tanakae	0.843
Cardamine_dentipetala	0.634
Cardamine_niigatensis	0.425
Cardamine_regeliana	0.513
Cardamine_scutata	0.513
Cardamine_flexuosa	0.863
Cardamine_gallaecica	0.863
Cardamine_pensylvanica	0.553
Cardamine_ovata	0.293
Cardamine_paucijuga	0.562
Cardamine_fallax	0.562
Cardamine_manshurica	0.319
Cardamine_rhizomata	0.307
Cardamine_ecuadorensis	0.307
Cardamine_griffithii	0.190
Cardamine_lihengiana	0.179
Cardamine_douglassii	0.311
Cardamine_bulbosa	0.311
Cardamine_bonariensis	0.159
Cardamine_cordifolia	0.244

Cardamine_breweri	0.244
Cardamine_pentaphyllos	0.104
Cardamine_sp._RS-2013	0.646
Cardamine_appendiculata	0.646
Cardamine_hirsuta	0.341
Cardamine_pattersonii	0.284
Cardamine_oligosperma	0.284
Cardamine_parviflora	0.110
Cardamine_trifolia	0.091
Cardamine_nuttallii	0.783
Cardamine_clematitis	0.783
Cardamine_occidentalis	0.617
Cardamine_purpurea	0.525
Cardamine_debilis	0.728
Cardamine_umbellata	0.728
Cardamine_victoris	0.523
Cardamine_digitata	0.383
Cardamine_pedata	0.554
Cardamine_blaisdellii	0.554
Cardamine_yezoensis	0.331
Cardamine_lyallii	0.221
Cardamine_rupicola	0.165
Cardamine_glechomifolia	0.402
Cardamine_circaeoides	0.402
Cardamine_microzyga	0.224
Cardamine_delavayi	0.181
Cardamine_asarifolia	0.148
Cardamine_bellidifolia	0.336
Cardamine_nipponica	0.336
Cardamine_alpina	0.229
Cardamine_resedifolia	0.187
Cardamine_pancicii	0.265
Cardamine_glauca	0.265
Cardamine_plumieri	0.127
Cardamine_carnosa	0.127
Cardamine_glanduligera	0.112
Cardamine_graeca	0.108
Cardamine_africana	0.102
Cardamine_concatenata	0.472
Cardamine_laciniata	0.472
Cardamine_angustata	0.237
Cardamine_diphylla	0.150
Cardamine_macrophylla	0.202
Cardamine_tangutorum	0.202
Cardamine_fragariifolia	0.112
Cardamine_yunnanensis	0.107
Cardamine_constancei	0.107
Cardamine_bradei	0.096
Cardamine_pectinata	0.143

Cardamine_impatiens	0.143
Cardamine_leucantha	0.179
Cardamine_microphylla	0.179
Cardamine_conferta	0.103
Cardamine_enneaphyllos	0.103
Cardamine_adriatica	0.409
Cardamine_monteluccii	0.409
Cardamine_fialae	0.404
Cardamine_maritima	0.404
Cardamine_serbica	0.261
Cardamine_montenegrina	0.261
Cardamine_rupestris	0.117
Cardamine_limprichtiana	0.069
Iodanthus_pinnatifidus	0.064
Nasturtium_officinale	0.112
Nasturtium_microphyllum	0.112
Leavenworthia_crassa	1.901
Leavenworthia_alabamica	1.901
Leavenworthia_exigua	0.957
Leavenworthia_uniflora	0.506
Leavenworthia_stylosa	0.783
Leavenworthia_aurea	0.783
Leavenworthia_texana	0.479
Leavenworthia_torulosa	0.145
Selenia_mexicana	0.243
Selenia_dissecta	0.243
Selenia_grandis	0.146
Selenia_jonesii	0.116
Selenia_aurea	0.086
Planodes_virginica	0.069
Ornithocarpa_torulosa	0.065
Rorippa_cantoniensis	0.351
Rorippa_indica	0.351
Rorippa_austriaca	0.322
Rorippa_islandica	0.322
Rorippa_palustris	0.583
Rorippa_amphibia	0.583
Rorippa_sylvestris	0.293
Rorippa_teres	0.093
Sisymbrella_aspera	0.086
Barbarea_orthoceras	0.222
Barbarea_verna	0.222
Barbarea_vulgaris	0.126
Armoracia_rusticana	0.056
Lepidium_limenophylax	3.445
Lepidium_didymum	3.445
Lepidium_banksii	3.153
Lepidium_aegrum	3.133
Lepidium_panniforme	3.107

Lepidium_seditiosum	3.070
Lepidium_oligodontum	3.015
Lepidium_crassum	2.927
Lepidium_juvencum	2.783
Lepidium_flexicaule	2.548
Lepidium_oleraceum	2.195
Lepidium_rekohuense	1.730
Lepidium_obtusatum	1.221
Lepidium_nesophilum	0.773
Lepidium_desvauxii	0.607
Lepidium_foliosum	0.426
Lepidium_africanum	0.268
Lepidium_graminifolium	0.178
Lepidium_rubtzovii	0.765
Lepidium_ruderale	0.765
Lepidium_lacerum	0.384
Lepidium_subcordatum	0.201
Lepidium_papilliferum	0.580
Lepidium_montanum	0.580
Lepidium_davisii	0.291
Lepidium_meyenii	0.258
Lepidium_alyssoides	0.403
Lepidium_virginicum	0.403
Lepidium_bonariense	0.324
Lepidium_navasii	0.221
Lepidium_sisymbrioides	0.385
Lepidium_solandri	0.385
Lepidium_naufragorum	0.256
Lepidium_sativum	0.223
Lepidium_densiflorum	0.223
Lepidium_apetalum	0.165
Lepidium_angustissimum	0.165
Lepidium_aucheri	0.109
Lepidium_squamatum	0.072
Lepidium_phlebopetalum	0.072
Lepidium_chalepense	0.058
Lepidium_heterophyllum	0.234
Lepidium_campestre	0.234
Lepidium_hirtum	0.153
Lepidium_draba	0.107
Lepidium_perfoliatum	0.074
Cyphocardamum_aretioides	0.049
Delpinophytum_patagonicum	0.041
Descurainia_appendiculata	2.845
Descurainia_pimpinellifolia	2.845
Descurainia_glaucescens	1.486
Descurainia_argentina	1.053
Descurainia_cumingiana_subsp._cumingiana	1.211
Descurainia_heterotricha	1.211

Descurainia_stricta	2.141
Descurainia_streptocarpa	2.141
Descurainia_myriophylla	1.772
Descurainia_obtusa_subsp._obtusa	1.613
Descurainia_leptoclada	1.389
Descurainia_adenophora	1.097
Descurainia_virletii	0.666
Descurainia_impatiens	0.517
Descurainia_athrocarpa	0.372
Descurainia_depressa	0.250
Descurainia_incana	1.444
Descurainia_incisa	1.444
Descurainia_californica	0.846
Descurainia_pinnata	0.493
Descurainia_brevisiliqua	0.443
Descurainia_sophioides	0.443
Descurainia_paradisa_subsp._nevadensis	0.720
Descurainia_longipedicellata	0.720
Descurainia_nelsonii	0.497
Descurainia_antarctica	0.307
Descurainia_lemsii	1.759
Descurainia_gonzalezii	1.759
Descurainia_millefolia	1.256
Descurainia_preauxiana	0.847
Descurainia_bourgeauana	0.918
Descurainia_gilva	0.918
Descurainia_artemisioides	0.402
Descurainia_tanacetifolia	0.271
Descurainia_sophia	0.123
Descurainia_kochii	0.123
Robeschia_schimperii	0.063
Ianhedgea_minutiflora	0.056
Pritzelago_alpina	0.141
Hornungia_alpina	0.141
Hornungia_petraea	0.075
Tropidocarpum_gracile	0.057
Smelowskia_bifurcata	0.315
Smelowskia_alba	0.315
Smelowskia_porsildii	0.272
Smelowskia_media	0.407
Smelowskia_borealis	0.407
Smelowskia_americana	0.276
Smelowskia_calycina	0.276
Smelowskia_flavissima	0.131
Smelowskia_parryoides	0.295
Smelowskia_sophiifolia	0.295
Smelowskia_jacutica	0.238
Smelowskia_pyriformis	0.275
Smelowskia_johnsonii	0.275

Smelowskia_inopinata	0.152
Smelowskia_bartholomewii	0.135
Smelowskia_tibetica	0.135
Smelowskia_annua	0.123
Smelowskia_sisymbrioides	0.123
Yinshania_acutangula_subsp._acutangula	0.094
Yinshania_zayuensis	0.188
Yinshania_henryi	0.188
Lobularia_canariensis_subsp._microsperma	0.735
Lobularia_canariensis_subsp._intermedia	0.735
Lobularia_canariensis_subsp._fruticosa	0.738
Lobularia_canariensis_subsp._palmensis	0.738
Lobularia_canariensis_subsp._spathulata	0.350
Lobularia_canariensis_subsp._canariensis	0.397
Lobularia_canariensis_subsp._marginata	0.397
Lobularia_libyca	0.142
Lobularia_arabica	0.141
Lobularia_maritima	0.141
Notoceras_bicorne	0.053
Morettia_parviflora	0.173
Morettia_canescens	0.173
Morettia_philaeana	0.098
Diceratella_inermis	0.087
Lachnocapsa_spathulata	0.071
Parolinia_intermedia	0.083
Anastatica_hierochuntica	0.083
Farsetia_robecchiana	0.185
Farsetia_undulicarpa	0.185
Farsetia_longistyla	0.152
Farsetia_linearis	0.119
Farsetia_aegyptia	0.176
Farsetia_longisiliqua	0.176
Farsetia_stylosa	0.059
Eremobium_aegyptiacum	0.200
Eremobium_lineare	0.200
Cithareloma_lehmannii	0.122
Eremobium_aegyptiacum_subsp._longisiliquum	0.076
Maresia_nana	0.057
Malcolmia_karelinii	0.132
Malcolmia_scorpioides	0.132
Malcolmia_africana	0.069
Malcolmia_triloba	0.098
Malcolmia_littorea	0.098
Malcolmia_ramosissima	0.050
Malcolmia_maritima	0.111
Malcolmia_orsiniana_subsp._angulifolia	0.111
Malcolmia_orsiniana	0.064
Aethionema_erinaceum	0.104
Aethionema_grandiflorum	0.104

Aethionema_elongatum	0.066
Aethionema_saxatile	0.073
Aethionema_arabicum	0.073

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