Electronic Supplementary Material

Details of methodology and analyses

(a) Literature search

We searched for relevant data on SciVerse Scopus database using the following series of related combinations of terms for herbivory:

TITLE-ABS-KEY("rate of grazing" OR "grazing rate" OR "amount of grazing" OR "level* of grazing" OR "grazing level*" OR "rate* of herbivor*" OR "herbivor* rate" OR "amount of herbivor*" OR "herbivory level*" OR "level* of herbivory" OR "degree of herbivor*" OR "rate* of defoliat*" OR "defoliat* rate" OR "amount of defoliat*" OR "defoliation level*" OR "level* of defoliation" OR "foli* damage*" OR "foli* level*" OR "level* of foli*" OR "leaf min* damag*" OR "leaf area remov*" OR "leaf damage" OR "damage to lea*" OR "percent leaf area" OR "leaf area damage" OR "removal of leaf" OR "leaf consumption" OR "consumption of leaves" OR "leaf herbivor*" OR "canopy consumption" OR "consumption of canopy" OR "canopy damag*" OR "canopy defoliation" OR "foliage damag*" OR "foliage consum*" OR "consumption of foliage" AND NOT *plankton* AND NOT alga*) AND DOCTYPE(ar OR ip OR cp OR le OR no OR sh)*

* Truncated words with all possible ending will be identified

(b) Data selection criteria

In collecting data our aim was to obtain measurements of leaf herbivory that were comparable across all plant species and ecosystems. We therefore only retained data that was likely to represent the amount of natural herbivory that a typical leaf from a given species would experience in a single year. We excluded studies or treatments within studies that added herbivores to plants. In order to conduct a phylogenetically explicit analysis we focused on species-level estimates. Finally, we excluded studies that only reported leaf herbivory during an outbreak year without baseline data because these extreme events do not represent natural herbivory rates unless corrected for frequency of occurrence. One caveat to our method is that our estimates of herbivory might be lower than historical averages if taxa that acted as major herbivores in the past recently went extinct. This might be especially true for some large grassland herbivores (e.g., Bison) and other megafauna (e.g., Moa, Woolly Mammoth and Giant Sloth), which were hunted to extinction or functionally removed from their native ecosystems. Even so, our estimates should accurately reflect modern rates of herbivory and the loss of these herbivores should not affect our ability to make inferences about evolutionary differences in herbivory and defence among plant lineages.

We focused on damage to leaf tissue for multiple reasons. First, leaf herbivory has strong impacts on individual plants and communities [1-3]. Studies show that even small amounts of leaf herbivory can reduce plant fitness [4, 5]. Although herbivory can cause variable impacts on plant growth, recent meta-analyses of experimental studies find that aboveground leaf herbivory frequently causes reduced plant growth, photosynthesis, and fitness compared to protected plants with effects as large as competition between plants [6, 7]. Leaf herbivory has also been shown to influence the evolution of defensive traits [8-10], plant population dynamics [3], species distributions and community composition [3, 11], and ecosystem productivity [12-14]. Second, quantifying leaf damage is easier and thus much more common than quantifying damage on roots, reproductive tissues, or damage caused by piercing herbivores [15, 16]. For example, damage caused by phloem feeders might only be apparent if one quantifies the loss of growth potential compared to undamaged plants. Third, leaf damage is easier to standardize across species since leaves are almost always present in the growing season, unlike some other tissues [e.g., flowers and fruits; 17]. It is difficult to say whether damage to leaves is representative of other tissues because few studies have compared damage rates directly [18]. The few studies that have made such comparisons suggest that leaf herbivory is usually higher than root herbivory and similar to or lower than damage to flowers and fruits [17, 19]. Fourth, we focused on percent leaf area lost caused by chewing, grazing, leaf mining, and scraping but excluded damage due to galling, phloem and xylem feeding because quantifying tissue loss due to these processes is difficult to do across many species [15, 16, 20]. The study of herbivory at the scale we present here, both in phylogenetic breadth and number of species, is currently only possible using percent leaf area damage.

To effectively compare rates of leaf herbivory across species we collected estimates of annual percent damage. In deciduous species, the limited growing season limits leaf life-span to a single year and measures collected towards the end of the growing season accurately reflect annual rates of damage [20]. In evergreen species, leaves can survive for multiple years, which could cause an overestimation of annual damage. This is probably a minor effect because most damage to leaves occurs within their first year [21]. A more complex issue occurs in species that continually produce new leaves because annual rates of herbivory will depend on the rate of leaf production. This issue has motivated researchers to present herbivory as a daily rate of damage usually measured over several months with regular sampling [22, 23]. These values are not easily converted into annual leaf herbivory because rates of damage change with leaf age and season. One cannot simply sum daily rates of damage over a year, which can reach over 100% [22], without correcting for leaf production and [the number of leaf flushes; 24]. Given these limitations, our approach for this type of data was to estimate total herbivory received by a leaf during its lifetime, most of which occurs within its first year of growth as an estimate of the proportion of annual primary production consumed (see below).

The various methodologies used to measure percent leaf herbivory have received much attention [20-22, 25]. The two most common sampling approaches are: i) single measures of herbivory on standing leaves, and ii) the quantification of herbivory on marked leaves over an extended period of time. Both methods have potential shortcomings. Standing measures of herbivory can underestimate annual herbivory when completely consumed leaves are not measured [20, 22, 25-27]. The marking approach can overestimate damage when missing leaves are assumed to have been completely consumed when in fact some leaves might have been dropped by the plant after a smaller amount of damage [20, 28]. In addition, marking leaves can alter rates of herbivory because repeated human visitation can increase rates of herbivory for some species [29, 30].

We included data collected using both the standing and marked methods. This was justified because standing measures of leaf herbivory are the most commonly reported and often the only available data for most species. Furthermore, some authors do account for completely consumed leaves by looking for evidence of chewing damage on petioles [31-33]. Most studies however, do not explicitly state how they deal with missing leaves and others reveal that it was impossible to determine the cause of damage even with careful observation [20]. However, when both types of data were available, we used that from marked leaves, assuming the total damage received at the end of the sampling period as a measure of annual herbivory. Details of the studies included in the database, including habitat, location, climate, and sampling methodology, can be found in Turcotte et al. [34].

To account for potential methodological biases, we created two datasets of different stringency. In temperate systems, studies that reported herbivory at the end of the summer or fall were included in the stringent dataset whereas a less-stringent dataset also included measurements made in mid-summer (7 studies, data on 22 species). In tropical systems we excluded studies that measured herbivory only during the first month of growth of new leaves. We did so because for most species this period represents an underestimate of annual herbivory; Coley and Barone [21] report that 68%, 47%, and 29% of damage occurs during leaf expansion of species found in tropical wet forests (shade-tolerant species), tropical wet forests (gap specialists), and tropical dry forests, respectively. For tropical systems, we only included data on mature leaves (standing or marked measures) in the stringent dataset. In the less stringent dataset we also included studies of young and old leaves, or of an unknown mixture of leaves (13 studies, 104 species), plus studies measuring herbivory on leaves that were two months old (2 studies, 22 species).

Leaf herbivory values were often extracted directly from figures using Web Plot Digitizer (http://arohatgi.info/WebPlotDigitizer/). We also took note when studies mentioned the main herbivores but few studies explicitly quantified herbivore visitation rates especially on different plant species. Of the studies that noted the type of damage, 45% report that insects are the main herbivores (32% Lepidoptera, 20% Coleoptera, and 6% Orthoptera), while 5% identify crustaceans, and 4% report vertebrates as the principal consumer. We acknowledge that our selection criteria might exclude the impact of certain herbivores, such as grassland grazers for which herbivory is not commonly studied by measuring percent leaf area damaged.

(c) Phylogenetic inference

We first created a backbone family-level phylogeny for the 161 families in the database using the Phylomatic v.3 online tool based on the APG megatree [http://phylodiversity.net/phylomatic; 35]. Species were then added to the tree as polytomies using currently accepted taxonomy [e.g., 36]. We resolved this tree to the species level based on published plastid *rbcL* sequence from NCBI's GenBank (www.ncbi.nlm.nih.gov/genbank), which was available for 487 out of 1058 species. For another 202 species we were able to obtain sequence data from congeners (hereafter "placeholder" species).

We aligned sequences using BioEdit v.7.1.3 [37] and excluded sequences shorter than 500 nucleotides. Using the family-level tree as a constraint we reconstructed phylogenetic relationships using maximum likelihood (ML) assuming a general time reversible model with 25 rate categories in RAxML v7.3.1 [38, 39]. We made the branch lengths of the tree proportional to time using Pathd8 v1.0 (http://www2.math.su.se/PATHd8/) and fossil calibrations (table S2). Finally, we generated a posterior distribution of dated trees using BEAST v1.7.4 [http://beast.bio.ed.ac.uk; 40], using the ML topology as a constraint and allowing branch lengths to vary assuming a general time reversible model of DNA evolution, as selected as the best fit model by jModelTest v2.1.1 [41]. We used a log-normal relaxed clock to estimate substitution rate variation and time calibrated the analysis using 19 fossil dates (table S2) as log-normal priors. We ran six BEAST analyses each lasting 33 to 72 million generations, where the first 8 to 15 million generations were discarded as burn-in. Each of the separate post-burn-in runs was then concatenated, and the maximum clade credibility values were extracted using TreeAnnotator. Phylogenetic inference was conducted on CIPRES (www.phylo.org).

Species for which no sequence data was available (367 species) were included as polytomies at the least inclusive node, mostly at the level of genus, although 27 species had to be added at their family node (the Nexus formatted script of the unresolved phylogeny is available as a supplementary material). We then resolved polytomies using a Bayesian approach that fits a birth-death diversification model, generating 1000 fully resolved trees [42].

(d) Phylogenetic comparative analysis

We used phylogenetic comparative methods to analyse differences in leaf herbivory across plant taxa and to characterize the evolutionary model that best explained variation in herbivory across lineages of vascular plants. First, we assessed the fit of a Brownian Motion (BM) model of stochastic evolution (Equation 1);

$$dX(t) = \sigma dB(t) \qquad (1)$$

This equation describes the amount of change in trait (X) over a short time period (t). The term ($dB(t)$) are normal random variables with a mean of zero and variance of ($\sigma^2 dt$). The rate of stochastic evolution is thus (σ^2)[43, 44]. Second, we compared the fit of the Hansen model [45, 46] that assumes an Ornstein-Uhlenbeck (OU) process in which traits evolve toward an evolutionary optimum in a way that is consistent with evolution by stabilizing selection, while genetic drift causes traits to evolve away from this optima in a stochastic manner [43, 44]. This model is represented by equation 2:

$$dX(t) = \alpha\,[\theta - X(t)]dt + \sigma dB(t) \qquad (2)$$

The additional term represents stabilizing selection, where (α) is the strength of selection pulling the trait value towards the optimum trait value (θ).

We compared the fit of alternative models using sample-size corrected Akaike information criteria (AICc) scores [47]. First we compared the fit of simple OU and BM models ('OU1' and 'BM1') where all branches in the phylogeny had a fixed evolutionary optimum (θ, OU1 model) and rate of stochastic evolution (σ^2, OU1 and BM1 models). Second, we allowed evolutionary parameters to vary with plant traits. Complex models assumed multiple rates of stochastic evolution (BMS) or multiple evolutionary optima (OUM) using the following trait categories: 1) life-history variation – annual, intermediate, and perennial, 2) woodiness – woody and non-woody, and 3) growth form – tree, vine, shrub, graminoid, and forb. Multi-optima and multi-rate models require information on expected trait values for each fitted clade. For this purpose, ancestral state estimates were inferred from extant tip data using the *make.simmap* function in *phytools* package [48] in R [49] that simulates stochastic character mapping using a continuous-time reversible Markov chain process. More complex models, that permitted variation in (σ^2), (θ_i), and (α) simultaneously [44], would not convergence on stable ML estimates.

Analyses were conducted on natural log-transformed leaf herbivory rates (x +1) using the *OUwie* v.1.33 package [44] in R v.3.0 [49]. Because large differences in herbivory between major lineages, it was not possible to run complex models across the entire phylogeny, we thus analysed each major taxonomic group separately. Basal angiosperms, basal eudicots, and basal coreeudicots were grouped into a single paraphyletic clade referred to as 'other angiosperms' since these species did not fit as monophyletic groupings with other major lineages (see Fig. 2B for the number of species within each lineage).

Supplemental tables

Table S1. Mean annual percent leaf tissue consumption as measured by four unpublished studies with taxonomic information and trait data. Study (A): data collected by R.M. Godfrey in Trinidad in 2011. Study (B): collected M.T.J. Johnson and G.T. Broadhead in Eastern U.S.A. in 2009. Study (C): collected by M.T.J. Johnson in Eastern Canada and U.S.A. in 2012. Study (D): collected by C.J.M. Thomsen in Ontario Canada in 2012.

study	**species**	**synonym**	**taxonomic lineage**	**woodiness**	**growth form**	**life-history**	**mean leaf damage (%)**
A	*Asclepias curassavica*		Asterids	Non-Woody	Shrub	Perennial	0.80
A	*Bidens pilosa*		Asterids	Non-Woody	Forb	Annual	0.40
A	*Cassia fruticosa*		Rosids	Woody	Tree	Perennial	5.00
A	*Chrysothemis pulchella*		Asterids	Non-Woody	Forb	Perennial	2.17
A	*Lantana camara*		Asterids	Woody	Vine	Perennial	5.58
A	*Laurentia longiflora*	*Hippobroma longiflora*	Asterids	Non-Woody	Forb	Perennial	0.20

Table continues on the next page

Table S1 continued

study	species	synonym	taxonomic lineage	woodiness	growth form	life-history	mean leaf damage (%)
A	*Mimosa pudica*		Rosids	Non-Woody	Forb	Intermediate	2.27
A	*Psiguria umbrosa*	*Anguria umbrosa;* *Citrullus umbrosa*	Rosids	Woody	Vine	Perennial	0.67
A	*Spermacoce assurgens*		Asterids	Non-Woody	Shrub	Intermediate	2.20
A	*Stachytarpheta jamaicensis*		Asterids	Non-Woody	Forb	Intermediate	8.33
A	*Trimezia martinicensis*		Monocots	Non-Woody	Forb	Perennial	0.20
B	*Ambrosia artemisiifolia*		Asterids	Non-Woody	Forb	Annual	1.15
B	*Aquilegia canadensis*		Other Angiosperms	Non-Woody	Forb	Perennial	1.43
B	*Asclepias incarnata*		Asterids	Non-Woody	Forb	Perennial	0.88
B	*Asclepias syriaca*		Asterids	Non-Woody	Forb	Perennial	2.68
B	*Borrichia frutescens*		Asterids	Woody	Shrub	Perennial	0.54

Table continues on the next page

Table S1 continued

study	species	synonym	taxonomic lineage	woodiness	growth form	life-history	mean leaf damage (%)
B	*Campanula americanum*		Asterids	Non-Woody	Forb	Annual	0.73
B	*Capsella bursa-pastoris*		Rosids	Non-Woody	Forb	Annual	0.10
B	*Carduus nutans*		Asterids	Non-Woody	Forb	Perennial	7.05
B	*Cassia fasciculata*		Rosids	Non-Woody	Forb	Annual	3.19
B	*Datura stramonium*		Asterids	Non-Woody	Forb	Annual	0.24
B	*Decodon verticillatus*		Rosids	Woody	Shrub	Perennial	1.21
B	*Erigeron annuus*		Asterids	Non-Woody	Forb	Annual	2.39
B	*Hordeum vulgare*		Monocots	Non-Woody	Graminoid	Annual	0.00
B	*Hypericum perforatum*		Rosids	Non-Woody	Forb	Perennial	2.81
B	*Impatiens capensis*		Asterids	Non-Woody	Forb	Annual	2.01
B	*Ipomoea hederacea*		Asterids	Non-Woody	Vine	Annual	12.49
B	*Ipomoea purpurea*		Asterids	Non-Woody	Vine	Annual	3.94

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Table S1 continued

study	species	synonym	taxonomic lineage	woodiness	growth form	life-history	mean leaf damage (%)
B	*Juglans nigra*		Rosids	Woody	Tree	Perennial	7.78
B	*Kalmia latifolia*		Asterids	Woody	Shrub	Perennial	1.81
B	*Lathyrus latifolius*		Rosids	Non-Woody	Vine	Perennial	0.91
B	*Liriodendron tulipifera*		Magnoliids	Woody	Tree	Perennial	3.90
B	*Lobelia cardinalis*		Asterids	Non-Woody	Forb	Perennial	1.13
B	*Lolium multiflorum*		Monocots	Non-Woody	Graminoid	Annual	0.07
B	*Mimulus ringens*		Asterids	Non-Woody	Forb	Perennial	1.55
B	*Oenothera biennis*		Rosids	Non-Woody	Forb	Intermediate	6.29
B	*Oenothera humifusa*		Rosids	Non-Woody	Forb	Perennial	1.10
B	*Oenothera laciniata*		Rosids	Non-Woody	Forb	Annual	0.56
B	*Phlox drummondii*		Asterids	Non-Woody	Forb	Annual	0.07
B	*Picea rubens*		Gymnosperms	Woody	Tree	Perennial	0.00

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Table S1 continued

study	species	synonym	taxonomic lineage	woodiness	growth form	life-history	mean leaf damage (%)
B	*Polystichum acrostichoides*		Ferns	Non-Woody	Forb	Perennial	2.31
B	*Rhus glabra*		Rosids	Woody	Shrub	Perennial	4.55
B	*Rhus typhina*		Rosids	Woody	Shrub	Perennial	0.75
B	*Robinia pseudoacacia*		Rosids	Woody	Tree	Perennial	7.34
B	*Rumex acetosella*		Other Angiosperms	Non-Woody	Forb	Perennial	3.23
B	*Rumex hastatulus*		Other Angiosperms	Non-Woody	Forb	Perennial	1.82
B	*Sabatia angularis*		Asterids	Non-Woody	Forb	Annual	4.08
B	*Senecio vulgaris*		Asterids	Non-Woody	Forb	Annual	2.44
B	*Solanum carolinense*		Asterids	Non-Woody	Forb	Perennial	3.05
B	*Solanum ptychanthum*		Asterids	Non-Woody	Forb	Annual	8.86

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Table S1 continued

study	species	synonym	taxonomic lineage	woodiness	growth form	life-history	mean leaf damage (%)
B	*Solidago sempervirens*		Asterids	Non-Woody	Forb	Perennial	1.62
B	*Spartina alterniflora*		Monocots	Non-Woody	Graminoid	Perennial	0.04
B	*Taraxacum officinale*		Asterids	Non-Woody	Forb	Annual	1.58
B	*Trillium erectum*		Monocots	Non-Woody	Forb	Perennial	5.23
B	*Trillium grandiflorum*		Monocots	Non-Woody	Forb	Perennial	0.00
B	*Lorinseria areolata*	*Woodwardia areolata*	Ferns	Non-Woody	Forb	Perennial	1.70
B	*Yucca filamentosa*		Monocots	Woody	Shrub	Perennial	0.11
C	*Abies balsamea*	*Abies balsamifera*	Gymnosperms	Woody	Tree	Perennial	3.40
C	*Asplenium platyneuron*		Ferns	Non-Woody	Forb	Perennial	2.28
C	*Brasenia schreberi*		Other Angiosperms	Non-Woody	Forb	Perennial	2.36

Table continues on the next page

Table S1 continued

study	species	synonym	taxonomic lineage	woodiness	growth form	life-history	mean leaf damage (%)
C	*Cystopteris fragilis*		Ferns	Non-Woody	Forb	Perennial	6.90
C	*Gymnocarpium dryopteris*		Ferns	Non-Woody	Forb	Perennial	4.85
C	*Juniperus communis*		Gymnosperms	Woody	Tree	Perennial	0.30
C	*Larix americana*		Gymnosperms	Woody	Tree	Perennial	6.52
C	*Nuphar variegatum*		Other Angiosperms	Non-Woody	Forb	Perennial	6.03
C	*Nymphaea odorata*		Other Angiosperms	Non-Woody	Forb	Perennial	9.77
C	*Osmunda claytoniana*		Ferns	Non-Woody	Forb	Perennial	1.30
C	*Phegopteris connectilis*		Ferns	Non-Woody	Forb	Perennial	11.55
C	*Phegopteris dryopteris*		Ferns	Non-Woody	Forb	Perennial	1.97
C	*Picea glauca*		Gymnosperms	Woody	Tree	Perennial	2.03

Table continues on the next page

197 **Table S1** continued

study	species	synonym	taxonomic lineage	woodiness	growth form	life-history	mean leaf damage (%)
C	*Picea mariana*		Gymnosperms	Woody	Tree	Perennial	0.00
C	*Pinus banksiana*		Gymnosperms	Woody	Tree	Perennial	0.60
C	*Pinus resinosa*		Gymnosperms	Woody	Tree	Perennial	4.27
C	*Polypodium virginianum*		Ferns	Non-Woody	Forb	Perennial	0.74
C	*Taxus canadensis*		Gymnosperms	Woody	Shrub	Perennial	0.04
C	*Thuja occidentalis*		Gymnosperms	Woody	Tree	Perennial	1.91
D	*Larix laricina*		Gymnosperms	Woody	Tree	Perennial	0.60
D	*Picea abies*		Gymnosperms	Woody	Tree	Perennial	0.06
D	*Pinus strobus*		Gymnosperms	Woody	Tree	Perennial	0.28
D	*Pontederia cordata*		Monocots	Non-Woody	Forb	Perennial	1.88
D	*Sagittaria latifolia*		Monocots	Non-Woody	Forb	Perennial	1.01
D	*Tsuga canadensis*		Gymnosperms	Woody	Tree	Perennial	0.88

198

Table S2. Nineteen fossil ages modelled as log-normal priors. Means of priors were set to 0 with a standard error of 1 and an offset value as listed in the table [dates were gathered from 50, 51].

node	year (mya)	node	year (mya)
Lamiales	44.3	Malpighiales	49
Angiosperms	131.0	Myrtales	88.2
Bignoniaceae	35	Pandanales	65.0
Caprifoliaceae	36	Poales	68.1
Caryophyllales	83.5	Proteales	98.0
Cornales	86.0	Sapindales	65
Dilleniaceae	51.9	Solanales	44.3
Ericales	91.2	Vitaceae	57.9
Fabales	59.9	Zingiberales	83.5
Gymnosperms	310		

Supplemental tables

Table S3. Comparison of evolutionary model fits for each major lineage. Top values represent median Akaike Information Criterion values corrected for sample size (AICc) from comparative analyses performed on the distribution of phylogenetic trees. Below these values we report the proportion of trees that show strong support for each model (ΔAICc ≤ 4). Models with the strongest support (ΔAICc ≤ 4) are shown in bold. Models include: Brownian Motion models of stochastic evolution with either a single rate of evolution (BM1) or multiple rates for different traits (BMS), and Ornstein-Uhlenbeck models of stabilizing selection with either a single evolutionary optimum (OU1) or multiple optima for different traits (OUM). Up to three different multi-rate and multi-optima models are possible for each lineage base on plant traits: life-history (annual, intermediate, and perennial), woodiness (woody, non-woody), and growth form (tree, shrub, vine, forb, and graminoid). The "other angiosperms" lineage represents a paraphyletic grouping of species not contained as monophyletic groups of species in the other major lineages and includes basal angiosperms, basal eudicots, and basal coreeudicots.

Table S3

lineage	BM1	BMS			OU1	OUM		
		growth form	woodiness	life-history		growth form	woodiness	life-history
Ferns	106.79				**82.56**			
	0.045				**1.000**			
Gymnosperms	57.82				**40.28**			
	0.000				**1.000**			
Magnoliids	89.43	89.91			**77.39**	**79.16**		
	0.047	0.022			**0.992**	**0.961**		
Monocots	474.14	443.58	458.10	474.52	352.95	**344.11**	354.54	354.19
	0.000	0.000	0.000	0.000	0.061	**0.923**	0.015	0.011
Rosids	2333.1	2283.77	2307.06	2321.3	1401.5	1400.54	**1390.57**	1403.4
	0.000	0.000	0.000	0.000	0.006	0.000	**0.810**	0.000
Asterids	1083.7	1026.10	1068.28	1055.1	649.55	**638.78**	**635.41**	652.15
	0.000	0.000	0.000	0.000	0.001	**0.799**	**0.859**	0.000
Other Angiosperms	338.88	318.27	334.17	337.54	**190.55**	193.34	**188.80**	192.96
	0.000	0.000	0.000	0.000	**0.935**	0.047	**0.937**	0.559

Table S4. Parameter estimates for the stabilizing selection models. Maximum likelihood (ML) parameter estimates for each major lineage for the Ornstein-Uhlenbeck models. See table S5 for the parameters of the poorly fitting BM models. Models include the single evolutionary optimum (OU1) and the multiple optima models for different traits (OUM). Up to three different multi-rate models are possible for each lineage base on plant traits: life-history (annual, intermediate, and perennial), woodiness (woody, non-woody), and growth form (tree, shrub, vine, forb, and graminoid). Estimates are median parameter values of the ML optima value across 1000 phylogenetic trees. Values in parentheses are median 95% confidence intervals that were calculated for each tree and thus incorporate both phylogenetic uncertainty and uncertainty in the maximum likelihood estimates. Parameters include the rate of stochastic evolution 'σ^2', the strength of stabilizing selection'α', and the ML evolutionary optimum 'θ', which is a phylogenetically informed estimate of the rate of herbivory for each group [43, 44].

Table S4

lineage	OU1			OUM Life-History				
	α	σ^2	θ	α	σ^2	θ-Annuals	θ – Interm.	θ – Per.
Ferns	1.13 (1.13-1.18)	1.7 (0.82-2.64)	5.83 (4.01-8.3)					
Gymnosperms	0.14 (-0.07-0.36)	0.13 (-0.06-0.33)	0.87 (0.42-1.47)					
Magnoliids	0.09 (-0.05-0.25)	0.12 (-0.04-0.32)	8.44 (5.47-12.18)					
Monocots	1.05 (0.03-2.64)	3 (0.07-7.2)	3.11 (2.25-4.01)	1.12 (0.03-2.64)	3.37 (0.07-7.14)	1.85 (-0.19-5.26)		3.17 (2.3-4.14)
Rosids	2.99 (2.99 – 3)	4.58 (4.03-5.2)	8.16 (7.5-8.86)	2.99 (2.99-3)	4.57 (4.02-5.2)	6.61 (3.87-10.8)	5.43 (2.3-11.4)	8.25 (7.57-8.97)
Asterids	3.21 (3.2-3.25)	5.35 (4.38-6.52)	4.31 (3.73-4.97)	3.2 (3.2-3.25)	5.31 (4.33-6.51)	3.09 (1.48-5.71)	3.75 (2.1-6.3)	4.44 (3.8-5.16)
Other Angiosperms	2.04 (2.04-2.06)	3.19 (2.13-4.44)	6.16 (4.8-7.81)	2.03 (2.03-2.06)	3.09 (2.07-4.26)	8.9 (1.94-2.29)	2.05 (-0.15-9.3)	6.27 (4.87-7.98)

Table continues on the next page

Table S4 continued

lineage	OUM Woodiness				OUM Growth Form						
	α	σ^2	θ-Non-Woody	θ-Woody	α	σ^2	θ-Shrub	θ -Tree	θ-Forb	θ-Vine	θ-Graminoid
Ferns											
Gymnosperms											
Magnoliids					0.16 (-0.12-0.5)	0.2 (-0.13-0.6)	12.12 (5.75-23.38)	7.58 (4.77-11.05)			
Monocots	1.2 (0.03-2.64)	3.51 (0.07-7.17)	2.99 (2.12-3.94)	3.77 (1.75-6.93)	1.25 (0.04-2.65)	2.95 (0.08-6.24)	2.43 (0.53-6.61)	5.21 (2.08-11.64)	5.03 (3.5-6.94)	3.07 (0.99-6.71)	1.52 (0.86-2.46)
Rosids	2.99 (2.99-3)	4.49 (3.95-5.08)	5.48 (4.28-6.94)	8.63 (7.9-9.42)	2.99 (2.99-3)	4.54 (3.99-5.17)	8.63 (6.82-10.85)	8.49 (7.7-9.35)	5.97 (4.58-7.7)	7.43 (4.92-10.94)	
Asterids	3.21 (3.21-3.25)	5.02 (4.11-6.14)	3.08 (2.45-3.83)	5.55 (4.63-6.61)	3.21 (3.21-3.24)	4.99 (4.07-6.07)	5.02 (3.75-6.59)	5.94 (4.671-7.468)	3.02 (2.36-3.79)	4.3 (2.3-7.44)	
Other Angiosperms	2.04 (2.04-2.06)	3.01 (2.01-4.35)	4.76 (3.29-6.7)	7.72 (5.55-10.55)	2.04 (2.04-2.06)	3.01 (2.01-4.33)	7.23 (4.56-11.09)	8.21 (4.79-13.42)	4.71 (3.23-6.67)	8.16 (2.94-20.4)	

Table S5. Parameter estimates for the stochastic evolution models: Maximum likelihood parameter estimates for each major lineage for the Brownian Motion models of stochastic evolution with either a single rate of evolution (BM1) or multiple rates for different traits (BMS). Up to three different multi-optima models are possible for each lineage base on plant traits: life-history (annual, intermediate, and perennial), woodiness (woody, non-woody), and growth form (tree, shrub, vine, forb, and graminoid). Estimates are median parameter values of the ML optima value across 1000 phylogenetic trees. Values in parentheses are median 95% confidence intervals that were calculated for each tree and thus incorporate both phylogenetic uncertainty and uncertainty in the maximum likelihood estimates. Parameters include the rate of stochastic evolution ‘σ^2’and the ML evolutionary optimum ‘θ’, which is a phylogenetically informed estimate of the rate of herbivory for each group [43, 44].

Table S5

lineage	BM1		BMS Life-History			
	σ^2	θ	σ^2 – Annual	σ^2 – Intermediate	σ^2 – Perennial	θ
Ferns	0.03 (0.01-0.04)	5.52 (-0.74-131.24)				
Gymnosperms	0.03 (0.01-0.05)	0.71 (-0.97-107.03)				
Magnoliids	0.04 (0.02-0.05)	8.78 (0.58-55.47)				
Monocots	0.12 (0.09-0.15)	3.61 (-0.78-85.84)	0.07 (-0.06-0.22)		0.11 (0.08-0.14)	3.62 (-0.77-81.7)
Rosids	0.28 (0.24-0.31)	6.71 (-0.82-301.21)	0.16 (0.02-0.3)	0.05 (-0.05-0.17)	0.27 (0.24-0.3)	6.76 (-0.8-270.7)
Asterids	0.23 (0.19-0.27)	4.18 (-0.8-107.64)	0.29 (-0.04-0.7)	0.4 (0-0.85)	0.17 (0.13-0.2)	4.17 (-0.69-67.2)
Other Angiosperms	0.2 (0.14-0.27)	6.38 (-0.97-1451.3)	0.001 (-0.002-0.005)	0.22 (-0.28-0.76)	0.18 (0.12-0.25)	6.42 (-0.96-1138.1)

Table continues on the next page

Table S5 continued

lineage	**BMS Woodiness**			**BMS Growth Form**					
	σ^{2} – Non-Woody	σ^{2} – Woody	θ	σ^{2} – Shrub	σ^{2} – Tree	σ^{2} – Forb	σ^{2} – Vine	σ^{2} – Graminoid	θ
Ferns									
Gymnosperms									
Magnoliids				0.02 (-0.01-0.06)	0.04 (0.02-0.06)				8.89 (0.76-52.07)
Monocots	0.1 (0.07-0.12)	0.11 (0.03-0.19)	3.62 (-0.69-66.6)	0.03 (-0.01-0.09)	0.14 (0.01-0.27)	0.06 (0.03-0.08)	0.1 (-0.01-0.2)	0.1 (0.06-0.14)	3.63 (-0.47-32.37)
Rosids	0.11 (0.07-0.15)	0.28 (0.25-0.32)	6.58 (-0.79 - 247)	0.25 (0.13-0.38)	0.27 (0.23-0.3)	0.11 (0.07-0.16)	0.09 (0.02-0.17)		6.76 (-0.68-190.27)
Asterids	0.23 (0.17-0.3)	0.16 (0.12-0.2)	4.19 (-0.67-68.1)	0.04 (0.02-0.06)	0.17 (0.12-0.22)	0.23 (0.16-0.29)	0.16 (0.03-0.3)		3.96 (-0.23-26.56)
Other Angiosperms	0.21 (0.11-0.31)	0.15 (0.08-0.21)	6.4 (-0.94-850)	0.26 (0.1-0.42)	0.01 (-0.00-0.01)	0.2 (0.11-0.29)	0.04 (-0.01-0.09)		6.2 (-0.63-128.8)

Supplemental figures

Supplemental figure legends

Figure S1. Evolutionary parameters for the best fitting model. Comparison of the evolutionary parameters estimated from the best fitting macroevolutionary model for each major plant lineage. ‘α’ represents the strength of stabilizing selection and ‘σ^2’ is the rate of stochastic evolution [43]. Values represent median estimates and median 95% confidence intervals over the distribution of 1000 phylogenies.

Figure S2. Relationship between herbivory and life-history variation. Percent leaf herbivory for lineages that vary in life-history strategy, which represent the evolutionary optima from the stabilizing selection model (OUM – Life-History). Values represent median percent leaf herbivory and median 95% confidence intervals over the distribution of 1000 phylogenies. Number of species for each group is found within data points. Annual ‘other angiosperms’ were poorly sampled and has a wide 95% confidence interval (1.9% – 32.3%) that extended beyond the bounds of the figure.

Figure S1

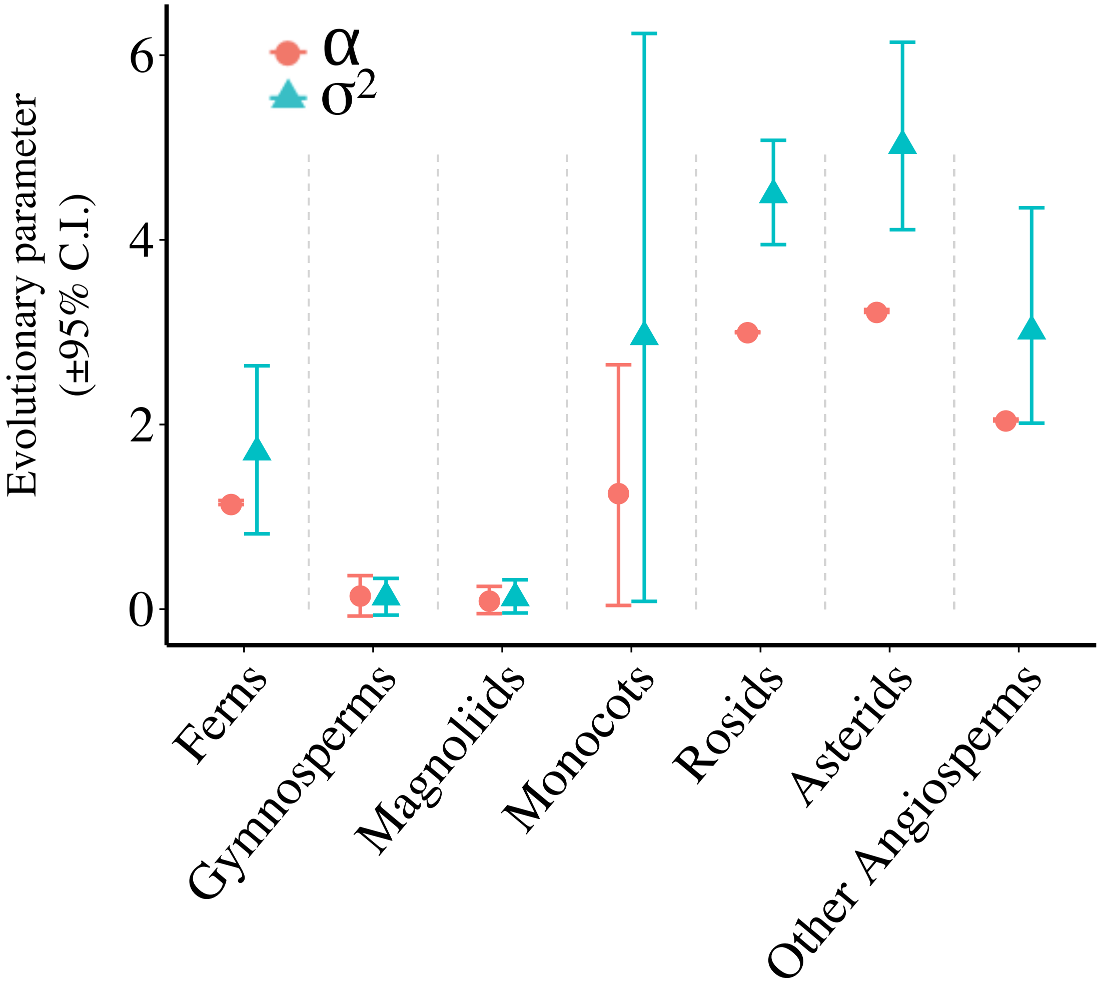
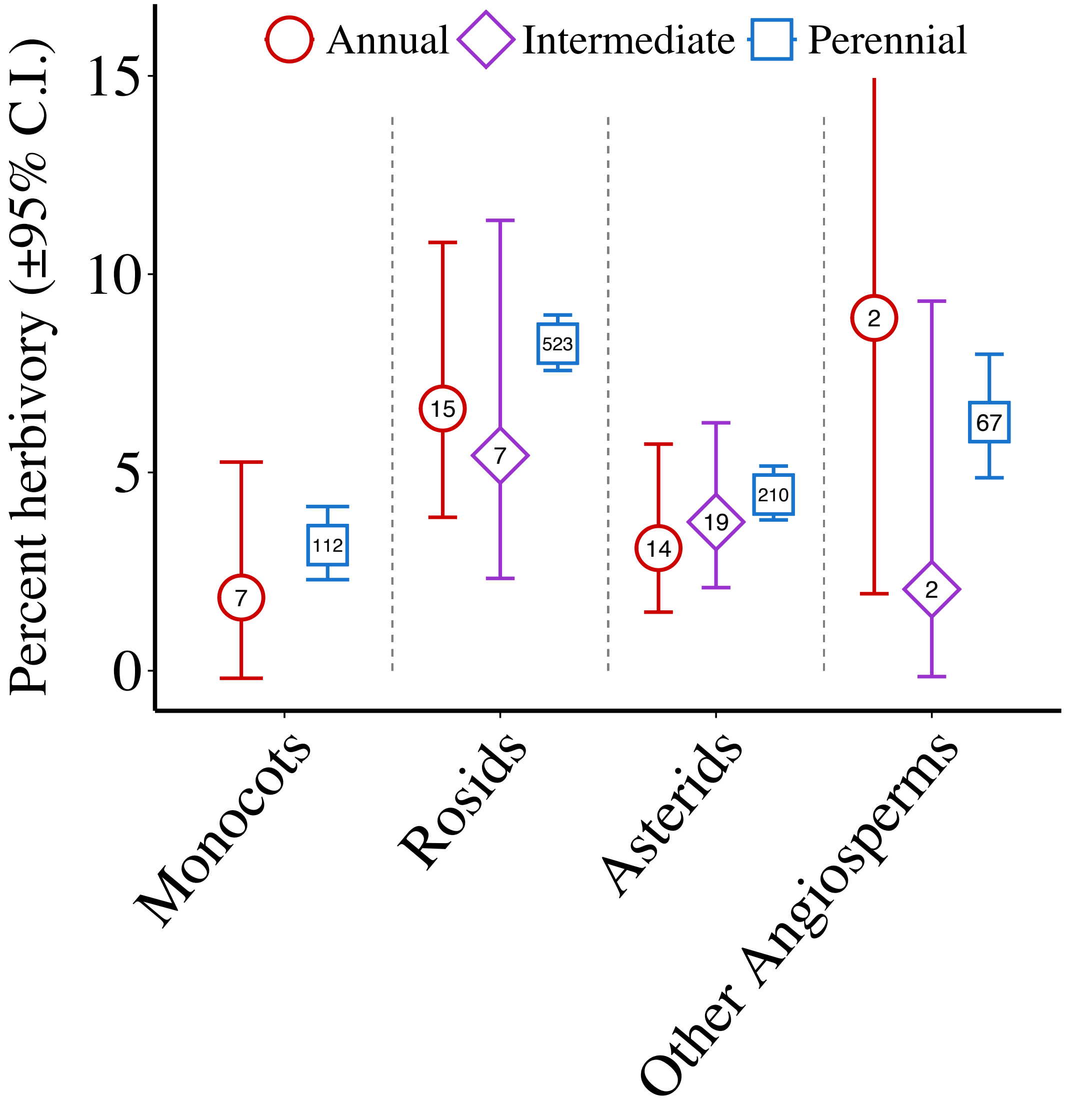

α
σ²
Evolutionary parameter
(±95% C.I.)
0
2
4
6
Ferns
Gymnosperms
Magnoliids
Monocots
Rosids
Asterids
Other Angiosperms

Figure S2


Annual
Intermediate
Perennial
Percent herbivory (±95% C.I.)
0
5
10
15
7
112
15
7
523
14
19
210
2
2
67
Monocots
Rosids
Asterids
Other Angiosperms

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