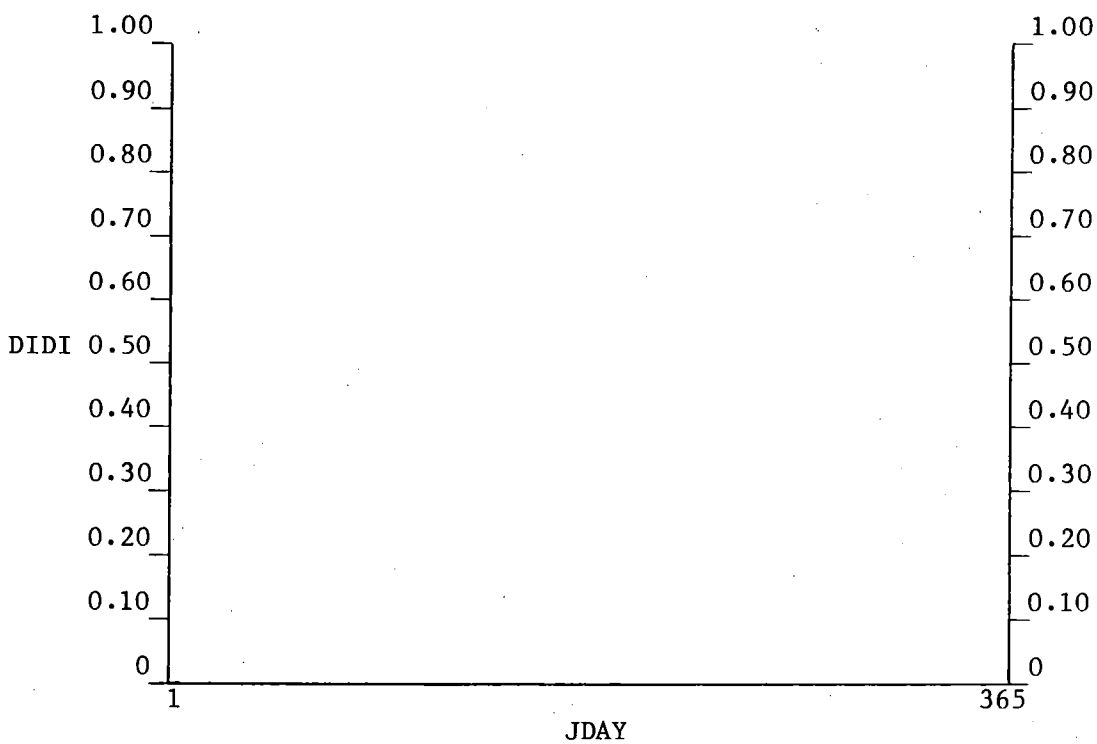
TOPIC 3. DIET DIGESTIBILITIES

General trends in diet digestibilities follow the general trends in the cell structures of the plants. The stages and parts of plant growth that have thinner and less lignified cell walls are, for the most part, more digestible than those stages and parts with more lignified cell walls. Cell chemistry also affects digestibility, however. Tannins, for example, act as inhibitors of digestion. Changes in cell structure occur as plant phenology changes over the growing season. Emerging, growing tissue cannot have rigid cell walls, for new tissue is being added as cells increase in both number and size. When the numbers and sizes of cells in plant tissue have both reached maximum, cell maturation occurs and cell walls increase in thickness and rigidity. The cells in stems become very rigid and serve as supporting tissue. Cells in leaf tissue mature, become decadent, and the leaf falls to the ground. Flower petals mature, wither, and fall. Functional changes in different plant parts are accompanied by structural changes in the cells, and these changes affect nutritive relationships between animal and range.

The concepts underlying relationships between cell structure and digestibility permit one to generalize on seasonal variations in diet digestibility. Consumption of decadent lignified dormant forage results in stable diet digestibilities. As the growing season progresses, diet digestibilities increase as new growth makes up an increasing proportion of the diet. As the growing season progresses and plants mature, diet digestibilities begin to drop until they reach the annual low when only decadent lignified forage is available again. Patterns of seasonal change are illustrated below.



Free-ranging ruminants are generally quite selective feeders, but there are times and locations where preferred species and parts are limited. In the spring, for example, new growth becomes available at a rate that is dependent on species phenology and growing conditions. As the snow melts, animals can supplement the winter diet of dormant forage with new growth as it becomes available, and overall diet digestibilities increase slowly. As plant growth continues, larger amounts of new growth become available and diet digestibilities increase more rapidly. It is important to realize that this pattern of digestibility coefficients applies to the diet rather than individual plants. Digestibilities change in relation to the phenology of the plant, and new plant tissue makes up increasingly larger proportions of the diet in the first part of the growing season and smaller proportions in the last part.

Digestibilities are measured by *in vivo* or *in vitro* methods. The former involves live animals and the latter, laboratory procedures. *In vivo* measurements were conducted in the early years of nutrition experimentation, and *in vitro* has become an accepted technique in later years. These two kinds of measurements are discussed and references given in UNITS 3.1 and 3.2. When direct measurements of particular diets are not available, then calculated diet digestibilities may be determined (UNIT 3.3). Reasonable estimates of digestibilities should be possible for all wild ruminants if general knowledge of nutritive processes is used to make the estimate.

UNIT 3.1: IN VIVO MEASUREMENTS OF DIGESTIBILITIES

There have been many experimental feeding trials of wild ruminants on different forages, with concomitant collection of feces and urine in order to determine at least apparent digestibilities. Results of these are published in the long lists of references that follow this UNIT.

Some of the empirical measurements are made in live animals consuming prescribed, often single-species diets. These measurements are not only expensive because collecting the current annual growth of browse plants is a very slow process. One very convincing exercise illustrating foraging conditions in the winter is the collection of a daily supply of dry weight current annual growth on a cold day with a clippers and bag, especially on an overbrowsed range. The cost of clipping just the CAG is prohibitive if wages must be paid. Volunteers have helped collect on some research projects. Ruminants must be on the test forages for several days before measurements are actually made to allow previous diet residues to pass through the gastrointestinal tract. Thus a five-day trial must last about two weeks total.

Another way to conduct in vivo trials is by collecting the entire plant and letting the test animals browse the parts and amounts desired. It is harder to determine the amounts eaten using this procedure, but less expensive to collect and feed the browse.

In vivo measurements are difficult to complete because wild ruminants do not consume single-species diets very readily, especially of lower quality forage. Single species tests eliminate the beneficial effects of associative digestibilities, resulting in even lower estimates of digestibilities of the lower-quality forages. A mix of forages provides a more suitable substrate for rumen microflora than a single-species substrate.

In vivo measurements of digestibilities have been tried using nylon bag techniques which permit tests of selected forages in a bag suspended in the rumen of a fistulated animal. This technique reduces the expense of large-scale collections, and alleviates the problem of consumption of low-palatibility forages and single-species diets. The bag does impede rumen fluid circulation and sorting, so the results are not exactly as they would be if the forage were free in the rumen.

In vivo digestibilities give the impression of biological reality, but all test results must be considered as estimates that vary in relation to a large number of test conditions. Results should be evaluated as patterns in an ecological context.

REFERENCES, UNIT 3.1

IN VIVO MEASUREMENTS OF DIGESTIBILITIES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JWMAA	41--4	667	676	od--	seas nutr yield, dig, pine	blair,rm; short,/	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
CJZOA	52-10	1201	1205	odvi	dig, prox comp, wint brows	mautz,ww; silver/	1974
JANSA	21--4	1017	1018	odvi	diges, brwse, cedar, aspen	youatt,wg; ullre/	1961
JANSA	32--5	999	1002	odvi	chrm-51, totl collctn tech	mautz,ww	1971
JRMGA	29--1	82	83	odvi	comparis in vivo, in vitro	ruggiero,lf; whel	1976
JWMAA	5---1	108	114	odvi	digestiv capacit of wt dee	forbes,eb; marcy/	1941
JWMAA	28--4	791	797	odvi	diges, cedar, aspen browse	ullrey,de; youat/	1964
JWMAA	31--3	448	454	odvi	dig, cedar, jack pine brow	ullrey,de; youat/	1967
JWMAA	32--1	162	171	odvi	dig, cedar, basalm fir brw	ullrey,de; youat/	1968
JWMAA	33--3	482	490	odvi	digest ener req, mich does	ullrey,de; youatt	1969
JWMAA	35--2	366	368	odvi	confin eff, dry mattr dige	mautz,ww	1971
JWMAA	35--4	732	743	odvi	limita, winter aspen brows	ullrey,de, youat/	1971
JWMAA	36--3	885	891	odvi	dig, metabol, aspen browse	ullrey,de; youat/	1972
JWMAA	36--4	1052	1060	odvi	var, determ diges capacity	mothershead,cl; /	1972
JWMAA	37--2	195	201	odvi	dry matter, enrg intak,dig	ammann,ap; cowan/	1973
JWMAA	39--1	67	79	odvi	feed analyses, digest, w-t	robbins,ct; van /	1975
JWMAA	40--4	630	638	odvi	dige, 7 northern browse sp	mautz,ww, silver/	1976
JWMAA	43--3	798	801	odvi	dosh, compar digest capaci	palmer,wl; cowan,	1979
UASPA	51--2	89	89	odvi	compar in viv, in vitr dig	ruggiero,l	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
TPCWD*14---		1	89	odhe	digestibil, forag sp, colo	dietz,dr; udall,/	1962
CAFGA	39--2	163	175	odhe	nutr val, fora plnts,calif	hagen,hl	1953
CAFGA	41--1	57	78	odhe	dig, naturl, artific foods	bissell,hd; harr/	1955
CWSPA	43---	1	44	odhe	vivo/vit rela, forag, colo	milchunas,dg; dy/	1978
JANSA	16--2	476	480	odhe	dosh, live oak, chamis, ca	bissell,hd; weir,	1957

odhe continued on the next page

*TPCWD is thought to be the correct CODEN for: State of Colorado - Dept. of Game and Fish Technical Publication.

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JRMGA	10--4	162	164	odhe	nutr val, wntr brows plnts	smith,ad	1957
JRMGA	12--1	8	13	odhe	browse adequa, overwinteri	smith,ad	1959
JRMGA	30--2	119	121	odhe	comp in viv, in vitr diges	urness,pj; smith/	1977
JRMGA	30--2	122	127	odhe/evaluat	deer habitat, nutr	wallmo,oc; carpe/	1977
JWIDA	10--2	166	169	odhe	invest tansy ragwort poisn	dean,re; winward,	1974
JWMAA	14--3	285	289	odhe	sagebrush as a winter feed	smisth,ad	1950
JWMAA	16--3	309	312	odhe	digestibil, native forages	smith,ad	1952
JWMAA	28--4	785	790	odhe	effect essenti oils, rumen	nagy,jg; steinho/	1964
JWMAA	31--3	443	447	odhe	prev diet, digest alfal ha	nagy,jg; vidacs,/	1967
JWMAA	34--4	964	967	odhe	cell wall dig, forag value	short,hl; reagor,	1970
JWMAA	38--4	823	829	odhe	capabil, utiliz fibr alfal	schoonveld,gg; n/	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
BJNUA	40--2	347	358	ceel	dosh, compar digest forags	milne,ja; macrae/	1978
HOECD	4---1	59	65	ceel	caca, seas diff, dig brows	cederlund,g; nyst	1981
NATUA	263--	763	764	ceel	intk, diges, vetega, scotl	milne,ja; macrae/	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
CJBOA	54--9	966	970	alal	qual, lowbsh crnbry, alask	oldemeyer,jl; sem	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
BPURD	1----	95	107	rata	feeding experimnts, lichns	jacobsen,e; skjen	1975
JWMAA	44--3	613	622	rata	digestib, rangifer forages	person,sj; pegau/	1980

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
				anam			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ATRLA	22-14	225	230	bibi	doca, yak, fora intak, dig	richmond,rj; hud/	1977
IZYBA	16---	54	57	bibi	diges, pelleted diet, rumi	hintz,hf; sedgew/	1976

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

ovca

CODEN VO-NU BEPA ENPA ANIM KEY WORDS----------AUTHORS---------- YEAR

ovda

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

obmo

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

oram

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

JRMGA 24--1 73 75 doca est dig ener, dry, org mat rittenhouse,lr; / 1971

JONUA 15--4 383 395 doca cellul, ligni, nutri value crampton,ew; mayn 1938

NEXAA 133-- 1 38 doca yucca, chamiza, rang suppl brown,ls 1922

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

AGJOA 51--3 226 234 dosh intak, dig tech, suppl fee harris,le; cook,/ 1959

JANSA 23--3 700 710 dosh nutritnl quali, blue grass reid,rl; jung,ga/ 1964

JBRGA 32--3 141 147 dosh comparsn meth predic diges milne,ja 1977

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

JWMAA 40--2 283 289 wldl nutr qual, dig, seed, frui epps,ea,jr 1976

XAMPA 1147- 1 220 wldl range, wildl habit evaluat paulson,ha,ed; r/ 1970

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

ATRLA 18--3 81 91 caca natu feed, roe de, ingesti drozdz,a; osiecki 1973
ATRLA 24-13 137 170 caca seas intak, dig, nat foods drozdz,a; osiecki 1979

UNIT 3.2: *IN VITRO* MEASUREMENTS OF DIGESTIBILITIES

In vitro digestibility measurements have become common-place since the early 1960's. Tilley and Terry (1963) used *in vitro* fermentation followed by pepsin digestion, and Oh et al. (1966) found the two-step technique of Tilley and Terry to be an accurate predictor (r = 0.88) of *in vivo* ruminant digestion of legumes and grasses. Van Soest (1965) related *in vitro* results to cell wall components of the feed. These early studies have been followed by a fair number of measurements on white-tailed and mule deer, but few studies have been done on the other wild ruminants.

In vitro measurements of digestibilities involve the use of very small samples of forage (a gram or less) in a temperature-controlled fermentation bath that has been inoculated with rumen fluid. The fermentation bath is maintained at body temperature for about 48 hours while digestion takes place. *In vitro* equipment used at Cornell's Wildlife Ecology Laboratory is pictured in Moen (1973:150). Up to 12 samples may be fermented at one time with this equipment. Duplicate samples of each forage are used, so six species may be evaluated during each run.

The cost and biological problems associated with *in vivo* measurements are eliminated with *in vitro* studies. New problems arise, however, as *in vitro* systems are more or less closed systems without biological absorption and feedback. Thus, the single sample present as a substrate is different from the real situation in the rumen where periodic feeding during each 24-hour period results in additions of new material tdo the rumen. The more or less continuous rumination and fermentation in the live animal results in a steady flow of both metabolites through the gastrointestinal walls and undigested waste products through the gastrointestinal canal.

Differences in the results from *in vivo* and properly-completed *in vitro* studies are not great. The economic advantages to *in vitro* studies are great, however. Further, the source of inocula need not be a major consideration; results with inocula from a captive deer on an alfalfa diet were within 2% of *in vivo* determinations, from a wild deer, within 1/2%, and from a cow, within 3% (Robbins et al. 1975). These differences may not satisfy a nutrition specialist, but they are all well within the range of accuracy when estimating diets, populations, and other ecological parameters of free-ranging animals. The use of cow inocula alleviates the need to hold wild ruminants for inocula. A fistulated white-tailed deer was available for rumen fluid for several years (See Moen 1973:149), but the much smaller fistula opening and the lower fluid component of rumen material in the deer compared to the cow made it much more convenient to use the readily-available and easily-collected rumen fluid from a cow at Cornell's Department of Animal Science. If docile wild ruminants are available for fistulation, especially the larger ones such as elk, then they should be used of course.

The results of a large number of *in vitro* tests of different plant parts, of forages collected at different times of the year, of associative digestibilities, and of the effects of inhibitors make it possible to get a much more complete picture of nutritive processes and patterns through the year under a wide variety of range conditions than with *in vivo* measurements. The accuracy of *in vitro* determinations of digestibilities by wild ruminants are fully as great as the accuracies in determining food habits and other characteristics of free-ranging animals. Hence *in vitro* measurements offer particular advantages for work with wild ruminants that far outweigh the disadvantages. Simply stated, many important and revealing nutritive evaluations could not be made without *in vitro* digestion techniques.

I wish to thank Dr. Peter Van Soest, Department of Animal Science, Cornell University, for the assistance given students and staff at the Wildlife Ecology Laboratory over the years as we have measured forage unique to white-tailed deer in New York State.

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Oh, H. K., B. R. Baumgardt, and J. M. Scholl. 1966. Evaluation of forages in the laboratory. V. Comparison of chemical analyses, solubility tests, and *in vitro* fermentation. J. Dairy Sci. 49:850-855.

Robbins, C. T., P. J. Van Soest, W. W. Mautz, and A. N. Moen. 1975. Feed analyses and digestion with reference to white-tailed deer. J. Wildl. Manage. 39(1):67-79.

Tilley, J. M. A. and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Brit. Grassl. Soc. 18:104-111.

Van Soest, P. J. 1965. Non-nutritive residues: A system of analysis for the replacement of crude fiber. J. Assoc. Off. Agric. Chem. 49:546-551.

REFERENCES, UNIT 3.2

IN VITRO MEASUREMENTS OF DIGESTIBILITIES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JANSA	39--1	248	248	odvi	cow vs deer, inoculm sourc	palmer,wl; cowan,	1974
JRMGA	28--5	419	421	odvi	in vitr solu, dry mttr dig	uresk,dw; dietz,/	1975
JRMGA	29--1	82	83	odvi	comparis in vitro, in vivo	ruggiero,l; whela	1976
JWMAA	27--2	184	195	odvi	rumen fermentation, energ	short,hl	1963
JWMAA	35--2	221	231	odvi	cellulo dig, chem, missour	torgerson,o; pfa/	1971
JWMAA	35--3	469	475	odvi	odhe, nutr, chappral, ariz	urness,pj; green/	1971
JWMAA	35--4	698	706	odvi	forag dig, diet, uplnd rng	short,hl	1971
JWMAA	38--1	20	31	odvi	in vitr dig, foods, missou	snider,cc; asplun	1974
JWMAA	39--1	67	79	odvi/	feed analyses, digest, w-t	robbins,ct; van /	1975
JWMAA	39--2	337	341	odvi	comp, digest, decid br, ne	robbins,ct; moen,	1975
JWMAA	40--2	301	307	odvi	eff innoc source, in vitro	palmer,wl; cowan/	1976
JWMAA	43--3	650	656	odvi	carbohyd, urea influ diges	mccullough,y	1979
JWMAA	43--3	788	790	odvi	pH influen, in vitro diges	burbank,rk; wool/	1979
SWNAA	24--2	297	310	odvi	botan comp, nutr cont diet	everitt,jh; gonza	1979
UASPA	51--2	89	89	odvi	compar in viv/in vitr dige	ruggiero,l	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
CJFRA	2---3	250	255	odhe	doug fir genot, brows pref	radwan,ma	1972
CWSPA	43---	1	44	odhe	viv/vitr rela, forag, colo	milchunas,dg; dy/	1978
FOSCA	16--1	21	27	odhe	dougl-fir, microb ferm, ca	oh,jh; jones,mb;/	1970
JRMGA	30--2	119	121	odhe	comparis in vitro, in vivo	urness,pj; smith/	1977
JRMGA	30--2	122	127	odhe	evaluat deer habitat, nutr	wallmo,oc; carpe/	1977
JRMGA	30--3	206	209	odhe	fo hab, semi-des grass-shr	short,hl	1977
JWMAA	28--4	785	790	odhe	eff essen oils,rumn micro	nagy,jg; steinhof/	1964
JWMAA	31--3	443	447	odhe	diet and dig, alfalfa hay	nagy,jg; vidacs,g/	1967
JWMAA	34--4	964	967	odhe	cell wall dig, forag value	short,hl; reagor,	1970
JWMAA	36--4	1341	1343	odhe	maint rumen fluid, in vitr	schwartz,cc; nagy	1972
JWMAA	38--3	531	534	odhe	pestici eff, in vitro dige	schwartz,cc; nagy	1974
JWMAA	39--4	670	673	odhe	nutr, diet, pondr pine ran	urness,pj; neff,/	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	35--4	681	688	ceel	in vitr dig, wint for, wyo	ward,al	1971
ZTTFA	24--4	200	204	ceel	inhib rum cellulolys, bark	prins,ra; geelen,	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CJBOA	54--9	966	970	alal	nutr qual,lo bush cran,	al oldemeyer,jl; see	1976
JWMAA	41--3	533	542	alal	browse qual, popula, kenai	oldemeyer,jl; fr/	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BPURD	1----	251	256	rata	in vitro digest of forages	person,sj; white/	1975
JWMAA	44--3	613	622	rata	in vitr, nylon-bag digesti	person,sj; pegau/	1980

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	41--2	161	168	anam/bibi	diet qual, for avail	schwartz,cc; nag/	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JAPEA	11--2	489	497	bibi	trophi ecol, shrtgras plai	peden,dg; van dy/	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	32--4	773	777	ovca	dig, alpine tundra plants	johnston,; bezau,/	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
				ovda			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
				obmo			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
				oram			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JBRGA	18--2	104	111	doca	dosh,2-stage tech, in vitr	tilley,jma; terry	1963
JDSCA	44-12	2242	2249	doca	eff partic size, cellu dig	dehority,ba; john	1961
JDSCA	49--7	850	855	doca	chem anal, solubili, fermn	oh,hk; baumgardt,	19
JRMGA	21--1	5	7	doca	in vitr dig, cattle, range	hoehne,oe; clant/	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JANSA	23--3	700	710	dosh	nutrit qual, in viv, vitro	reid,rl; jung ga/	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CPLSA	42--4	692	697		in vitro diges, festu asso	bezeau,lm; johnst	1962
JRMGA	24--2	134	136		in vitr dige, native hay	karn,jf; clanton/	1971
JRMGA	29--1	63	65	many	effect of 2,4-d on digestn	thilenius,jf; br/	1976
XAMPA	1147-	1	220	wldl	range, wildl habit evaluat	paulson,ha,ed; r/	1970

In vitro browse digestibilities

The SERIALS lists include many references with data on digestibilities. The tabulation below includes results of in vitro measurements on dormant browse plants of New York State that have been evaluated at Cornell's Wildlife Ecology Laboratory. They are included here to provide digestibility data for a relatively large number of white-tailed deer browses in Northeastern United States. Additional species should be added from published papers.

Common name	Scientific name	GENS	SPEC	Dry matter Digestibility Coefficient
Alternate leaved dogwood	Cornus alternifolia	corn	alte	0.64 *
Apple	Pyrus malus	pyru	malu	0.62 **
Arrowwood	Viburnum dentatum	vibu	dent	0.45 **
Aspen	Populus tremuloides	popu	trem	0.61 **
Balsam fir	Abies balsamea	abie	bals	0.62 *
Basswood	Tilia americana	tili	amer	0.57 **
Beech	Fagus grandifolia	fagu	gran	0.40 **
Blackberry	Rubus alleghaniensis	rubu	alle	0.48 *
Black cherry	Prunus serotina	prun	sero	0.37 *
Boxelder	Acer negundo	acer	negu	0.57 **
Bur oak	Quercus macrocarpa	quer	macr	0.43 **
Cucumber tree	Magnolia acuminata	magn	acum	0.53 **
Elderberrry	Sambucus canadensis	samb	cana	0.37 *
Elm	Ulmus americana	ulmu	amer	0.38 *
Fire cherry	Prunus pensylvanica	prun	pens	0.40 *
Gray birch	Betula populifolia	betu	popu	0.47 *
Gray dogwood	Cornus racemosa	corn	race	0.55 ***
Hawthorn	Crategus sp.	crat	----	0.43 **
Hazelnut	Corylus cornuta	cory	corn	0.51 **
Hemlock	Tsuga canadensis	tsug	cana	0.70 **
Hop hornbeam	Ostrya virginiana	ostr	virg	0.37 *
Lilac	Syringa vulgaris	syri	vulg	0.46 *
Meadow sweet	Spiraea sp.	spir	----	0.35 *
Mountain maple	Acer spicatum	acer	spic	0.49 *
Nannyberry	Viburnum lentago	vibu	lent	0.54 **

Continued on the next page

Paper birch	Betula papyrifera	betu papy	0.56 **
Red maple	Acer rubrum	acer rubr	0.57 **
Red oak	Quercus rubra	quer rubr	0.42 **
Red osier dogwood	Cornus stolonifera	corn stol	0.51 **
Red raspberry	Rubus idaeus	rubu idae	0.42 *
Red spruce	Picea rubens	pice rube	0.55 *
Scotch pine	Pinus sylvestris	pins sylv	0.64 *
Shagbark hickory	Carya ovata	cary ovat	0.48 **
Speckled alder	Alnus rugosa	alnu ovat	0.30 *
Staghorn sumac	Rhus typhina	alnu rugo	0.55 **
Striped maple	Acer pensylvanicum	rhus typh	0.54 *
Sugar maple	Acer saccharum	acer pens	0.46 **
White ash	Fraxinus americana	acer sach	0.48 **
White cedar	Thuja occidentalis	frax amer	0.67 **
White pine	Pinus strobus	thuj occi	0.60 *
Wild grape	Vitis sp.	pins stro	0.38 *
Willow	Salix sp.	viti ----	0.53 *
Witch hazel	Hamamelis virginiana	sali ----	0.49 **
Yellow birch	Betula alleghaniensis	betu alle	0.33 *

* - Wildlife Ecology Laboratory, New York measurements for Delmar.

** - Robbins, C. T. 1973. The biological basis for the determination of carrying capacity. PhD Thesis, Cornell University, Ithaca, N.Y. 239 pp.

*** - WEL Job # 74-01.

UNIT 3.3: CALCULATED DIET DIGESTIBILITIES

Wild ruminants have mixtures of species in their rumens at any one time, resulting in overall diet digestibilities that represents the effects of all of the individual forage species combined. How can diet digestibilities be estimated when the digestibilities of each of the forages in the diet at any one time have not been measured?

The dynamic characteristics of wild ruminant diets can never be duplicated under controlled condiitions. It is, therefore, inevitable that diet digestibilities must be calculated since there is no place to "look up" the digestibilities of selected natural diets.

How can diet digestibilities be calculated? First, diet components are tabulated from food habits studies. Second, the fractions of the total diet made up of the different components are determined from preference and rumen content studies. Third, estimates of the digestibilities of each forage and plant part for the time of year being analyzed are made based on published data, patterns useful for estimation and interpolation, and first approximations where necessary. Fourth, a weighted mean procedurre is used to calculate overall diet digestibility.

Weighted means are determined by multiplying the forage digestibility coefficient (FDIC) of each forage and plant part by its fraction in the diet (FRDI). The sum of the forage digestibilities is the weighted mean diet digestibility (DIDI). A tabular format for this is illustrated below.

Forage	
1. _____	FDIC x FRDI = ____
2. _____	FDIC x FRDI = ____
.	
.	
n. _____	FDIC x FRDI = ____

A sample calculation:

1. _____	0.62	x	0.15	= 0.09
2. _____	0.60	x	0.20	= 0.12
3. _____	0.54	x	0.25	= 0.14
4. _____	0.50	x	0.40	= 0.20
SUMS	1.00			0.55 = DIDI

This weighted mean procedure is useful for estimating the contributions of different forages based on animal preferences, for estimating the contributions of different plant parts in relation to their abundance in the rumen and digestibilies, and other effects of selective grazing or browsing. The procedure does not take interactions between different components of a diet, or associative digestibility effects, however. Highly digestible species may provide a suitable substrate that will increase the digestibilities of lower quality species. Another associative digestibility effect to consider is that of chemical inhibition. One species may contain inhibitors that not only result in a low digestibility of that species, but also reduce digestibilities of otehr species present in the rumen at the same time.

The weighted mean procedure is a good place to start evaluating diets. More research on actual diet mixtures taken by free-ranging wild ruminants would result in better understanding of nutritive processes, however. Even though we do not yet have ultimate knowledge of these processes, ecological processes continue and all components of the total picture should be considered in context. Thus we go on to new considerations in the remaining CHAPTERS of this book.

REFERENCES, UNIT 3.3

CALCULATED DIET DIGESTIBILITIES

SERIALS

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

odvi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

odhe

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

ceel

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

alal

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

rata

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

anam

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

bibi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

ovca

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

ovda

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

obmo

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------- AUTHORS---------- YEAR

oram

CHAPTER 11, WORKSHEET 3.3a

Weighted mean diet digestibilities

This WORKSHEET presents a format for calculating weighted mean diet digestibilities. Ten blanks are provided: most diets are composed of as few as three or four most abundant forages. Use blanks 1 - 9 for the forage species that should be considered separately. Combine all the rest in the last blank.

Animal _____ Location _____ JDAY _____

		FDIC	x	FRDI	=	
1.	_____	____	x	____	=	____
2.	_____	____	x	____	=	____
3.	_____	____	x	____	=	____
4.	_____	____	x	____	=	____
5.	_____	____	x	____	=	____
6.	_____	____	x	____	=	____
7.	_____	____	x	____	=	____
8.	_____	____	x	____	=	____
9.	_____	____	x	____	=	____
10.	_____	____	x	____	=	____
		SUMS		____		____ = DIDI

CLOSING COMMENTS

CHAPTER ELEVEN: FORAGE CHARACTERISTICS AND THE DIGESTIBILITY OF PLANT TISSUE, contains descriptions of some of the basic cell characteristics that affect the digestibilities of different species and plant parts through time. The relatively recent cellular approach to digestibilities was preceded by a century of chemical analyses of plant material. The relatively recent *in vitro* digestibility measurements have been preceded by thousands of *in vivo* trials on domestic ruminants, and a fair number on wild ruminants. Extensive literature lists covering both the earlier chemical composition and the later cell characteristics work, the earlier *in vivo* measurements and the later *in vitro* ones, have been included in this CHAPTER. The data in these references are needed when calculating forage consumption in CHAPTER 12.

GLOSSARY OF SYMBOLS USED - CHAPTER ELEVEN

ABUP = Absorbed but unused protein
ACTI = Activity
ADF = Acid detergent fiber
APDE = Apparent digestible energy
APDP = Apparent digestible protein
AUUE = Absorbed but unused urinary energy

CRPR = Crude protein
CSCP = Cell soluble content in percent of forage
CSDP = Cell soluble digestibility in percent
CSFF = Cell soluble fraction of the forage
CWCP = Cell wall content in percent of forage
CWDG = In vivo cell wall digestibility
CWDP = Cell wall digestibility in percent
CWFF = Cell wall fraction of the forage

DIDI = Diet digestibility
DMDP = Dry matter digestibility in percent
DORM = Dormant

EURN = Endogenous urinary nitrogen

FDIC = Forage digestibility coefficient
FEEN = Fecal energy
FEPR = Fecal protein
FLBU = Floral buds
FLOP = Flowers open
FRDI = Fraction of the diet digestibility

GREN = Gross energy

HEFE = Heat of fermentation
HNUM = Heat of nutrient metabolism

JDAY = Julian day

KCAL = Kilocalories

LCUC = Lignin-cutin content expressed as percent of the acid-detergent fiber
LEBU = Leaf buds
LEEM = Leaves emerging
LEFA = Leaves fallen
LEWI = Leaves withering
LGCC = Lignin-cutin content of the acid-detergent fiber
LGCC = Lignin-cutin content as a percent of the acid-detergent fiber
LGNC = Lignin content of the acid-detergent fiber

MAIN = Maintenance
MEEN = Metabolizable energy
MFEN = Metabolic fecal energy
MFNT = Metabolic fecal nitrogen
MNIC = Metabolizable nitrogenous compounds
MUEN = Metabolic urinary energy

NEEN = Net energy
NENS = Net nitrogen synthesized

PIUF = Protein in undigested forage
PLPA = Plant Part
PROD = Production
PTCW = Percent cell wall

REGU = Regulation

SFDI = Seeds and fruits dispersed
SFMT = Seeds and fruits maturing

TDIP = True digestible protein
TDMD = True dry matter digestibility in percent
TRDE = True digestible energy

UFOR = Undigested forage residue
UREN = Urinary energy
URNI = Urinary nitrogen

GLOSSARY OF CODENS - CHAPTER ELEVEN

AAAHA Australian Journal of Experimental Agriculture and Animal Husbandry
ABSZA Annales Botanici Societatis Zoologicae Botanicae Fennicae Vanamo
ADAGA Advances in Agronomy
ADCSA Advances in Chemistry Series
AGJOA Agronomy Journal(US)
AGNSA New South Wales Agricultural Gazette
AJBOA American Journal of Botany
AJCNA American Journal of Clinical Nutrition
AMEBA Annales Medicinae Experimentalis et Biologiae Fenniae
AMNAA American Midland Naturalist
AMNTA American Naturalist
AMSCA American Scientist
APMBA Applied Microbiology (US)
ATICA Arctic (Canada)
ATRLA Acta Theriologica (Poland)
AZOFA Annales Zoologici Fennici (Finland)
AZWBA Arizona Game and Fish Department Wildlife Bulletin

BIJOA Biochemical Journal (England)
BJNUA British Journal of Nutrition (England)
BOGAA Botanical Gazette (US)
BOREA Botanical Review (US)
BPURD Biological Papers of the University of Alaska Special Report
BSECB Biochemical Systematics and Ecology
BTBCA Bulletin of the Torrey Botanical Club
BZSSA Botanicheskii Zhurnal SSSR (USSR)

CAEBA California Agricultural Experiment Station Bulletin
CAFGA California Fish and Game
CFGGA California Department of Fish and Game, Game Bulletin
CGFPA Colorado Division of Game, Fish, and Parks Special Report
CJBOA Canadian Journal of Botany
CJFRA Canadian Journal of Forest Research (Canada)
CJZOA Canadian Journal of Zoology
CNAPA Canada Department of Agriculture Publication
CNDRA Condor
CNJNA Canadian Journal of Animal Science
CNRDA Canadian Journal of Research, Section D, Zoological Sciences
COVEA Cornell Veterinarian
CPLSA Canadian Journal of Plant Science
CRPSA Crop Science
CWRSB Canadian Wildlife Service Report and Management Bulletin Series
CWSPA Colorado Division of Wildlife Special Report

ECMOA Ecological Monographs
ECOLA Ecology
ELPLB Ekologia Polska
ENDEA Endeavour

FOSCA Forest Science
FRCRA Forestry Chronicle
FRSTA Forestry

GRBNA Great Basin Naturalist

HLTPA Health Physics
HOECD Holarctic Ecology

IZYBA International Zoo Year Book

JACSA Journal of the American Chemical Society
JAFCA Journal of Agricultural Food and Chemistry
JAGRA Journal of Agricultural Research
JANCA Journal of the Association of Official Analytic Chemists
JANSA Journal of Animal Science
JAPEA Journal of Applied Ecology
JASIA Journal of Agricultural Science
JBRGA Journal of the British Grassland Society
JCECD Journal of Chemical Ecology
JDSCA Journal of Dairy Science
JECOA Journal of Ecology
JFUSA Journal of Forestry
JOMAA Journal of Mammalogy
JONUA Journal of Nutrition
JPHAA Journal of the American Pharmaceutical Association
JRMGA Journal of Range Management
JSFAA Journal of the Science of Food and Agriculture
JWIDA Journal of Wildlife Diseases
JWMAA Journal of Wildlife Management

LATBA Louisiana Agricultural Experiment Station Bulletin

MDCBA Minnesota Department of Conservation Technical Bulletin
MDCRA Michigan Department of Conservation Game Division Report
MGLHA Mitteilungen aus dem Gebiete derr Lebensmitteruntersuchung und hygiene
MLTBB Maine Life Sciences and Agricultural Experiment Station Technical Bulletin
MUATA Minnesota Agricultural Experiment Station Technical Bulletin

NAREA Nutrition Abstracts and Reviews
NASRA National Academy of Sciences--National Research Council, Publication
NATUA Nature (England)
NAWTA North American Wildlife and Natural Resources Conference, Transactions of the, NCANA Naturaliste Canadien, Le
NDFRA North Dakota Farm Research
NETMA Netherlands Journal of Agricultural Science
NEXAA New Mexico Agricultural Experiment Station Bulletin
NEZFA New Zealand Journal of Agricultural Research
NFGJA New York Fish and Game Journal

NOSCA Northwest Science
NUABA Nevada Agricultural Experiment Station Bulletin

OIKSA Oikos (Denmark)
OJSCA Ohio Journal of Science

PASHA Proceedings of the American Society for Horticultural Science
PCGFA Proceedings of the Southeastern Association of Game and Fish Commissioners
PLPHA Plant Physiology
PLSOA Plant and Soil
PMSCA Proceedings of the Minnesota Academy of Science
PNASA Proceedings of the National Academy of Sciences of the United States
PNUSA Proceedings of the Nutrition Society
PSAFA Proceedings of the Society of American Foresters
PYTCA Phytochemistry
PZSLA Proceedings of the Zoological Society of London

RAPHB Recent Advances in Phytochemistry

SCIEA Science
SJECA Soviet Journal of Ecology (English translation of Ekologiya)
SOSCA Soil Science
SSSAA Soil Science Society of America, Proceedings
SSSJD Soil science Society of America Journal
SWNAA Southwestern Naturalist
SZSLA Symposia of the Zoological Society of London

TAEBA Texas Agricultural Experiment Station Bulletin
TAEMA Texas Agricultural Experiment Station Miscellaneous Publication
TNWSD Transactions of the Northeast Section, The Wildlife Society
TPCWD Colorado Division of Wildlife Technical Publication

UABPA Biological Papers of the University of Alaska
UASPA Proceedings of the Utah Academy of Sciences, Arts and Letters
UAXBA Utah Agricultural Experiment Station Bulletin
UCPZA University of California Publications in Zoology

WAEBA Wyoming Agricultural Experiment Station Bulletin
WCDBA Wisconsin Department of Natural Resources Technical Bulletin
WGFBA Wyoming Game and Fish Commission Bulletin
WLMOA Wildlife Monographs
WMBAA Wildlife Management Bulletin (Ottowa) Series 1 (Canada)
WUAPA Wisconsin Agricultural Experiment Station, Research Report
WVAFA West Virginia Agriculture and Forestry
WZMNA Wissenschaftliche Zeitschrift Karl-Marx Universitaet Leipzig Mathematisch-Naturwissenschaftliche Reihe

XAAHA U S D A Agricultural Handbook
XAGCA U S D A Circular
XAMPA U S D A Miscellaneous Publication

XARRA U S Forest Service Research Note RM
XATBA U S D A Technical Bulletin
XFINA U S Forest Service Research Note INT
XFIPA U S Forest Service Research Paper INT
XFNSA U S Forest Service Research Note SO
XFPNA U S Forest Service Research Paper PNW
XFPSA U S Forest Service Research Paper SO
XFRMA U S Forest Service Research Paper RM
XPNWA U S Forest Service Research Note PNW

ZEJAA Zeitschrift fuer Jagdwissenschaft
ZTTFA Zeitschrift fuer Tierphysiologie Tierer naehrung und Futtermittelkunde

LIST OF PUBLISHERS - CHAPTER ELEVEN

acpr	Academic Press	New York	nyny
agrc	Agricultural Research Council	London	loen
butt	Butterworth	Washington, D. C.	wadc
cdch	C. D. Church	Corvallis, OR	coor
dvnc	D. Van Nostrand Co.	New York	nyny
esli	E. and S. Livingstone, Publishers	Edinburgh, Great Britain	edgb
isup	Iowa State University Press	Ames, IO	amia
long	Longman	London	loen
mhbc	McGraw-Hill Book Company, Inc.	New York	nyny
mopc	Morrison Publishing Company	Ithaca, NY	itny
nasc	National Academy of Science	Washington, D. C.	wadc
nhfg	New Hampshire Fish & Game Dept.	Concord, NH	conh
olbo	Oliver and Boyd	Edinburgh, Scotland	edsc
prha	Prentice-Hall, Inc.	Englewood Cliffs, NJ	ecnj
spve	Springer-Verlaug Inc.	New York	nyny
stmp	St. Martin's Press	New York	nyny
whfr	W. H. Freeman Co.	San Francisco, CA	sfca

LIST OF WORKSHEETS - CHAPTER ELEVEN

GLOSSARY OF PLANT CODE NAMES

GENS SPEC	SCIENTIFIC NAME
abie amab	Abies amabilis
abie bals	Abies balsamea
abie conc	Abies concolor
abie gran	Abies grandis
abie lasi	Abies lasiocarpa
abie ----	Abies
abut inca	Abutilon incanum
abut theo	Abutilon theophrasti
acac angu	Acacia angustissima
acac farn	Acacia farnesiana
acac greg	Acacia greggii
acac roem	Acacia roemeriana
acac ----	Acacia
acal grac	Acalypha gracilens
acer circ	Acer circinatum
acer glau	Acer glaubrum
acer macr	Acer macrophyllum
acer negu	Acer negundo
acer pens	Acer pensylvanicum
acer pseu	Acer pseudoplatanus
acer rubr	Acer rubrum
acer sacc	Acer saccharinum
acer sach	Acer saccharum
acer spic	Acer spicatum
acer ----	Acer
achi lanu	Achillea lanulosa
achi mill	Achillea millefolium
aden fasc	Adenostoma fasciculatum
aesc cali	Aesculus californica
aesc hipp	Aesculus hippocastanum
aesc pavi	Aesculus pavia
agar arve	Agaricus arvensis
agar bisp	Agaricus bisporus
agar camp	Agaricus campestris
agos glau	Agoseris glauca

agro smit	Agropyron smithii
agro spic	Agropyron spicatum
agro trac	Agropyron trachycaulon var. majus
agro trah	Agropyron trachycaulon
agro ----	Agropyron
agrs bore	Agrostis borealis
agrs idah	Agrostis idahoensis
agrs ----	Agrostis
albi juli	Albizia julibrissin
alec juba	Alectoria jubata
alec sarm	Alectoria sarmentosa
alec ----	Alectoria
alli text	Allium textile
alnu cris	Alnus crispa
alnu crmo	Alnus crispa var. mollis
alnu glut	Alnus glutinosa
alnu inca	Alnus incana
alnu rubr	Alnus rubra
alnu rugo	Alnus rugosa
alnu sinu	Alnus sinuata
alnu sito	Alnus sitohensis
alnu ----	Alnus
amar palm	Amaranthus palmerii
amar retr	Amaranthus retroflexus
amar ----	Amaranthus
ambr arte	Ambrosia artemisiifolia
ambr psil	Ambrosia psilostachya
ambr trif	Ambrosia trifida
amel alni	Amelanchier alnifolia
amel arbo	Amelanchier arborea
amel bart	Amelanchier bartramiana
amel cana	Amelanchier canadensis
amel flor	Amelanchier florida
amel spic	Amelanchier spicata
amel utah	Amelanchier utahensis
amel ----	Amelanchier
amor cane	Amorpha canescens
ampe arbo	Ampelopsis arborea
anac cana	Anacharis canadensis
andm glau	Andromeda glaucophylla

andp dive	Andropogon divergens
andp elli	Andropogon elliottii
andp gera	Andropogon gerardi
andp subt	Andropogon subtenuis
andp tene	Andropogon tener
andp tern	Andropogon ternarius
andp virg	Andropogon virginicus
andp ----	Andropogon
ante plan	Antennaria plantaginifolia
arab drum	Arabis drummondii
aral nudi	Aralia nudicaulis
aral race	Aralia racemosa
arcg lati	Arctagrostis latifolia
arcs alpi	Arctostaphylos alpina
arcs glan	Arctostaphylos glandulosa
arcs patu	Arctostaphylos patula
arcs pung	Arctostaphylos pungens
arcs stan	Arctostaphylos stanfordiana
arcs uvur	Arctostaphylos uva-ursi
arcs visc	Arctostaphylos viscida
arcs ----	Arctostaphylos
arct cale	Arctotheca calendula
aren groe	Arenaria groenlandica
aris long	Aristida longiseta
aris stri	Aristida stricta
aris ----	Aristida
arni fulg	Arnica fulgens
aron arbu	Aronia arbutifolia
aron mela	Aronia melanocarpa
arte arbu	Artemisia arbuscula
arte arno	Artemisia arbuscula nova
arte arct	Artemisia arctica
arte cali	Artemisia californica
arte camp	Artemisia campestris
arte cana	Artemisia cana
arte fili	Artemisia filifolia
arte frig	Artemisia frigida
arte gnap	Artemisia gnaphalodes (see also arte vulg)
arte ludo	Artemisia ludoviciana
arte nova	Artemisia nova
arte peda	Artemisia pedatifida

arte spin	Artemisia spinescens
arte trid	Artemisia tridentata
arte trip	Artemisia tripartita
arte vulg	Artemisia vulgaris (see also arte gnap)
arte ----	Artemisia
aste chil	Aster chilensis
aste comm	Aster commutatus
aste foli	Aster foliaceus
aste pilo	Aster pilosus
aste tena	Aster tenacetifolius
aste ----	Aster
astr bisu	Astragalus bisulcatus
astr emor	Astragalus emoryanus
astr mise	Astragalus miser
astr patt	Astragalus pattersonii
astr recu	Astragalus recurvus
astr tetr	Astragalus tetrapterus
astr ----	Astragalus
atri cane	Atriplex canescens
atri conf	Atriplex confertifolia
atri coro	Atriplex coronata
atri eleg	Atriplex elegans
atri hali	Atriplex halimoides
atri holo	Atriplex holocarpa
atri lent	Atriplex lentiformis
atri line	Atriplex linearis
atri nutt	Atriplex nuttallii
atri poly	Atriplex polycarpa
atri rose	Atriplex rosea
atri semi	Atriplex semibaccata
atri volu	Atriplex volutans
aula turg	Aulacomnium turgidum
aven fatu	Avena fatua
aven sati	Avena sativa
bahi oppo	Bahia oppositifolia
bals sagg	Balsamorhiza saggittata
benz aest	Benzoin aestivale (see also lind benz)
berb nerv	Berberis nervosa
berb thun	Berberis thunbergii
berb trif	Berberis trifoliata

berc scan	Berchemia scandens
betu alba	Betula alba
betu alle	Betula alleghaniensis
betu glan	Betula glandulosa
betu lent	Betula lenta
betu lute	Betula lutea
betu mino	Betula minor
betu nana	Betula nana
betu nigr	Betula nigra
betu papy	Betula papyrifera
betu pend	Betula pendula
betu popu	Betula populifolia
betu pube	Betula pubescens
betu pulm	Betula pulma
betu pumi	Betula pumila
betu verr	Betula verrucosa
betu ----	Betula
boer tenu	Boerhaavia tenuifolia
bole edul	Boletus edulis
bout grac	Bouteloua gracilis
bout ----	Bouteloua
brac decu	Bracharia decumbens
bras kabe	Brassica kaber
brom briz	Bromus brizaeformis
brom moll	Bromus mollis
brom pump	Bromus pumpellianus
brom rigi	Bromus rigidus
brom tect	Bromus tectorum
brun cirr	Brunnichia cirrhosa
buch dact	Buchloe dactyloides
bume texa	Bumelia texana
cala cana	Calamogrostis canadensis
cala casc	Calamagrostis canadensis var. scabra
calc amer	Callicarpa americana

cale stra	Calliergon stramineum
calg schi	Calliergonella schieberi
cali erio	Calliandra eriophylla
call palu	Calla palustris
calm cana	Calmagrostis canadensis
calt lept	Caltha leptosepala
calu vulg	Calluna vulgaris
came micr	Camelina microcarpa
camp rotu	Campanula rotundifolia
cams radi	Campsis radicans
cant ciba	Cantharellus cibarius
care aqua	Carex aquatilis
care bige	Carex bigelowii
care brev	Carex brevipes
care cane	Carex canescens
care eben	Carex ebenea
care geop	Carex geophila
care heli	Carex heliophora
care lacu	Carex lacustris
care mult	Carex multicaulis
care scir	Carex scirpoidea
care stri	Carex stricta
care ----	Carex
carn giga	Carnegiea gigantea
carp betu	Carpinus betulus
cart tinc	Carthamus tinctorius
cary aqua	Carya aquatica
cary cord	Carya cordiformis
cary glab	Carya glabra
cary illi	Carya illinoensis
cary leid	Carya leidodermus
cary ovat	Carya ovata (see also hico ovat)
cary texa	Carya texana
cary tome	Carya tomentosa
cary ----	Carya

casa cham	Cassia chamaecrista (see also casa fasc)
casa fasc	Cassia fasciculata (see also casa cham)
casa mari	Cassia marilandica
casa nict	Cassia nictitans
casa roem	Cassia roemeriana
casa ----	Cassia
casi hypn	Cassiope hypnoides
casi tetr	Cassiope tetragona
casn dent	Castanea dentata
casn vulg	Castanea vulgaris
cata spec	Catalpa speciosa
cean amer	Ceanothus americanus
cean cord	Ceanothus cordulatus
cean cune	Ceanothus cuneatus
cean diva	Ceanothus divaricatus (see also cean leuc)
cean fend	Ceanothus fenderli
cean foli	Ceanothus foliosus
cean greg	Ceanothus greggii
cean inte	Ceanothus integerrimus
cean leuc	Ceanothus leucodermis (see also cean diva)
cean parv	Ceanothus parvifolius
cean pros	Ceanothus prostratus
cean velu	Ceanothus velutinus
cean ----	Ceanothus
celt laev	Celtis laevigata
celt occi	Celtis occidentalis
celt pall	Celtis pallida
celt reti	Celtis reticulata
cera arve	Cerastium arvense
cerc betu	Cercocarpus betuloides
cerc brev	Cercocarpus breviflorus
cerc ledi	Cercocarpus ledifolius
cerc mont	Cercocarpus montanus
cerd ----	Cercidium
cerp deme	Ceratophyllum demersum
cers cana	Cercis canadensis
cetr cucu	Cetraria cucullata
cetr isla	Cetraria islandica
cetr niva	Cetraria nivalis
chae caly	Chaemaedaphne calyculata

cham foli	Chamaebatia foliolosa
chan caly	Chamaedaphne calyculata
chap thyo	Chamaecyparis thyoides
char vulg	Chara vulgaris
chen albu	Chenopodium album
chlo cucu	Chloris cucullata
chlo gaya	Chloris gayana
chrs gram	Chrysopsis graminifolia
chry lanc	Chrysothamnus lanceolatus
chry naus	Chrysothamnus nauseosus
chry pulc	Chrysothamnus pulcherrimus
chry sten	Chrysothamnus stenophyllus
chry tere	Chrysothamnus teretifolius
chry visc	Chrysothamnus viscidiflorus
chry vise	Chrysothamnus viscidiflorus serrulatus
chry ----	Chrysothamnus
cicu ----	Cicuta
cirs hook	Cirsium hookerianum
cirs undu	Cirsium undulatum
citr limo	Citrus limon
clad alpe	Cladonia alpestris
clad grac	Cladonia gracillis
clad miti	Cladonia mitis
clad rang	Cladonia rangifera
clad rani	Cladonia rangiferina
clad ----	Cladonia
clar lute	Cladrastis lutea
clav purp	Claviceps purpurea
clem drum	Clematis drummondii
clet alni	Clethra alnifolia
cole ramo	Coleogyne ramosissima
coll line	Collomia linearis
colu texe	Colubrina texensis

coma pall	Comandra pallida
comp pere	Comptonia peregrina
cond obtu	Condalia obtusifolia
conv arve	Convolvulus arvensis
corn alte	Cornus alternifolia
corn cana	Cornus canadensis
corn drum	Cornus drummondi
corn flor	Cornus florida
corn nutt	Cornus nuttallii
corn pani	Cornus paniculata (see also corn race)
corn race	Cornus racemosa (see also corn pani)
corn rugo	Cornus rugosa
corn stol	Cornus stolonifera
corn ----	Cornus
coro vari	Coronilla varia
cory amer	Corylus americana
cory avel	Corylus avellana
cory cali	Corylus californica
cory corn	Corylus cornuta (see also cory rost)
cory rost	Corylus rostrata (see also cory corn)
cory ----	Corylus
coto pyra	Cotoneaster pyracantha
covi trid	Covillea tridentata
cowa stan	Cowania stansburiana
crat crus	Crataegus crus-galli
crat mono	Crataegus monogyna
crat poli	Crataegus polita
crat ----	Crataegus
crot cory	Croton corymbulosus
crot mona	Croton monanthogynus
crot neom	Croton neomexicanus
crot ----	Croton
cryp japo	Cryptomeria japonica
cucu foet	Cucurbita foetidissima
cucu pepo	Cucurbita pepo
cusc exal	Cuscuta exaltata
cymo wats	Cymopterus watsonii

cyna vinc	Cynanchum vincetoxicum
cyno dact	Cynodon dactylon
cypc ----	Cyperaceae
cype rotu	Cyperus rotundus
cyri race	Cyrilla racemiflora
dact glom	Dactylis glomerata
dale albi	Dalea albiflora
daph meze	Daphne mezereum
delp ande	Delphinium andersonii
delp barb	Delphinium barbeyi
delp glac	Delphinium glaucescens
delp glam	Delphinium glaucum
delp nels	Delphinium nelsonii
delp occi	Delphinium occidentale
delp ----	Delphinium
desc soph	Descarainia sophia
desh caes	Deschampsia caespitosa
desh flex	Deschampsia flexuosa
desi soph	Descurainia sophia
desm cool	Desmanthus cooleyi
desm fall	Desmanthus fallax
deso glut	Desmodium glutinosum
diap lapp	Diapensia lapponica
dicr beig	Dicranum beigeri
dier loni	Diervilla lonicera
dioc mult	Dioclea multiflora
dios texa	Diospyros texana
dios virg	Diospyros virginiana
drab aure	Draba aurea

echi crus	Echinochloa crusgalli
ecin crus	Ecinochloa crusgalli
elae angu	Elaeagnus angustifolia
eleo smal	Eleocharis smalli
elym glau	Elymus glauca
empe eame	Empetrum eamesii ssp. hermaphroditum
empe nigr	Empetrum nigrum
ephe anti	Ephedra antisyphilitica
ephe neva	Ephedra nevadensis
ephe torr	Ephedra torreyana
ephe trif	Ephedra trifurca
ephe viri	Ephedra viridis
ephe ----	Ephedra
epil angu	Epilobium angustifolium
epil lati	Epilobium latifolium
equi ----	Equisetum
erag ----	Eragrostis
ergo race	Ergonium racemosum
eria ----	Eriastrum
erid cali	Eriodictyon californicum
erie ----	Erigeron
erig hera	Eriogonum heracleoides
erig race	Eriogonum racemosum
erig wrig	Eriogonum wrightii
erig ----	Eriogonum
erip vagi	Eriophorum vaginatum
erip ----	Eriophorum
erod cicu	Erodium cicutarium
erod mosc	Erodium moschatum
erys aspe	Erysimum asperum
eryt amer	Erythronium americanum
eryt gran	Erythronium grandiflorum
euca obli	Eucaluptus obliqua

euon amer	Euonymus americana
euph cict	Euphorbia cictyesperma
euph coro	Euphorbia corollata
euph fend	Euphorbia fendleri
euph pros	Euphorbia prostrata
euph ----	Euphorbia
euro lana	Eurotia lanata
evol nutt	Evolvulus nuttallianus
fagu gran	Fagus grandifolia
fagu sylv	Fagus sylvatica
fagu ----	Fagus
fero wisl	Ferocactus wislizenii
fest alta	Festuca altaica
fest ariz	Festuca arizonia
fest idah	Festuca idahoensis
fest octo	Festuca octoflora
fest ----	Festuca
flou cern	Flourensia cernua
fome ----	Fomes
fore neom	Forestiera neomexicana
frag amer	Fragaria americana
fras ----	Franseria
frax amer	Fraxinus americana
frax exce	Fraxinus excelsior
frax lati	Fraxinus latifolia
frax quad	Fraxinus quadrangulata
frax ----	Fraxinus
fuma offi	Fumaria officinalis
gali bore	Galium boreale
gaul proc	Gaultheria procumbens

gayl bacc	Gaylussacia baccata
gels semp	Gelsemium sempervirens
gera rich	Geranium richardsoni
gera ----	Geranium
geum peck	Geum peckii
geum trif	Geum triflorum
geum ----	Geum
gili mult	Gilia multiflora
gled tria	gleditsia triacanthos
gram ----	gramineae
gray spin	Grayia spinosa
guai coul	Guaiacum coulteri
guar cocc	Guara coccinea
guti micr	Gutierrezia microcephala
guti saro	Gutierrezia sarothrae
guti spha	Gutierrezia sphaerocephala
guti texa	Gutierrezia texana
gyro escu	Gyromitra esculenta
halo glom	Halogeton glomeratus
hama vern	Hamamelis vernalis
hama virg	Hamamelis virginiana
hedy bore	Hedysarum boreale
hele hoop	Helenium hoopesii
heli quin	Helianthella quinquenervis
heln angu	Helianthus angustifolius
heln annu	Helianthus annuus
heln hirs	Helianthus hirsutus
helo heli	Heliopsis helianthoides
heve ----	Hevea

hevl escu	Hevella esculenta
hico ovat	Hicoria ovata
hila bela	Hilaria belangeri
hoff brac	Hoffmanseggia brachycarpa
hord lepo	Hordeum leporinum
hous caer	Houstonia caerulea var. faxonorum
hydr arbo	Hydrangea arborescens
hyme odor	Hymenoxys odorata
hyme rich	Hymenoxys richardsonii var. floribunda
hype macu	Hypericum maculatum
hypr perf	Hypericium perforatum
ilex cori	Ilex coriacea
ilex deci	Ilex decidua
ilex glab	Ilex glabra
ilex opac	ilex opaca
ilex vert	Ilex verticillata
ilex vomi	Ilex vomitoria
impa cape	Impatiens capensis
ipom ----	Ipomoea
iva axil	Iva axillaris
jacq tamn	Jacquemontia tamnifolia
jugl cine	Juglans cinerea
jugl nigr	Juglans nigra
junc comm	Juncus communis
junc trif	Juncus trifidus
juni hori	Juniperus horizontalis
juni knig	Juniperus knightii
juni occi	Juniperus occidentalis

juni pinc	Juniperus pinchoti
juni scop	Juniperus scopulorum
juni utah	Juniperus utahensis
juni virg	Juniperus virginiana

kalm angu	Kalmia angustifolia
kalm lati	Kalmia latifolia
kalm poli	Kalmia polifolia
koch amer	Kochia americana
koch chil	Kochia childsii
koch scop	Kochia scoparia
koch vest	Kochia vestita
kram secu	Krameria secundiflora
kunz trid	Kunzia tridentata (see also purs trid)

lact cana	Lactuca canadensis
lact ----	Lactuca
lamn minr	Lamna minor
lari lari	Larix laricina
lari lept	Larix leptolepis
lari occi	Larix occidentalis
lath ----	Lathyens
laty ochr	Lathyrus ochroleucus
laty ----	Lathyrus
ledu groe	Ledum groenlandicum
ledu palu	Ledum palustris v. decumbens
lept mult	Leptoptaenia multifida
lesp stip	Lespediza stipulacea
leuc retu	Leucaena retusa
leuo minu	Leucophyllum minus
leut edit	Leucothoe editorum
lewi pygm	Lewisia pygmeae

liat punc	Liatrus punctata
libo decu	Libocedrus decurrens
ligs port	Ligusticum porteri
ligu obtu	Ligustrum obtusifolium
lind benz	Lindera benzoin (see also benz aest)
linm usit	Linum usitatissimum
liqu styr	Liquidambar styraciflua
liri tuli	Liriodendron tulipifera
lois proc	Loiseleuria procumbens
loli rigi	Lolium rigidum
loni albi	Lonicera albinura
loni cana	Lonicera canadensis
loni invo	Lonicera involucrata
loni japo	Lonicera japonica
loni morr	Lonicera morrowii
loni vill	Lonicera villosa
loni xylo	Lonicera xylosteum
lotu wrig	Lotus wrightii
lotu ----	Lotus
lupi arct	Lupinus arcticus
lupi caud	Lupinus caudatus
lupi seri	Lupinus sericeus
lupi ----	Lupinus
luzu spic	Luzula spicata
lyco anno	Lycopodium annotinum var. pungens
lyco sela	Lycopodium selago var. appressum
lyon luci	Lyonia lucida
macl pomi	Maclura pomifera
magn acum	Magnolia acuminata
magn macr	Magnolia macrophylla
magn virg	Magnolia virginiana

maho repe	Mahonia repens
maia cana	Maianthemum canadense
mani escu	Manihot esculenta
medi sati	Medicago sativa
meli offi	Melilotus officinalis
meli ----	Melilotus
ment pipe	Mentha piperita
menz pilo	Menziesia pilosa
mert cili	Mertensia ciliata
mimo frag	Mimosa fragrans
mira line	Mirabilis linearis
mona odor	Monardella odoratissima
morc angu	Morchella angusticeps
morc coni	Morchella conica
morc cras	Morchella crassipes
morc deli	Morchella deliciosa
morc escu	Morchella esculenta
moru alba	Morus alba
moru micr	Morus microphylla
moru rubr	Morus rubra
muhl mont	Muhlenbergia montana
muhl ----	Muhlenbergia
musa acum	Musa acuminata
myos alpe	Myosotis alpestris
myri aspl	Myrica asplenifolia
myri ceri	Myrica cerifera
myri gale	Myrica gale
myri pens	Myrica pensylvanica
myro exal	Myriophyllum exalbescens

nemo mucr	Nemopanthus mucronata
neph arct	Nephroma arcticum
noli macr	Nolina macrocarpa
noli micr	Nolina microcarpa
noli texa	Nolina texana
nuph vari	Nuphar variegatum
nuph ----	Nuphar
nymp tube	Nymphaea tuberosa
nyss sylv	Nyssa sylvatica
oeno ----	Oenothera
opun enge	Opuntia engelmannii
opun fulg	Opuntia fulgida
opun poly	Opuntia polycantha
opun spin	Opuntia spinosior
opun ----	Opuntia
orth lute	Orthocarpus luteus
oryz aspe	Oryzopsis asperfolia
oryz hyme	Oryzopsis hymenoides
osmo clay	Osmorhiza claytoni
osmo occi	Osmorhiza occidentalis
ostr virg	Ostrya virginiana
oxyd arbo	Oxydendrum arboreum
oxyt ----	Oxytropis
pani ----	Panicum
park ----	Parkinsonia
parm ----	Parmelia
part quin	Parthenocissus quinquefolia
part vita	Parthenocissus vitacea
pasp ----	Paspalum

pelg ----	Peltigera
pens leon	Penstemon leonardi
pens whip	Penstemon whippleanus
pere nana	Perezia nana
peri gair	Perideridia gairdneri
pers borb	Persea borbonia
pers ----	Persea
phal arun	Phalaris arundinacea
phas ----	Phaseolus
phle prat	Phleum pratense
phyl caer	Phyllodoce caerulea
phys malv	Physocarpus malvaceus
phys pube	Physocarpus pubescens
phyt amer	Phytolacca americana
pice abie	Picea abies
pice enge	Picea engelmanni
pice glau	Picea glauca
pice mari	Picea mariana
pice obov	Picea obovata
pice rube	Picea rubens
pice sitc	Picea sitchensis
pice ----	Picea
pins albi	Pinus albicaulis
pins bank	Pinus banksiana
pins cemb	Pinus cembroides
pins clau	Pinus clausa
pins cont	Pinus contorta
pins ctla	Pinus contorta latifolia
pins echi	Pinus echinata
pins elli	Pinus elliottii
pins lamb	Pinus lambertiana
pins mont	Pinus monticola
pins nigr	Pinus nigra
pins nrca	Pinus nigra var. calabrica
pins nrma	Pinus nigra var. maritima
pins palu	Pinus palustris
pins pond	Pinus ponderosa
pins radi	Pinus radiata
pins resi	Pinus resinosa
pins rigi	Pinus rigida

pins sibe	Pinus siberica
pins silv	Pinus silvestris
pins stro	Pinus strobus
pins sylv	Pinus sylvestris
pins taed	Pinus taeda
pins virg	Pinus virginiana
pins ----	Pinus
plan majo	Plantago major
plan purs	Plantago purshii
plat occi	Platanus occidentalis
pleu schr	Pleurozium schreberi
poa cusi	Poa cusickii
poa fend	Poa fendleriana
poa fern	Poa fernaldiana
poa patt	Poa pattersoni
poa rupi	Poa rupicola
poa sand	Poa sandbergii
poa ----	Poa
poly alas	Polygonum alaskanum
poly avic	Polygonum aviculare
poly conv	Polygonum convolvulus
poly fago	Polygonum fagopyrum
poly pens	Polygonum pensylvanicum
poly vivi	Polygonum viviparum
poys muni	Polystichum munitum
poyt juni	Polytrichum juniperinum var. alpestre
poyt pili	Polytrichum piliferum
popu delt	Populus deltoides
popu gran	Populus grandidentata
popu trem	Populus tremula
popu treu	Populus tremuloides
popu tric	Populus trichocarpa
popu ----	Populus
pota ampl	Potamogeton amplifolius
pota epih	Potamogeton epihydrus
pota pect	Potamogeton pectinatus
pota rich	Potamogeton richardsonii
pota robi	Potamogeton robinsii
pota zost	Potamogeton zosteriformis
pota ----	Potamogeton
pote dive	Potentilla diversifolia
pote grac	Potentilla gracilis

pote trid	Potentilla tridentata
pote ----	Potentilla
pros chil	Prosopis chilensis
pros juli	Prosopis juliflora
pros velu	Prosopis velutina
pros ----	Prosopis
prun amer	Prunus americana
prun ande	Prunus andersonii
prun demi	Prunus demissa (see also prun virg)
prun emar	Prunus emarginata
prun fasc	Prunus fasciculata
prun ilic	Prunus ilicifolia
prun mari	Prunus maritima
prun mela	Prunus melanocarpa (see also prun vrme)
prun minu	Prunus minutiflora
prun pens	Prunus pensylvanica
prun sero	Prunus serotina
prun subc	Prunus subcordata
prun umbe	Prunus umbellata
prun virg	Prunus virginiana (see also prun demi)
prun vrme	Prunus virginiana melanocarpa (see also prun mela)
prun ----	Prunus
pscy mont	Pseudocymopterus montanus
pseu menz	Pseudotsuga menziesii
pseu taxi	Pseudotsuga taxifolia
pseu tagl	Pseudotsuga taxifoflia glauca
psor tenu	Psoralea tenuiflora
pter aqui	Pteridium aquilinum
puer loba	Pueraria lobata
purs trid	Purshia tridentata (see also kunz trid)
purs ----	Purshia
pyrl pube	Pyrularia pubera
pyru angu	Pyrus angustifolia
pyru comm	Pyrus communis
pyru coro	Pyrus coronaria
pyru malu	Pyrus malus
pyru ----	Pyrus

quer acut	Quercus acutissima
quer agri	Quercus agrifolia
quer alba	Quercus alba
quer bico	Quercus bicolor
quer bore	Quercus borealis
quer bref	Quercus brevifolia (see also quer cine)
quer brev	Quercus breviloba
quer cali	Quercus californica
quer chry	Quercus chrysolepis
quer cine	Quercus cinerea (see also quer bref)
quer cocc	Quercus coccinea
quer doug	Quercus douglasii
quer dumo	Quercus dumosa
quer dura	Quercus durata
quer elli	Quercus ellipsoidalis
quer emor	Quercus emoryi
quer falc	Quercus falcata (see also quer rubr)
quer gamb	Quercus gambelli
quer garr	Quercus garryana
quer harv	Quercus harvardii
quer ilic	Quercus ilicifolia
quer inca	Quercus incana
quer kell	Quercus kelloggii
quer lyra	Quercus lyrata
quer macr	Quercus macrocarpa
quer mari	Quercus marilandica
quer mini	Quercus minima
quer mino	Quercus mino (see also quer stel)
quer mont	Quercus montana
quer nigr	Quercus nigra
quer nutt	Quercus nuttallii
quer obtu	Quercus obtusa
quer palu	Quercus palustris
quer petr	Quercus petraea
quer phel	Quercus phellos
quer phil	Quercus philtas
quer prin	Quercus prinoides
quer prnu	Quercus prinus
quer robu	Quercus robur
quer rubr	Quercus rubra (see also quer falc)
quer shum	Quercus shumardii
quer stel	Quercus stellata (see also quer mino)
quer turb	Quercus turbinella
quer velu	Quercus velutina
quer virg	Quercus virginiana
quer wisl	Quercus wislizenii
quer ----	Quercus

ranu ----	Ranunculus
rham cali	Rhamnus californica
rham caro	Rhamnus caroliniana
rham fran	Rhamnus frangula
rham purs	Rhamnus purshiana
rhod lapp	Rhododendron lapponicum
rhod maxi	Rhododendron maximum
rhod rose	Rhododendron roseum
rhod ----	Rhododendron
rhoo cana	Rhodododendron canadense
rhus arom	Rhus aromatica
rhus cana	Rhus canadensis
rhus copa	Rhus copallina
rhus dive	Rhus diversiloba
rhus glab	Rhus glabra
rhus hirt	Rhus hirta (see also rhus typh)
rhus micr	Rhus microphylla
rhus radi	Rhus radicans
rhus tril	Rhus trilobata (see also schm tril)
rhus typh	Rhus typhina (see also rhus hirt)
rhus vire	Rhus virens
rhus ----	Rhus
robi neom	Robinia neomexicana
robi pseu	Robinia pseudoacacia
rosa acic	Rosa acicularis
rosa egla	Rosa eglanteria
rosa fend	Rosa fendleri (see also rosa wood)
rosa humi	Rosa humilis
rosa maco	Rosa macounii
rosa maja	Rosa majalis
rosa mult	Rosa multiflora
rosa palu	Rosa palustris
rosa rugo	Rosa rugosa
rosa setg	Rosa setigera
rosa setr	Rosa setigeria
rosa spal	Rosa spaldingii
rosa spin	Rosa spinosissima
rosa wood	Rosa woodsii (see also rosa fend)
rosa woul	Rosa woodsii ultralmontana
rosa ----	Rosa
rubu alle	Rubus allegheniensis
rubu arct	Rubus arcticus
rubu bail	Rubus baileyanus
rubu cham	Rubus chamaemorus
rubu idae	Rubus idaeus

rubu occi	Rubus occidentalis
rubu parv	Rubus parviflorus
rubu saxa	Rubus saxatilis
rubu spec	Rubus spectabilis
rubu viti	Rubus vitifolius
rubu ----	Rubus
rudb hirt	Rudbeckia hirta
rume acet	Rumex acetosella
rume cris	Rumex crispus
saba ----	Sabal
sagi cune	Sagittaria cuneata
sagi rigi	Sagittaria rigida
sali alax	Salix alaxensis
sali amyg	Salix amygdaloides
sali arbu	Salix arbusculoides
sali arct	Salix arctica
sali bebb	Salix bebbiana
sali capr	Salix caprea
sali glau	Salix glauca
sali humi	Salix humilis
sali inte	Salix interior
sali lasi	Salix lasiolepis
sali lute	Salix lutea
sali nigr	Salix nigra
sali phyl	Salix phylicifolia
sali plan	Salix planifolia
sali scou	Salix scouleriana
sali uvur	Salix uva-ursi
sali ----	Salix
sals kali	Salsola kali
salv mell	Salvia mellifera
salv refl	Salvia reflexa
samb call	Sambucus callicarpa
samb cana	Sambucus canadensis
samb glau	Sambucus glauca
samb pube	Sambucus pubens
samb ----	Sambucus
sang cana	Sanguisorba canadensis
sapi sebi	Sapium sebiferum

sarc verm	Sarcobatus vermiculatus
sass albi	Sassafras albidum
schm tril	Schmaltzia trilobata (see also rhus tril)
scir cesp	Scirpus cespitosus
scol fest	Scolochloa festucacea
sene jaco	Senecio jacobaea
sene long	Senecio longilobus
sene neom	Senecio neomexicanus
sene ridd	Senecio riddellii
sene tria	Senecio triangularis
sene ----	Senecio
sequ giga	Sequoiadendron giganteum
seta fabr	Setaria faberi
seta glau	Setaria glauca
seta lute	Setaria lutescens
seta viri	Setaria viridis
shep cana	Shepherdia canadensis
sibb proc	Sibbaldia procumbens
sile acau	Silene acaulis var. exscapa
sile doug	Silene douglasii
sile noct	Silene noctiflora
simm chin	Simmondsia chinensis
sita hyst	Sitanion hystrix
smia trif	Smilacina trifolia
smil bona	Smilax bona-nox
smil glau	Smilax glauca
smil rotu	Smilax rotundifolia
smil smal	Smilax smallii
smil tamm	Smilax tammoides
smil tamn	Smilax tamnoides
smil ----	Smilax
sola ----	Solanum
soli cutl	Solidago cutleri
soli macr	Solidago macrophylla var. thyrsoidea
soli nemo	Solidago nemoralis

sorb amer	Sorbus americana
sorb aucu	Sorbus aucuparia
sorg hale	Sorghum halepense
spar eury	Sparganium eurycarpum
spar fluc	Sparganium fluctuans
spat ----	Spartina
spha cocc	Sphaeralcea coccinea
spha gros	Sphaeralcea grossulariaefolia
sphg fusc	Sphagnum fuscum
sphg girg	Sphagnum girgensohnii
spir alba	Spiraea alba
spir lati	Spiraea latifolia
spir ----	Spiraea
spor cryp	Sporobolis cryptandrus
spor curt	Sporobolis curtissii
spor ----	Sporobolis
stan pinn	Stanleya pinnata
ster pasc	Stereocaulon paschale
ster ----	Stereocaulon
stip colu	Stipa columbiana
stip coma	Stipa comata
stip pine	Stipa pinetorum
symp occi	Symphoricarpos occidentalis
symp orbi	Symphoricarpos orbiculatus
symp oreo	Symphoricarpos oreophilus
symp rotu	Symphoricarpos rotundifolius
symp vacc	Symphoricarpos vaccinioides
sypl tinc	Symplocos tinctoria
syri vulg	Syringa vulgaris
tara offi	Taraxacum officinale
tara ----	Taraxacum
taxu bacc	Taxus baccata
taxu cana	Taxus canadensis

tetr cane	Tetradymia canescens
tetr glab	Tetradymia glabrata
thel ----	Thelesperma
thla alpe	Thlaspi alpestre
thuj occi	Thuja occidentalis
thuj plic	Thuja plicata
tide lanu	Tidestromia lanuginosa
tili amer	Tilia americana
tili cord	Tilia cordata
trad occi	Tradescantia occidentalis
trad suba	Tradescantia subaspera
trag dubi	Tragopogon dubius
trag ----	Tragopogon
trib terr	Tribulus terrestris
trif hybr	Trifolium hybridum
trif parr	Trifolium parryi
trif prat	Trifolium pratense
trif subt	Trifolium subterraneum
trif ----	Trifolium
trig mari	Triglochin maritima
tris spic	Trisetum spicatum var. pilosiglume
tsug cana	Tsuga canadensis
tsug hete	Tsuga heterophylla
typh augu	Typha augustifolia
ulmu alat	Ulmus alata
ulmu amer	Ulmus americana
ulmu glab	Ulmus glabra
umbi ----	Umbilicaria
umbr cali	Umbrellularia californica
ungn spec	Ungnadia speciosa
unio lati	Uniola latifolia

vacc angu	Vaccinium angustifolium
vacc arbo	Vaccinium arboreum
vacc caes	Vaccinium caespitosum
vacc cras	Vaccinium crassifolium
vacc elli	Vaccinium elliottii
vacc idae	Vaccinium idaea
vacc memb	Vaccinium membranaceum
vacc myrt	Vaccinium myrtilloides (see also vacc myti)
vacc myti	Vaccinium myrtillus (see also vacc myrt)
vacc oval	Vaccinium ovalifolium
vacc oxyc	Vaccinium oxycoccus
vacc parv	Vaccinium parvifolium
vacc scop	Vaccinium scoparium
vacc stam	Vaccinium stamineum
vacc ulig	Vaccinium uliginosum
vacc ulal	Vaccinium uliginosum var. alpinum
vacc vaci	Vaccinium vacillans
vacc viti	Vaccinium vitis-idaea
vacc vitm	Vaccinium vitis-idaea var. minus
vacc ----	Vaccinium
vale occi	Valeriana occidentalis
vale sitc	Valeriana sitchensis
vall amer	Vallisneria americana
vera cali	Veratrum californicum
vera viri	Veratrum viride
verb ence	Verbesina encelioides
vero worm	Veronica wormskjoldii
verp bohe	Verpa bohemica
vibu alni	Viburnum alnifolium
vibu cass	Viburnum cassinoides
vibu dent	Viburnum dentatum
vibu lent	Viburnum lentago
vibu moll	Viburnum molle
vibu opul	Viburnum opulus
vibu prun	Viburnum prunifolium
vibu rufi	Viburnum rufidulum
vici pulc	Vicia pulchella
viti aest	Vitis aestivalis
viti bico	Vitis bicolor
viti cord	Vitis cordifolia (see also viti vulp)
viti ripa	Vitis riparia
viti rotu	Vitis rotundifolia
viti vulp	Vitis vulpina (see also viti cord)
viti ----	Vitis

xant pens	Xanthium pensylvanicum
xanx frut	Xanthoxylum fruticosum
yucc elat	Yucca elata
yucc glau	Yucca glauca
yucc moha	Yucca mohavensis
yucc reve	Yucca reverchonii
yucc thom	Yucca thompsoniana
yucc trec	Yucca treculeana
yucc ----	Yucca
zea mays	Zea mays
ziza equa	Zizania equatica
zyga eleg	Zygadenus elegans

JULIAN DAY: MONTH AND DAY EQUIVALENTS*

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	060	091	121	152	182	213	244	274	305	335	1
2	002	033	061	092	122	153	183	214	245	275	306	336	2
3	003	034	062	093	123	154	184	215	246	276	307	337	3
4	004	035	063	094	124	155	185	216	247	277	308	338	4
5	005	036	064	095	125	156	186	217	248	278	309	339	5
6	006	037	065	096	126	157	187	218	249	279	310	340	6
7	007	038	066	097	127	158	188	219	250	280	311	341	7
8	008	039	067	098	128	159	189	220	251	281	312	342	8
9	009	040	068	099	129	160	190	221	252	282	313	343	9
10	010	041	069	100	130	161	191	222	253	283	314	344	10
11	011	042	070	101	131	162	192	223	254	284	315	345	11
12	012	043	071	102	132	163	193	224	255	285	316	346	12
13	013	044	072	103	133	164	194	225	256	286	317	347	13
14	014	045	073	104	134	165	195	226	257	287	318	348	14
15	015	046	074	105	135	166	196	227	258	288	319	349	15
16	016	047	075	106	136	167	197	228	259	289	320	350	16
17	017	048	076	107	137	168	198	229	260	290	321	351	17
18	018	049	077	108	138	169	199	230	261	291	322	352	18
19	019	050	078	109	139	170	200	231	262	292	323	353	19
20	020	051	079	110	140	171	201	232	263	293	324	354	20
21	021	052	080	111	141	172	202	233	264	294	325	355	21
22	022	053	081	112	142	173	203	234	265	295	326	356	22
23	023	054	082	113	143	174	204	235	266	296	327	357	23
24	024	055	083	114	144	175	205	236	267	297	328	358	24
25	025	056	084	115	145	176	206	237	268	298	329	359	25
26	026	057	085	116	146	177	207	238	269	299	330	360	26
27	027	058	086	117	147	178	208	239	270	300	331	361	27
28	028	059	087	118	148	179	209	240	271	301	332	362	28
29	029	[060]	088	119	149	180	210	241	272	302	333	363	29
30	030		089	120	150	181	211	242	273	303	334	364	30
31	031		090		151		212	243		304		365	31

* For leap year, February 29 = JDAY 60. Add 1 to all subsequent JDAYs.