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A key to Raunkiaer plant life forms with revised subdivisions

by H. Ellenberg and D. Mueller-Dombois

I. KEY TO THE MAIN GROUPS OF PLANT LIFE FORMS

Aa Aut	otrophic plants	
Ba Ko	ormophytes (= vascular plants)	
Ca S	Self-supporting plants	
Da	Woody plants, or herbaceous evergreen perennials	
	Plants that grow taller than 25–50 cm, or whose shoots do not die back periodically to that height limit * Phanerophytes	1
	Plants whose mature branch or shoot system remains peren- nially within 25–50 cm above ground surface, or plants that grow taller than 25–50 cm, but whose shoots die back peri- odically to that height limit *	
	Chamaephytes	2
Db	Perennial (including biennial) herbaceous plants with periodic shoot reduction	
	Periodic shoot reduction to a remnant shoot system that lies relatively flat on the ground surface	
	Hemicryptophytes	3
	Periodic reduction of the complete shoot system to storage organs that are imbedded in the soil	
	Geophytes (Cryptophytes)	4
Dc	Annuals. Plants whose shoot and root system dies after seed production and which complete their whole life cycle within	
	one year Therophytes	5

^{*} In particularly favourable environments (e.g. humid tropics and warm seepage water habitats) this height limit may be extended to 100 cm.

Cb	Plants	that	grow	by	sup	porting	themsel	ves	on	others
			0		r	0				

Ea Plants that root in the ground

Da i lanto that loot in the ground	
Plants that germinate on the ground and maintain their contact with the soil Lianas (Eu-lianas)	6
Plants that germinate on other plants and then establish their roots in the ground, or plants that germinate on the ground, grow up the tree and disconnect their soil contact Hemi-epiphytes (Pseudo-lianas).	7
EbPlants that germinate and root on other plants (these include dead standing plants, telegraph poles and wires, stumps and such like)EpiphytesEpiphytes	8
Cc Free-moving water plants (= errants) Errant vascular Hydrophytes	9
Bb Thallophytes (= non-vascular cryptogams)	
Fa <i>Plants attached to the ground surface</i> (here defined as any material making up the surface of the ground, such as mineral soil, rock, humus, litter, decaying wood or other solid media covering the surface)	
Ga Perennials Cushion-formed or pulvinate mosses and liverworts and fruticose lichens Thallo-chamaephytes	10
Flat-matted mosses and liverworts, foliose and crustose lichens, algae (including endolithic lichens and algae) Thallo-hemicryptophytes	11
Gb Annuals Thallo-therophytes	12
Fb Plants attached to others, either directly to the bark, leaves or such like, or indirectly to soil and humus pockets occur- ring in branch-forks, bark fissures etc. Thallo-epiphytes	13
Fc Free-moving autotrophic thallophytes (= errants)	
Ha Photosynthesizers In water (salt, brackish or fresh) Errant thello-hydronhytes	14
In snow and ice Krvophytes	15
	57

		At and near the soil s	urface (including humus and decay-	
		ing wood)	Edaphophytes	16
	Hb	Chemosynthesizers	Chemo-edaphophytes	17
Ab	Semi-aut Green plan Ia Ib	totrophic plants nts growing attached Kormophytes Thallophytes	to other living autotrophic plants Vascular Semi-parasites Thallo-semi-parasites	18 19
Ac	Heterotr	ophic plants		
	Ka	Kormophytes		
		Growing on living	g plants Vascular Parasites	20
		Growing on dead	organic matter Vascular Saprophytes	21
	Kb	Thallophytes Growing on or in	living plants	
			Thallo-parasites	22
		Growing on dead	organic matter Thallo-saprophytes	23

II. KEY TO THE SUBDIVISIONS OF THE MAIN GROUPS OF PLANT LIFE FORMS

Subdivision has been carried through the autrophic terrestrial plant life form groups 1–13. These are also the main producers of concern to the terrestrial plant ecologist. A satisfactory subdivision of life form groups 14–23 requires special knowledge and would go beyond the present scope.

The key employs the decimal system. The first digit designates the main life form group, e.g.:

1. Phanerophytes

2. Chamaephytes etc.

The second digit denotes the next subgroup, e.g.:

1.1 Phanerophytes with normal woody stems and branches

- 1.2 Tuft trees
- 1.3 Bottle trees etc.

The third digit denotes an important characteristic in the Phanerophytes:

- 1.01 Single-stemmed (scapose) = trees
- 1.02 branched from near the base (caespitose) = shrubs

The forth digit refers to height classes in the phanerophytes:

1.001 < 2 m = nanophanerophytes 1.002 2- 5 m = microphanerophytes 1.003 5-50 m = mesophanerophytes 1.004 > 50 m = megaphanerophytes

The above digit places are reserved for these attributes in the phanerophytes. Other important attributes, such as evergreen vs. deciduous, follow by added digits, and whatever attribute best characterizes the subgroups occupies further digit places. In the other life form groups, such as chamaephytes, hemicryptophytes etc., the digits following the first one are also chosen for the next important characteristics, which are of course not always the same as in the phanerophytes. In the height classes, the smallest is always denoted with 1, the next higher one with 2 etc.

In places where a zero (0) occupies a certain digit place, the attribute is undetermined.

Abbreviations of life form names have been added only as far as they are already used in literature.

1. **Phanerophytes** (P)

1.1 Ph	anerophytes with normal woody stems and	
\mathbf{br}	anches	Р
1.11	Trees = single-stemmed phanerophytes with more or	
	less numerous lateral branches ($=$ scapose)	P scap
1.111	Dwarf trees = Nanophanerophytes $< 2 \text{ m} \dots \dots$	N P scap
1.112	Small trees = Microphanerophytes $2-5 \text{ m} \dots \dots$	Mi P scap
1.113	Large trees = Mesophanerophytes $5-50 \text{ m} \dots \dots$	Mes P scap
1.114	Giant trees = Megaphanerophytes $> 50 \text{ m} \dots \dots$	Meg P scap
1.12	Shrubs = Phanerophytes branched from near the base	
	of the stem (= caespitose) $\dots \dots \dots$	P caesp
1.121	Normal-sized shrubs = Nanophanerophytes $< 2 \text{ m}$.	N P caesp
1.122	Tall shrubs = Microphanerophytes $2-5 \text{ m} \dots \dots$	Mi P caesp
1.123	Giant shrubs = Mesophanerophytes $> 5 \text{ m} \dots$	Mes P caesp

1.13	"Krummholz" = creeping phanerophytes, whose stems	
	or branches are bowed down, but whose height exceeds	
	50 cm vertically from the ground (= reptant habit)	\mathbf{rept}
1.131	Typical "krummholz" <2 m	N P rept
1.132	Tall "krummholz" $> 2 \text{ m}$	Mi P rept

The above height classes and the distinction between trees, shrubs and krummholz need to be applied to specific field conditions. For simplifying the mechanism of this classification the following separations are based on features that apply to almost all normally woody phanerophytes (P) in their appropriate size-class ranges, whether they are trees or shrubs.

1.100.1	Evergreen	
	Broad-leaved	
	Without bud protection, probably almost exclusively tropi-	
4 400 44	cal rain (ombro $=$ 0) forest species	
1.100.11	Malacophyllous ($=$ m; soft leaves that collapse immedi-	D
	ately when held over hot water vapor, e.g. <i>Macaranga</i>).	omP
1.100.12	Semi-sclerophyllous to sclerophyllous $(= s, e.g.$ Coffea $)$.	osP
	With bud protection	
1.100.13	Malacophyllous (= m, e.g. Hibiscus tiliaceus)	mP
1.100.14	Sclerophyllous (= s, e.g. Metrosideros collina) $\dots \dots$	sP
1.100.15	Needle-leaved (belonido = b, e.g. $Pinus$)	bP
1.100.2	Summer-green or cold-deciduous (aestivo $=$ a)	
1.100.21	Broad-leaved (e.g. Fagus)	aP
1.100.22	Needle-leaved (e.g. Larix)	abP
1.100.3	Drought-deciduous (cheimo $=$ c), mostly with strong	
	bud protection during the dry season, e.g. Erythryna)	cP

Each of these life forms can be further subdivided by:

- (a) Crown shape
- 1.100.001 With sphaerical crown (e.g. Mangifera indica)
 - .002 With umbrella-like crown (e.g. Samanea saman)
 - .003 With cylindrical crown (e.g. *Metrosideros collina* in ash-fallout areas on Hawaii)
 - .004 With conical crown (e.g. many alpine temperate-zone conifers, but also for example young *Rhizophora mangle*)
 - .005 With umbellate crown (e.g. Albizzia moluccana)
 - .006 With irregular crown or crown of indefinite shape

- (b) Crown extension
- 1.100.000.1 Crown restricted to the uppermost top of tree (most co-dominant trees of ombrophilous tropical lowland forest)
 - .000.2 Crown restricted to upper $\frac{1}{3}$ of tree height
 - .000.3 Crown about $\frac{1}{2}$ length of tree
 - .000.4 Crown extending down to more than $\frac{1}{2}$ of tree length
 - .000.5 Crown extending to near the base of the tree
 - (c) Leaf size (includes phyllodes)
 - .000.01 Nanophyllous, usually less than 1 cm²
 - .000.02 Microphyllous, usually less than 5 cm^2
 - .000.03 Mesophyllous
 - .000.04 Macrophyllous, usually larger than 100 cm²
 - .000.05 Megaphyllous (giant leaves), usually larger than 500 cm²
 - (d) Leaf shape (includes phyllodes)

Needle-shaped leaves, already accounted for as belonido; includes all temperate-zone conifers, but also *Araucaria* and *Casuarina*. The latter has narrow cylindrical phyllodes as photosynthetic organs, which appear needle-shaped.

- .001 Scale-needles (e.g. Thuja, Chamaecyparis)
- .002 Micro-needles, shorter than 1 cm
- .003 Meso-needles, 1-5 cm
- .004 Macro-needles, longer than 5 cm Laminate leaves = broad-leaved, already accounted for; this group includes all but the following:
- .005 Feathery leaves (many legume trees, e.g. Albizzia spp.)
- (e) Rooting features that are recognizable above the ground
- 1.100.000.000.1 Buttresses, board-roots (characteristic for many lowland tropical rain forest trees, e.g. *Ficus variegata*, *Shorea balangaran* and other dipterocarps)
 - .2 Stilt-roots, regardless of function (e.g. Pandanus, Rhizophora, Iriartea orbignyana)
 - .3 Pneumatophores = asparagus- or knee-shaped epi-surface roots, e.g. Avicennia, Sonneratia, Bruguiera
 - .4 Aerial roots, suspended as adventitious roots from main stem or branches (e.g. *Eucalyptus robusta* in perhumid rain forest conditions, *Metrosideros*, several *Ficus* spp.)
 - .5 Xylopod = bulbous, water-storing, mostly subterranean stem base (e.g. Capparis spp.)
 - (f) Bark features
- 1.100.000.000.01 Green bark, mostly thin or moderately thick (e.g. Commiphora)
 - .02 Thin, smooth, non-green bark (e.g. many humid tropical trees, e.g. Albizzia moluccana, Ficus religiosa)
 - .03 Moderately thick, smooth, non-green bark that remains relatively smooth at maturity (e.g. *Fagus silvatica*, most *Abies* spp.)
 - .04 Moderately thick, smooth, non-green bark becoming fissured at maturity (e.g. Fraxinus excelsior, Thuja)

- .05 Thick, fissured bark (e.g. Quercus robur, Pseudotsuga menziesii, Pinus ponderosa)
- .06 Thick, corky bark (e.g. Quercus suber)
- (g) Thorns (thorns and spines in the morphological sense)
- 1.100.000.000.001 Absent
 - .002 Very few, mostly on branches
 - .003 A few, mostly on stem
 - .004 A few, both on stem and branches
 - .005 Abundant
 - .006 Leaves or phyllodes reduced to thorns
 - (h) Position of inflorescence

1.100.000.000.000.1 Apically (e.g. Abies)

- .2 Laterally on branches or no definite position, i.e. throughout the crown (e.g. *Pseudotsuga*)
- .3 On main stem or main branches, i.e. cauliflory (e.g. Cercis siliquastrum, some Ficus spp., Theobroma cacao, Couroupita)

1.2 Tuft trees. Phanerophytes with woody stems and large apical leaf-fronds or terminal, rosulate branches (= rosulate phanero-

\mathbf{phy}	tes, e.g. palms a	and tree ferns)		 P ros
1.201	Dwarf trees $=$	Nanophanerophytes	$<\!2\ { m m}$	 N P ros
1.202	Small trees $=$	Microphanerophytes	2– 5 m	 Mi P ros
1.203	Large trees $=$	Mesophanerophytes	$5-50 \mathrm{m}$	 Mes P ros
1.204	Giant trees $=$	Megaphanerophytes	$> 50 \mathrm{m}$	 Meg P ros

The above height classes should be applied to specific field conditions where they arise. Following are the more common forms of rosulate phanerophytes:

- 1.210 Unbranched
- 1.210.1 Laminate leaf-fronds (e.g. some *Cecropia* spp.)
- 1.210.2 Feathery leaf-fronds (e.g. Cocos)
- 1.210.3 Fan-shaped leaf-fronds (e.g. Mauritia)
- 1.220 Branched
- 1.220.1 Simple, laminate leaf-fronds (e.g. Xanthorroea)
- 1.220.2 Feathery leaf-fronds (e.g. Schizolobium excelsum)
- 1.220.3 Fan-shaped leaf-fronds (e.g. Hyphaene thebaica)
- 1.230 Tufted, twin stems arising from common rootstock or rhizome
- 1.240 Hollow stem filled with roots (*Puya raimondii*)
- 1.200.4 Leaves with woolly hair cover (e.g. giant *Senecio* of high tropical mountains)
- 1.200.5 Semi-succulent leaves (e.g. Aloë spp.)

1.3 Bottle trees. Phanerophytes with markedly swollen, waterstoring stem (phanerophyta dolaria = dol, e.g. *Adansonia*).. P dol

- 1.300 Height and tree-shrub variations can be locally evaluated as before. Therefore the two zero digits.
- 1.300.1 Evergreen
- 1.300.11 Normal leaves (e.g. *Brachychiton*)
- 1.300.12 Leaf-fronds (palm, e.g. Colpothrinax wrightii)
- 1.300.13 Succulent leaves (e.g. Aloë dichotoma)
- 1.300.2 Drought-deciduous (including aphyllous forms,
- 1.4 Tall succulents, with succulent stem extending from base to apex or with upright growing succulent cladophylls..... P succ
- 1.400 Height and tree-shrub variations as before, except megaphanerophytes, which are not present
- 1.410 Single-stemmed, but commonly branched
- 1.410.1 Cylindri-formed stem
- 1.410.2 Cladophyllous (e.g. Opuntia macracantha)
- 1.411.1 Nanophanerophytes (e.g. Ferrocactus wislizenii)
- 1.413.1 In height up to mesophanerophyte (e.g. Carnegia gigantea)
- 1.420.1 Caespitose, cylindri-formed, in height up to mesophanerophyte (e.g. *Pachycereus pringlei*)
- 1.5 Phanerophytes with herbaceous stem or variously lignified (but herbaceously derived) stem. This group includes all herbaceous and suffruticose (woody base with herbaceous branch-ends) perennials that become taller than about 50 cm and do not exhibit a periodic die-back to that height limit. In particularly favourable environments this height limit may be extended to 1 m, e.g. humid tropics, warm seepage water habitats a.o.
- 1.500 Where applicable, height and scapose-caespitose variations can be evaluated as before. Therefore the two zero digits. A third variation for stoloniferous and rhizomatous forms appears practical to include here
- 1.500.1 Phanerophytic grasses or graminoid phanerophytes ... P gram
- 1.500.11 Lignified (e.g. various species of bamboo)
- 1.520.11 Caespitose
- 1.530.11 Reptant
- 1.500.12 Herbaceous (e.g. various species of sugar cane)
- 1.520.12 Caespitose
- 1.530.12 Reptant

1.500.21	Lignified (or suffruticose)
1.510.21	Scapose, with large leaf-fronds (e.g. Musa spp.)
1.520.21	Caespitose
1.520.211	With large leaf-fronds (some Musa spp.)
1.520.212	With normal branches and leaves (e.g. Indigofera)
1.530.21	Reptant
1.500.22	Herbaceous
1.510.22	Scapose
1.520.22	Caespitose
1.520.221	Centrally open, or with loose center
1.520.221.1	With large leaf-fronds (tall herbaceous ferns, e.g. <i>Hicriopteris</i>)
1.520.221.2	2 With normal branches and leaves (e.g. Begonia spp.)
1.520.222	Centrally dense, or with compact center, usually with flower
	stalk arising from center
1.520.222.1	Leaves relatively glabrous (non-woolly, e.g. Lobelia deckenii,
	Lupinus alopecurus)
1.520.222.2	2 Leaves woolly
1.530.22	Reptant

Phanerophytic forbs (non-graminoid herbs).....

P herb

2. Chamaephytes (Ch)

1.500.2

In addition to the features given in the key (p.56) chamaephytes have typically a shoot-crowding habit. They are more or less broomy or bunchy from the ground up to 30–50 cm. This applies particularly to those with ascending shoots. If they become taller than 50 cm, branches or shoots thin out rapidly as a rule. This is the shoot portion that dies back periodically in the unfavourable season. In more favourable habitats this height limit may be extended to 100 cm, for classifactory reasons. Another typical chamaephyte habit is sprawling along the ground. Therefore, in contrast to phanerophytes, height differences are not as important. Instead, of major importance is the degree of lignification and the habit of the shoot system. But a height classification is given at the end.

2.1 Woody dwarf-shrubs. Woodiness completed into

branch-tips. Frutescent chamaephytes Ch frut 2.11 Caespitose (most frequent, therefore "caesp" may be omitted) 2.111 Evergreen

2.111.01 Malacophyllous (m, e.g. Daphne striata)m Ch frut

2.111.02 Sclerophyllous (s, e.g. Mahonia aquifolia) s Ch frut

2.111.03 Aphyllous, phyllocladous (p, e.g. Ephedra spp.). p Ch frut

2.112 Cold-deciduous (aestivo = a, e.g. Vaccinium myrtillus) a Ch frut
2.12 Reptant (e.g. Arctostaphylos uva-ursi) Ch frut rept
2.13 Pulvinate (cushion form, e.g. Acantholimon spp.) Ch frut pulv
2.2 Semi-woody dwarf-shrubs. Woodiness restricted
to the base of the shoot system. Suffutescent chamae-
2.24 Coorritogo
2.21 Caespitose
2.211 Evergreen
2.211.01 Malacophyllous (e.g. <i>Hellaninemum nummul.</i>)mCh sull
2.211.02 Scierophyllous (r) s Ch suff
2.211.03 Aphyllous, phyllocladous (?) p Ch suff
2.212 Cold or drought-deciduous (thero = t, e.g. V accinium
parvijolium)t Ch suff
2.22 Reptant (e.g. Linnaea borealis) Ch suff rept
2.23 Pulvinate (?) Ch suff pulv
2.24 Scapose (e.g. Crotalaria mucronata) Ch suff scap
2.3 Herbaceous chamaephytes. Includes all non-woody evergreen pe- rennial forbs, grasses and ferns that do not get much taller than 1 m or
die back periodically to a remnant shoot system that remains green at
least 25 cm above the ground surface Ch herb
2.31 Caespitose
2.311 Evergreen in the strict sense (e.g. Dryopteris paleacea) Ch herb
2.312 Shoots dying back periodically, i.e. almost all at once
(thero = t); transitory to hemicryptophytes (e.g.
Andropogon virginicus) t Ch herb
2.32 Reptant
2.321 Evergreen (e.g. Stellaria holostea) Ch herb rept
2.322 Shoots with periodic die-back (t, Stenotaphrum secun-
datum) t Ch herb rept
2.33 Pulvinate Ch herb pulv
2.331 Globose (g, e.g. Androsace helvetica) g Ch herb pulv
2.332 Flat (f, e.g. Silene acaulis) f Ch herb pulv
2.34 Scapose Ch herb scap
2.4 Low succulents. These include all succulents below 50 cm height,

2.4 Low succulents. These include all succulents below 50 cm height, except those that die back to a remnant portion at the soil surface (hemicryptophytes) or within the soil (geophytes), e. g. many succulents characteristic of the South African and American deserts... Ch succ
2.41 Stem-succulents (st, e.g. Euphorbia mauretanica) Ch st succ

- 2.42 Leaf-succulents, some may be hemicryptophytes, which are here included (l, e.g. *Crassula* spp.) Ch l succ
 2.43 Root-succulents, with subterranean storage organs
- 2.43 Root-succulents, with subterranean storage organs (r, e. g. *Pachypodium bispinosum*)..... Ch r succ
- 2.5 Poikilohydrous chamaephytes. These are mostly ferns, as far as known, of arid climates, whose water household changes with the humidity of the surrounding atmosphere. Their shoots survive the droughty season in latent condition and become green immediately upon return of moister conditions (e.g. *Cheilanthus hirta*) Ch poik

Subdivisions as to height can be applied where necessary, for example:

2.000.1Very low chamaephyte< 3 cm</th>.2Low chamaephyte3- 10 cm.3Typical chamaephyte10- 30 cm.4Tall chamaephyte30-100 cm.5Very tall chamaephyte till > 100 cm

3. Hemicryptophytes (H)

The remnant shoot system, which during the unfavourable season lies relatively flat on the ground, is often protected by dead shoot remains. During the growing season the active shoots are always raised above the perennial ground-shoot. Hemicryptophytes are typically herbaceous throughout, but the maturing stem may show some secondary thickening (lignification), particularly when standing as a dead remnant, e.g. in many biennials.

3.10 Ca	aespitose hemicryptophytes (bunched or circular	
\mathbf{sh}	oot arrangement)	H caesp
3.101	Cold-deciduous shoot system (aestivo = a, e.g. Dactylis)	a H caesp
3.102	Drought-deciduous (cheimo = c, e.g. Heteropogon con-	-
	<i>tortus</i>)	c H caesp
3.103	Sparingly evergreen (e) during unfavourable season;	
	transitory to chamaephytes (e.g. <i>Deschampsia flexuosa</i>)	e H caesp
3.20 R	eptant hemicryptophytes (creeping or matted)	H rept
3.201	Cold-deciduous (e.g. Agrostis stolonifera)	a H rept
3.202	Drought-deciduous (e.g. Tricholaena repens)	c H rept
3.203	Sparingly evergreen (e.g. Cynodon dactylon)	e H rept
3.3 Sc	apose hemicryptophytes	
3.30	Without rosette	H scap

3.301	Cold-deciduous (e.g. Scrophularia nodosa)	a H scap
3.302	Drought-deciduous (e.g. Chrysopogon acicularis)	c H scap
3.31	Rosette	H ros
3.311	Cold-deciduous (e.g. Bellis perennis)	a H ros
3.312	Drought-deciduous (e.g. Desmodium triflorum)	c H ros
3.32	Semi-rosette (sem)	H sem
3.321	Cold-deciduous (e.g. Ranunculus acer)	a H sem
3.322	Drought-deciduous (e.g. Erigeron canadensis in sum-	
	mer-drought areas)	c H sem
3.4 Ag	$[uatic hemicryptophytes (hydrophyte = hyd) \dots]$	hyd H
3.41	Caespitose (e.g. Isoëtes)	hyd H caesp
3.42	Reptant (e.g. Pilularia)	hyd H rept
3.43	Scapose (e.g. Lobelia dortmanna)	hyd H scap

In addition a breakdown into height classes can be applied, where required, as follows:

3.000.1	Very small hemicryptophyte	$< 3 \mathrm{~cm}$
.2	Small hemicryptophyte	3-10 cm
.3	Medium-sized hemicryptophyte	10– 30 cm
.4	Tall hemicryptophyte	30–100 cm
.5	Very tall hemicryptophyte	> 100 cm

4. Geophytes (G, Cryptophytes)

These herbaceous plants with their survival organs well protected in the soil are typically found in climates with pronounced unfavourable seasons. However, they may occur also in less severe climates, where they may fill a temporary niche as complementary species in certain plant communities.

4.1 Roo	ot-budding geophytes (radicigemma = rad) \dots	G rad
4.11	Spring-green (earizo = ear) \dots	ear G rad
4.12	Summer-green (aestivo = a; e.g. Cirsium arvense)	a G rad
4.13	Rain-green (cheimo = c) $\dots \dots \dots \dots \dots \dots$	c G rad
4.2 Bul	lbous geophytes, arising from bulbs or corms	G bulb
4.21	Spring-green (e.g. Leucoium vernum)	ear G bulb
4.22	Summer-green (e.g. Lilium martagon)	a G bulb
4.23	Rain-green (e.g. Stenomesson)	c G bulb
4.3 Rhi	izome-geophytes, arising from rhizomes of various	
leng	ths	G rhiz

4.31	Spring-green (e.g. Anemone nemorosa)	ear G rhiz
4.32	Summer-green (e.g. Agropyron repens)	a G rhiz
4.33	Rain-green	c G rhiz
4.4 Aq	uatic geophytes (hydrophytic = hyd)	hyd G
4.41	Root-budding (?)	hyd G rad
4.42	Bulbous (?)	hyd G bulb
4.43	Rhizome (e.g. Nymphaea)	hyd G rhiz

Subdivisions as to caespitose, scapose or reptant growth habit can be applied where required:

4.001 Caespitose4.002 Scapose4.003 Reptant

Subdivisions for height differences can be applied as follows:

4.000.1	Very small geophyte	< 3 cm
.2	Small geophyte	3-10 cm
.3	Medium-sized geophyte	10– 30 cm
.4	Tall geophyte	30-100 cm
.5	Very tall geophyte	1– 3 m
.6	Extremely tall geophyte	$>3 \mathrm{m}$

5. Therophytes (T, Annuals)

As a rule therophytes live much shorter than a year and some complete their life cycle within a few weeks. However, exceptions are, for instance, the weeds in the winter-rye fields, which germinate in the fall and flower in the following vegetation period, or the succulent mesembrianthemums of African deserts that, because of their water-storing properties, may live longer than a year after a penetrating rain. Yet, they are therophytes in that they complete their life cycle within one favourable growing period and die after seed production. Not included are the hapoxanthous species (like *Agave, Argyroxiphium* a.o.) that die after seed production, but grow for several years before reaching that state. They are true perennials and their life cycle does not depend on one favourable growing season.

5.10 Ca	espitose therophytes	Т	caesp
5.101	Spring-green (e.g. Aira caryophyllea)	ear T	caesp
5.102	Summer-green (e.g. Setaria viridis)	a T	caesp
5.103	Rain-green (e.g. Chloris inflata)	c T	caesp

5.104	Winter-green, i.e. germinating in fall and living till		
	next summer or fall (metoporino = met, e.g. Apera		
	spica-venti)	$met \ T$	caesp
5.2 Re	ptant therophytes	Т	rept
5.201	Spring-green (e.g. Veronica hederifolia)	ear T	rept
5.202	Summer-green (e.g. Alopecurus geniculatus)	a T	rept
5.203	Rain-green (?)	c T	rept
5.204	Winter-green (e.g. Stellaria media)	$met \ T$	rept
5.3 Sea	apose therophytes		
5.30	Without rosette	Т	scap
5.301	Spring-green (e.g. Veronica triphyllos)	ear T	scap
5.302	Summer-green (e.g. Chenopodium polyspermum)	a T	scap
5.303	Rain-green (e.g. Eragrostis tenella)	c T	scap
5.304	Winter-green (e.g. Ranunculus arvensis)	$met \ T$	scap
5.31	Rosette, without leaves on the stalk	Т	ros
5.311	Spring-green (e.g. Erophila verna)	ear T	ros
5.312	Summer-green (?)	a T	ros
5.313	Rain-green (?)	c T	ros
5.314	Winter-green (e.g. Arnoseris minima)	$met \ T$	ros
5.32	Semi-rosette, with leaves on the stalk	Т	sem
5.321	Spring-green (e.g. Stenophragma thalianum)	ear T	sem
5.322	Summer-green (e.g. Sonchus oleraceus)	a T	sem
5.323	Rain-green (?)	c T	sem
5.324	Winter-green (e.g. Capsella bursa-pastoris)	$met \ T$	sem
5.4 Aq	uatic therophytes (e.g. Najas)	hyd T	
5.5 Su	cculent therophytes (e.g. Portulaca oleracea)	Т	succ
Subdivi	sions for height can be applied as follows:		
5.000.1	Very small therophyte $< 3 \text{ cm}$		
.2	Small therophyte 3– 10 cm		
.3	Medium-sized therophyte 10– 30 cm		
.4	Tall therophyte 30–100 cm		
0			

6. Lianas (L), Eu-lianas

Lianas are treated as a special group, since they depend for their support on other, self-supporting plants or artificial props, which in turn determine also the height of the liana.

6.1	Phanerophytic and chamaephytic lianas, including	
	all climbing plants that do not die back periodically to the	
	ground	PL
6.11	Root climbers, closely attached to their support by modi-	
	fied adventitious roots (radici = r) $\dots \dots \dots$	r PL
6.11	11 Woody (fruticose, e.g. <i>Hedera helix</i>)	r PL frut
6.11	12 Semi-woody (suffruticose, e.g. Parthenocissus spp.)	r PL suff
6.11	13 Herbaceous (?)	r PL herb
6.12	2 Winding climbers, encircling their support (strepano = st)	st PL
6.12	21 Woody (e.g. many tropical lianas)	st PL frut
6.12	22 Semi-woody (e.g. Humulus lupulus)	st PL suff
0 10		
0.1_{2}	23 Herbaceous (e.g. <i>Polygonum dumetorum</i>)	st PL herb
$6.12 \\ 6.13$	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of dif- 	st PL herb
6.12 6.13	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) 	st PL herb el PL
6.12 6.13	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) 	st PL herb el PL el PL frut
6.12 6.13 6.13 6.13	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) Semi-woody (some Cissus spp.) 	st PL herb el PL el PL frut el PL suff
$\begin{array}{c} 6.12 \\ 6.13 \\ 6.13 \\ 6.13 \\ 6.13 \end{array}$	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) Semi-woody (some Cissus spp.) Herbaceous (e.g. Passiflora spp.) 	st PL herb el PL el PL frut el PL suff el PL herb
6.13 6.13 6.13 6.13 6.13 6.14	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) Semi-woody (some Cissus spp.) Herbaceous (e.g. Passiflora spp.) Spread-climbers, propping their branches on other plants 	st PL herb el PL el PL frut el PL suff el PL herb
6.13 6.13 6.13 6.13 6.14	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) Semi-woody (some Cissus spp.) Herbaceous (e.g. Passiflora spp.) Spread-climbers, propping their branches on other plants (diateino = d) 	st PL herb el PL el PL frut el PL suff el PL herb d PL
6.13 6.13 6.13 6.13 6.14 6.14	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) Semi-woody (some Cissus spp.) Herbaceous (e.g. Passiflora spp.) Spread-climbers, propping their branches on other plants (diateino = d) Woody (e.g. Chusquea and other bamboos) 	st PL herb el PL el PL frut el PL suff el PL herb d PL d PL frut
6.13 6.13 6.13 6.13 6.14 6.14 6.14	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) Semi-woody (some Cissus spp.) Herbaceous (e.g. Passiflora spp.) Spread-climbers, propping their branches on other plants (diateino = d) Woody (e.g. Chusquea and other bamboos) Semi-woody (e.g. many Rubus spp.) 	st PL herb el PL el PL frut el PL suff el PL herb d PL d PL frut d PL suff
$\begin{array}{c} 6.12 \\ 6.13 \\ 6.13 \\ 6.14 \\ 6.14 \\ 6.14 \\ 6.14 \\ 6.14 \end{array}$	 Herbaceous (e.g. Polygonum dumetorum) Tendril climbers, attaching themselves by tendrils of different morphological origin (elitto = el) Woody (e.g. Bauhinia spp.) Semi-woody (some Cissus spp.) Herbaceous (e.g. Passiflora spp.) Spread-climbers, propping their branches on other plants (diateino = d) Woody (e.g. Chusquea and other bamboos) Semi-woody (e.g. many Rubus spp.) Herbaceous (?) 	st PL herb el PL el PL frut el PL suff el PL herb d PL d PL frut d PL suff d PL herb

Within each group, subdivisions are possible, e.g.:

6.000.01	Evergreen (no additional symbol)
6.000.02	Cold-deciduous, summer-green (aestivo = a) \ldots a
6.000.03	Drought-deciduous, rain-green (cheimo = c) $\ldots c$

Height classes can be applied in relation to the supporting life forms, or for a finer definition separate height classes may be devised by beginning with the 5th digit, i.e. 6.000.1, etc.

6.2 Hemicryptophytic lianas, dying back periodically to a rem-	
nant shoot system near the ground	HL
6.21 Root climbers (?)	r HL
6.22 Winding climbers (?)	st HL
6.23 Tendril climbers (e.g. Vicia sepium)	el HL
6.24 Spread climbers (e.g. Galium mollugo)	d HL
6.3 Geophytic lianas, dying back periodically to subterranean	
storage organs	GL

6.32	Winding climbers (e.g. Convolvulus arvensis)	st GL
6.33	Tendril climbers (e.g. Lathyrus maritimus)	el GL
6.34	Spread climbers (e.g. Corydalis clasiculata)	d GL
6.4 Th	nerophytic lianas	TL
6.42	Winding climbers (e.g. Polygonum convolvulus)	st TL
6.43	Tendril climbers (e.g. Vicia hirsuta)	el TL
6.44	Spread climbers (e.g. Galium aparine)	d TL

7. Hemi-epiphytes, pseudo-lianas, epiphytic lianas (EL)

These plants may either be classified as lianas or as epiphytes depending on their developmental status during analysis. However, where their nature can be assessed with certainty the following classification may be applied:

- 7.1 Roots winding around host plant or otherwise surrounding it (e.g. by ramifying roots); stranglers
- 7.2 Roots descending down without encircling host plant
- 7.21 Along trunk of host plant
- 7.22 Hanging free from branches of host plant

8. Epiphytes (E), vascular epiphytes

8.1	Epiphytes	with	normal	root	systems	growing	in	soil	\mathbf{or}	humus
	pockets (mos	stly fac	ultative e	piphy	tes)					

- 8.11 Phanerophytes (e.g. Cheirodendron trigynum) PE
- 8.12 Chamaephytes ChE
- 8.121 Woody or suffruticose (e.g. *Psilotum nudum*) ChE frut
- 8.122 Herbaceous ChE herb
- 8.122.1 With leaves arranged in funnel shape (e.g. Asplenium nidus)
- 8.122.2 With leaves not showing any funnel arrangement, i.e. leaves as in normal soil-adapted herbs (e.g. many orchids)
- 8.2 Epiphytes with strongly modified root systems, stems or leaves (or other unusual morphological modifications) adapted to growth on branches that have no soil or humus pocket-accumulations in branch forks etc. (mostly obligative epiphytes)
- 8.21 Succulents (e.g. *Peperomia* spp.) ChE succ8.22 Non-succulent plants

- 8.221 With unmodified leaves (i.e. not in any way peculiar or unusual), but modified stems or roots
- 8.221.1 With strongly swollen stem-base (e.g. Myrmecodia tuberosa)
- 8.221.2 With green string-like roots (e.g. many orchids)
- 8.222 With strongly modified (i.e. unusual) leaves
- 8.222.1 With upright cup or funnel-shaped leaves (e.g. Bromelia spp.)
- 8.222.2 With leaves specially adapted to form humus layers (e.g. *Platy-cerium*)
- 8.223 With completely modified plant body, resembling bearded lichens (e.g. *Tillandsia usneoides*)

Two ecologically significant height strata can usually be evaluated:

- 8.000.01 Occupying sun-exposed positions in the upper tree canopy
- 8.000.02 Occupying lower canopy area and lower branches, growing in more shaded positions
- 9. Errant vascular Hydrophytes, free-moving in water, not attached or rooted in the ground (e.g. *Eichhornia, Salvinia, Lemna, Utricularia*) Kormo-Hydrophyta natantia k Hyd nat Subdivisions possible.

10. Thallo-chamaephytes (Th Ch)

10.1 Hummock-forming mosses ($=$ sphagnoid bryo-
phytes) Br Ch sph
10.2 Heavy carpet-forming mosses (= reptant bryo-
phytes, e.g. <i>Pleurozium schreberi</i>) Br Ch rept
10.21 On mineral soil and humus Br Ch rept (soil)
10.22 On decaying wood Br Ch rept (wood)
10.23 On rock Br Ch rept (rock)
10.3 Cushion-forming mosses (= pulvinate bryophytes,
e.g. <i>Leucobryum glaucum</i>) Br Ch pulv
10.31 On mineral soil and humus Br Ch pulv (soil)
10.32 On decaying wood Br Ch pulv (wood)
10.33 On rock Br Ch pulv (rock)
10.4 Cushion-forming or caespitose and fruticose lichens (= chamaephytic lichens, e.g. <i>Cladonia silvatica</i>) Li Ch
Substrate differences may be recognized.

11. Thallo-hemicryptophytes (Th H)

11.1	Flat-lying mosses, bryo-hemicryptophytes (e.g. <i>Plagio-</i> <i>thecium curvifolium</i>)	Br H	
11.2	Flat-lying liverworts, hepatic hemicryptophytes (e.g. Marchantia)	Нер Н	
11.3	Foliose lichens, lichen-hemicryptophytes (e.g. Peltigera)	Li H	fol
11.4	Crustose lichens, crustaceous lichen-hemicryptophytes		
	(e.g. <i>Lecidea</i>)	Li H	crust
11.5	Endolithic lichens, living in stones near the surface	${ m Li}~{ m H}$	end
11.6	Adnate algae, phyco-hemicryptophytes (e.g. some <i>Pleurococcus</i>)	Phyc H	
11.7	Endolithic algae	Phyc H o	end

12. Thallo-therophytes (Th T)

12.1	Short-living mosses, bryo-therophytes (e.g. <i>Ephemerum</i>)	Br T
12.2	Short-living liverworts, hepatic therophytes (e.g. Riccia)	Нер Т
	etc.	

13. Thallo-epiphytes (T E), living on bark or leaves

13.1 Ep	iphytic thallo-chamaephytes	Th C	h E
13.11	Mosses (e.g. Pseudisothecium)	Br C	h E
13.12	Liverworts	Hep C	h E
13.13	Lichens (e.g. Alectoria)	Li C	h E
13.2 Ep	iphytic thallo-hemicryptophytes	Th H	E
13.21	Mosses (e.g. Hypnum cupressiforme)	Br H	E
13.22	Liverworts	Hep H	E
13.23	Lichens (e.g. Parmelia)	Li H	E
13.24	Algae (e.g. Pleurococcus)	Phyc H	E
13.3 Ep	iphytic thallo-therophytes	Th T	E
13.31	Mosses	Br T	Е
13.32	Algae	Phyc T	Е

10.-13. Subdivisions incomplete,

14.-23. to be worked out later.

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