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Tentative physiognomic-ecological classification of plant formations of the earth

by H. ELLENBERG and D. MUELLER-DOMBOIS

based on a discussion draft of the UNESCO working group
on vegetation classification and mapping¹

This physiognomic classification has been elaborated as basis for mapping world vegetation on a scale of 1:1 Million or smaller. It will permit the world-wide comparison of ecological habitats indicated by equal plant life form combinations.²

Plant formations and other divisions in this context are conceived as combinations of plant life forms, i.e. as physiognomic units. For naming, ecological terms have been included for brevity; wherever possible, definitions are based on physiognomic criteria. In the following classification, units of unequal rank are distinguished by different symbols:

I, II etc. = FORMATION CLASS

A, B etc. = Formation subclass

1, 2 etc. = Formation group

a, b etc. = Formation

(1), (2) etc. = *Subformation*

(a), (b) etc. = Further subdivisions

¹ A first list, prepared by SCHMITHÜSEN and ELLENBERG (1964) and revised by D. POORE and ELLENBERG (1965), has been discussed in Paris (Jan. 1966) by GAUSSEN (President), BUDOWSKI, ELLENBERG, FRÄNZLE, GERMAIN, KÜCHLER, LEBRUN, D. POORE and SOTCHAVA. The definitions of the terms have been added by the authors. For comments and corrections we thank the colleagues mentioned above, mainly Professor KÜCHLER.

The authors will be grateful for any further comment. Please send it to Professor ELLENBERG, Untere Karspuele 2, D-34 Goettingen (West Germany).

² Some formations are covering only small areas which cannot be represented on small scale maps. They have been mentioned here to facilitate a more general use of this physiognomic-ecological classification.

A key to the plant life forms is published in this periodical, page 56-73.

I. CLOSED FORESTS, formed by trees at least 5 m tall with their crowns interlocking.¹

A. Mainly evergreen forests, i.e. the canopy is never without foliage, however, individual trees may shed their leaves.

1. Tropical ombrophilous forests. (Conventionally called tropical rain forests). Consisting mainly of evergreen trees mostly with little or no bud protection, neither cold nor drought resistant. Truly evergreen, i.e. individual trees may stand leafless for a few weeks only and not at the same time as all the others. Leaves of many species with "drip tips".

a. Tropical ombrophilous lowland forest. Composed of numerous species of fast growing trees, some of them exceeding 50 m in height, generally with smooth bark, some with buttresses. Very sparse undergrowth, and this composed mainly of tree reproduction. Palms and other tuft trees usually rare, lianas nearly absent except pseudo-lianas (i.e. plants originating on tree branches, subsequently rooting in the ground). Crustose lichens and green algae are the only constantly present epiphytic life forms; vascular epiphytes are less abundant than in b-d.²

b. Tropical ombrophilous submontane forest. Tree growth largely the same as in a. In the undergrowth herbaceous life forms more frequent. The most important difference from a is the more frequent appearance of vascular epiphytes.

c. Tropical ombrophilous montane forest. (Corresponds most closely to text book descriptions of the virgin tropical rain forest). Abundant vascular and other epiphytes. Tree sizes markedly reduced (< 50 m); crowns extending deeper down the stem than in a or b. Bark often more or less rough. Undergrowth abundant, often represented by rosulate nano- and microphanerophytes (e. g. tree ferns or small palms); the ground layer rich in hygromorphous herbs and cryptogams.

(1) *broad-leaved*, most common form;

(2) *needle-leaved* or microphyllous;

(3) *bamboo*, rich in tree-grasses replacing largely the tuft micro- or nano-phanerophytes.

¹ In reproductive stage or as immature secondary growth temporarily less than 5 m tall, but individuals of scapose life form (i.e. real trees, not shrubs). In sub-polar conditions, the limit may be only 3 m, in tropical ones 8 or 10 m.

² In lowlands vascular epiphytes are abundant only where fog frequently occurs, e.g. near the coast.

- d. Tropical ombrophilous "subalpine" forest. (Not including cloud forest or woodland. Considered unique by some investigators, but probably not important. Definition required.)
- e. Tropical ombrophilous cloud forest. Tree crowns, branches and trunks as well as lianas burdened with epiphytes, mainly chamaephytic bryophytes. Also the ground covered with hygromorphic chamaephytes (e.g. *Selaginella* and herbaceous ferns). Trees often gnarled, with rough bark and rarely exceeding 20 m in height.
- (1) *broad-leaved*, most common form;
- (2) *needle-leaved* or microphyllous.
- f. Tropical ombrophilous alluvial forest. Similar to b, but richer in palms and in undergrowth life forms, particularly tall forbs¹ (e.g. *Muscaceae*); buttresses frequent.
- (1) *riparian* (on the lowest forested river banks, frequently flooded), mostly dominated by fast-growing trees; herbaceous undergrowth nearly absent, epiphytes extremely rare, poor in species;
- (2) *occasionally flooded* (on relatively dry terraces accompanying active rivers), most common form of f. More epiphytes than in (1) and (3), many lianas;
- (3) *seasonally water-logged* (along the lower river courses, where the water accumulates on large flats for several months); trees frequently with stilt roots; canopy density not uniform; as a rule poor in undergrowth, except for more open places.
- g. Tropical ombrophilous swamp forest. (Not along rivers, but on edaphically wet habitats, which may be supplied either with fresh or brackish water). Similar to f, but as a rule poorer in tree species. Many trees with buttresses or pneumatophores; mostly higher than 20 m.
- (1) *broad-leaved*, dominated by dicots,
- (2) *dominated by palms*, but broad-leaved trees in the undergrowth.
- h. Tropical evergreen peat forest (with organic surface deposits). Poor in tree species, with lower canopy than g (as a rule not higher than 20 m). Trees have slow growth rates and thin diameters and are commonly equipped with pneumatophores or stilt roots.
- (1) *broad-leaved*, dominated by dicotylous plants,
- (2) *dominated by palms*, which may be equipped with asparagus-shaped pneumatophores.

¹ "Forb" (American) means "non-graminoid herb".

(IA2)

2. Tropical and subtropical evergreen seasonal forests. Consisting mainly of evergreen trees with some bud protection. Foliage reduction during the dry season is noticeable, often as partial shedding. Transitional between 1 and 3. Subdivisions a–c largely similar to those under 1:

- a. Tropical (or subtropical) evergreen seasonal lowland forest.
- b. Tropical (or subtropical) evergreen seasonal submontane forest.

(1) *broad-leaved*, most common form,

(2) *needle-leaved*.

- c. Tropical (or subtropical) evergreen seasonal montane forest. In contrast to 1 c no tree ferns; instead, evergreen shrubs are more frequent.
- d. Tropical (or subtropical) evergreen dry “subalpine” forest. Physiognomically resembling the winter-rain evergreen sclerophyllous dry forest (8 a), usually occurring above the cloud forest (1 e). Mostly evergreen sclerophyllous trees, smaller than 20 m, with little or no undergrowth (if not opened by human activity). Poor in lianas and epiphytes, except lichens.

3. Tropical and subtropical semi-deciduous forests. Most of the upper canopy trees drought-deciduous; many of the understorey trees and shrubs evergreen and more or less sclerophyllous. Nearly all trees with bud protection; leaves without “drip tips”. Trees show rough bark, except some bottle trees, which may be present.

- a. Tropical (or subtropical) semi-deciduous lowland forest. The taller trees are often bottle trees (e.g. *Ceiba*). Practically no epiphytes present. Undergrowth composed of tree reproduction and true woody shrubs. Succulents may be present (e.g. in form of thin-stemmed caespitose cacti). Both therophytic and hemicryptophytic lianas occur occasionally. A sparse herb layer may be present, mainly consisting of graminoid hemicryptophytes and forbs.
- b. Tropical (or subtropical) semi-deciduous montane or cloud forest. Similar to a, but canopy lower and covered with xerophytic epiphytes (e.g. *Tillandsia usneoides*). Within group 3, a submontane formation cannot be clearly distinguished.

4. Subtropical ombrophilous forests. (Present only locally and in small fragmentary stands, because the subtropical climate is typically a climate with a dry season. Where the subtropical ombrophilous forest occurs, e.g. Queensland/Australia and Taiwan, it usually grades rather

inconspicuously into the tropical ombrophilous forest. Its trees are less vigorous and allow some shrubs to grow in the understorey. The subtropical ombrophilous forest should however not be confused with the tropical ombrophilous montane forest, which occurs in a climate with a similar mean annual temperature, but with less pronounced temperature differences between summer and winter.) Consequently, seasonal rhythms are more evident in all subtropical forests, even in the ombrophilous ones.

The subtropical ombrophilous forest is physiognomically more closely related to the tropical than to the temperate one. Therefore the subdivisions are conform more or less to point 1 a-h.

5. Mangrove forests. (Occur only in the tidal range of the tropical and subtropical zones). Composed almost entirely of evergreen sclerophyllous broad-leaved trees and shrubs with either stilt roots or pneumatophores. Epiphytes in general rare, except lichens on the branches and adnate algae on the lower parts of the trees. (Subdivisions possible; transitions to 1 g exist).

6. Temperate and subpolar evergreen ombrophilous forests. (Occurring only in the extremely oceanic, nearly frostfree climate on the southern hemisphere, mainly in Chile). Consisting mostly of truly evergreen hemi-sclerophyllous trees and shrubs. Rich in thallo-epiphytes and in ground-rooted herbaceous ferns.

a. Temperate evergreen ombrophilous broad-leaved forest. Some vascular epiphytes and lianas present; height generally exceeds 10 m.

(1) *without conifers,*

(2) *with conifers admixed.*

b. Temperate evergreen ombrophilous alluvial forest. Richer in herbaceous undergrowth than a. (Not yet sufficiently investigated).

c. Temperate evergreen ombrophilous swamp forest. (Perhaps existing, but not yet known).

d. Subpolar evergreen ombrophilous forest. In contrast to a, vascular epiphytes lacking and canopy height much reduced (in general less than 10 m).

7. Temperate evergreen seasonal broad-leaved forests (with pronounced summer rainfall¹). Consisting mainly of hemi-sclerophyllous evergreen

¹ Correspond to the "lauraceous" forests of RÜBEL etc., which are often believed to be "winter-rain evergreen", but in reality cannot support summer drought. Most frequent in E Asia.

(IA7)

trees and shrubs. Rich in herbaceous chamaephytic and hemicryptophytic undergrowth. Very few or no vascular epiphytes and lianas. Grades into subtropical or temperate ombrophilous forest. Probably includes subpolar types.

(Subdivisions similar to 2 a–d possible).

8. Winter-rain evergreen broad-leaved sclerophyllous forests. (Often understood as Mediterranean, but present also in SW Australia, Chile etc. Climate with pronounced summer drought). Consisting mainly of sclerophyllous evergreen trees and shrubs, most of which show rough bark. Herbaceous undergrowth almost lacking. No vascular and only few cryptogamic epiphytes, but evergreen woody lianas present.

a. Winter-rain evergreen sclerophyllous lowland forest (including submontane). Corresponds largely to the description under 8.

b. (Alluvial and swamp forests of this type perhaps existing, but not sufficiently known).

9. Temperate and subpolar evergreen coniferous forests. Consisting mainly of needle-leaved or scale-leaved evergreen trees, but broad-leaved trees may be admixed. Vascular epiphytes and lianas practically lacking.

a. Evergreen giant conifer forest. Dominated by trees higher than 50–60 m (e.g. *Sequoia*- and *Pseudotsuga*-forest in the Pacific West of North America).

b. Evergreen (non-giant) conifer forest with rounded crowns. Dominated by trees 5–50 m high, with more or less broad, irregularly rounded crowns (e.g. *Pinus* ssp.).

(1) *with evergreen sclerophyllous understorey* (Mediterranean),

(2) *without evergreen sclerophyllous understorey*.

c. Evergreen (non-giant) conifer forest with conical crowns. Dominated by trees 5–50 m high (only exceptionally higher), with more or less conical crowns (like most *Picea* and *Abies*).

d. Evergreen (non-giant) conifer forest with cylindrical crowns (boreal). Similar to c, but crowns with very short branches and therefore very narrow, cylindro-conical.

B. Mainly deciduous forests. Majority of trees shed their foliage simultaneously in connection with the unfavourable season.

1. Drought-deciduous forests (tropical and subtropical). Unfavourable season mainly characterized by drought, in most cases winter-drought.

Foliage is shed regularly every year. Most trees with relatively thick, fissured bark.

- a. Drought-deciduous lowland (and submontane) forest. Practically no evergreen plants in any stratum, except some succulents. Woody and herbaceous lianas present occasionally, also deciduous bottle-trees. Ground vegetation mainly herbaceous (hemicryptophytes, particularly grasses, geophytes and some therophytes), but sparse.

(1) *broad-leaved*;

(2) *microphyllous* (including feathery-leaved legume-trees).

- b. Drought-deciduous montane (and cloud) forest. Some evergreen species in the understorey. Drought-resistant epiphytes present or abundant, often of the bearded form (e.g. *Usnea* or *Tillandsia usneoides*); canopy as in 1 B 1 a. This formation is not frequent, but well developed, e.g. in northern Peru.

(Further types of drought-deciduous forest may need recognition).

- 2. Cold-deciduous forests with evergreen trees (or shrubs) admixed.** Unfavourable season mainly characterized by winter frost. Deciduous trees dominant, but evergreen species present as part of the main canopy or as understorey. Climbers and vascular epiphytes scarce or absent.

- a. Cold-deciduous forest with evergreen broad-leaved trees and climbers (e.g. *Hedera helix* in Western Europe). Rich in cryptogamic epiphytes, including mosses. Even vascular epiphytes may be present at the base of tree stems.
- b. Cold-deciduous forest with broad-leaved sclerophyllous understorey (e.g. sub-Mediterranean forest).
- c. Cold-deciduous forest with evergreen needle-leaved trees. (Further subdivisions possible).

- 3. Cold-deciduous forests without evergreen trees.** Deciduous trees absolutely dominant. Evergreen chamaephytes and some evergreen nanophanerophytes may be present. Climbers insignificant, vascular epiphytes absent (except occasionally at the lower base of the trees); thalloepiphytes always present, particularly lichens.

- a. Temperate lowland and submontane cold-deciduous forest. Trees up to 50 m tall. Primarily algae and crustose lichens as epiphytes.
- b. Montane or boreal cold-deciduous forest (including lowland or submontane in topographic positions with high atmospheric humidity).

(IB3b)

Foliose and fruticose lichens, and bryophytes as epiphytes. Trees up to 50 m tall, but in montane or boreal forest normally not taller than 30 m.

- (1) *mainly broad-leaved,*
- (2) *mainly deciduous coniferous (e.g. Larix),*
- (3) *mixed broad-leaved and deciduous coniferous.*

c. Subalpine or subpolar cold deciduous forest. In contrast to a and b canopy height significantly reduced (not taller than 20 m). Tree trunks frequently gnarled. Epiphytes similar to b, but in general more abundant. Often grading into woodland (see II).

- (1) *with primarily hemicryptophytic undergrowth,*
- (2) *with primarily chamaephytic undergrowth.* May merge with forests admixed with conifers (see 2 c).

d. Cold-deciduous alluvial forest. (Flooded by rivers, therefore moister and richer in nutrients than a). Trees and shrubs with high growth rates and vigorous herbaceous undergrowth.

- (1) *occasionally flooded;* physiognomically similar to a, with tall trees and abundant macrophyllous shrubby undergrowth;
- (2) *regularly flooded;* trees not as tall and dense as in a, but herbaceous undergrowth abundant and tall. (In Eurasia *Salix*- or *Alnus*-species frequently dominating).

e. Cold-deciduous swamp or peat forest. (Flooded until late spring or early summer, surface soil organic). Relatively poor in tree species. Ground cover mostly continuous.
(Subdivisions like b).

C. Extremely xeromorphic forests. Dense stands of xeromorphic phanerophytes, such as bottle trees, tuft trees with succulent leaves and stem succulents. Undergrowth with shrubs of similar xeromorphic adaptations, succulent chamaephytes and herbaceous hemicryptophytes, geophytes and therophytes. Often grading into woodlands (see II).

1. Sclerophyllous-dominated extremely xeromorphic forests. Life form combination as above, except for predominance of sclerophyllous trees, many of which have bulbous stem bases largely imbedded in the soil (xylopods).

(Subdivisions possible, but not yet sufficiently investigated).

2. Thorn-forests. Species with thorny appendices predominate.

a. Mixed deciduous-evergreen thorn forest. May merge with 1.

b. Purely deciduous thorn forest. Most common form.

3. Mainly succulent forests. Tree-formed (scapose) and shrub-formed (caespitose) succulents very frequent, but the other xero-phanerophytes present as well.

II. WOODLANDS (open stands of trees). Formed by trees at least 5 m tall, with most of their crowns not touching each other, but covering at least 30 % of the surface; grass cover sometimes present. This formation class does not include savannas or parklands.

A. Mainly evergreen woodlands, i.e. evergreen as defined in I A.

1. Evergreen broad-leaved woodlands. Mainly sclerophyllous trees and shrubs, no epiphytes.

(Subdivisions with regard to undergrowth variations possible).

2. Evergreen needle-leaved woodlands. Mainly needle- or scale-leaved. Crowns of many trees extending to the base of the stem or at least very branchy.

a. Evergreen coniferous woodlands with rounded crowns (e.g. *Pinus*).

(1) *with evergreen sclerophyllous understorey* (Mediterranean),

(2) *without evergreen sclerophyllous understorey*.

b. Evergreen coniferous woodland with conical crowns prevailing (mostly subalpine).

c. Evergreen coniferous woodland with very narrow cylindro-conical crowns (e.g. *Picea* in the boreal region).

(Further subdivisions according to undergrowth variations and frequency of epiphytes are possible).

B. Mainly deciduous woodlands (see I B).

1. Drought-deciduous woodlands.

(Subdivisions more or less like forests).

2. Cold-deciduous woodlands with evergreen trees (see I B 2).

3. Cold-deciduous woodlands (see I B 3. Most frequent in the subarctic region, elsewhere only on swamps or bogs); without evergreen trees.

(IIB3)

- a. Broad-leaved deciduous woodland.
- b. Needle-leaved deciduous woodland.
- c. Mixed deciduous woodland (broad-leaved and needle-leaved).

C. Extremely xeromorphic woodlands. Similar to I C, the only difference being the more sparse stocking of individual trees. (Subdivisions as under I C).

III. FOURRÉS (Shrublands or thickets). Mainly composed of caespitose woody phanerophytes 0.5 to 5 m tall.¹ Each of the following subdivisions may either be:

shrubland = most of the individual shrubs not touching each other, often with a grass stratum; or:
thicket = individual shrubs interlocked.

A. Mainly evergreen fourrés (evergreen in the sense of I A).

1. Evergreen broad-leaved shrublands (or thickets).

- a. Low bamboo thicket (or, less frequently, shrubland). Lignified creeping graminoid nano- or microphanerophytes.
- b. Evergreen tuft tree shrubland (or thicket). Composed of small trees and woody shrubs (e.g. Mediterranean dwarf palm shrubland or Hawaiian tree fern thicket).
- c. Evergreen broad-leaved hemi-sclerophyllous thicket (or shrubland). Caespitose, creeping or lodged nano- or microphanerophytes with relatively large and soft leaves (e.g. subalpine *Rhododendron* thickets, or *Hibiscus tiliaceus* matted thickets of Hawaii).

(Subdivisions possible).

- d. Evergreen broad-leaved sclerophyllous shrubland (or thicket). Dominated by broad-leaved sclerophyllous shrubs and immature trees (i.e. chaparral or macchia). May often merge with parkland, grassland or heath.
- e. Evergreen suffrutescent thicket (or shrubland). Stand of semi-lignified nanophanerophytes that in dry years may shed part of their shoot systems (e.g. *Cistus* heath).¹
(Additional units may be distinguished).

¹ Not to be confused with developing second growth forests, see footnote relating to I. Sometimes, fourrés may reach more than 5 m in height.

2. Evergreen needle-leaved and microphyllous shrublands (or thickets).

- a. Evergreen needle-leaved thicket (or shrubland). Composed mostly of creeping or lodged needle-leaved phanerophytes (e.g. *Pinus montana*, "Krummholz").
- b. Evergreen microphyllous shrubland (or thicket). Often ericoid shrubs (mostly in tropical subalpine belts).
(Further subdivisions possible).

B. Mainly deciduous fourrés (deciduous in the sense of I B).

1.-3. (Subdivisions similar to II B 1-3).

4. Cold-deciduous shrublands (or thickets).

- a. Temperate deciduous thicket (or shrubland). More or less dense scrub without or with only little herbaceous undergrowth. Poor in cryptogams.
- b. Subalpine or subpolar deciduous thicket (or shrubland). Upright or lodged caespitose nanophanerophytes with great vegetative regeneration capacity. As a rule completely covered by snow for at least half a year.
 - (1) *with primarily hemicryptophytic undergrowth*, mainly forbs (e.g. subalpine *Alnus viridis* thicket),
 - (2) *with primarily chamaephytic undergrowth*, mainly dwarf shrubs and fruticose lichens (e.g. *Betula tortuosa* shrubland at the polar tree line).
- c. Deciduous alluvial shrubland (or thicket). Fast growing shrubs, occurring as pioneers on river banks or islands that are often vigorously flooded, therefore mostly with very sparse undergrowth.
 - (1) *with lanceolate leaves* (e.g. *Salix*, mostly in lowland or submontane region),
 - (2) *microphyllous* (e.g. *Tamarix*).
- d. Deciduous peat shrubland (or thicket). Upright caespitose nanophanerophytes with *Sphagnum* and (or) other peat mosses.
(Subdivisions possible).

C. Extremely xeromorphic (subdesert) shrublands. Very open stands of shrubs with various xerophytic adaptations, such as extremely scleromorphic or strongly reduced leaves, green branches without leaves, or succulent stems, etc., some of them with thorns.

¹ Occasionally less than 50 cm tall, thereby grading into IV A 1 a.

(IIIC)

1. Mainly evergreen subdesert shrublands. In extremely dry years some leaves and shoot portions may be shed.

a. (Truly) evergreen subdesert shrubland.

(1) *broad-leaved*, dominated by sclerophyllous nanophanerophytes, including some phyllocladous shrubs (e.g. mulga scrub in Australia),

(2) *microphyllous*, or leafless, but with green stems (e.g. *Retama retam*),

(3) *succulent*, dominated by variously branched stem and leaf succulents.

b. Semi-deciduous subdesert shrubland. Either facultatively deciduous shrubs or a combination of evergreen and deciduous shrubs.

(1) *facultatively deciduous* (e.g. *Atriplex-Kochia*-saltbush in Australia),

(2) *mixed evergreen and deciduous*, transitional to 2.

2. Deciduous subdesert shrublands. Mainly deciduous shrubs, often with a few evergreens.

a. Deciduous subdesert shrubland without succulents.

b. Deciduous subdesert shrubland with succulents.

IV. DWARF-SCRUB AND RELATED COMMUNITIES, rarely exceeding 50 cm in height (sometimes called heaths or heathlike formations). According to the density of the dwarf-shrub cover are distinguished:

dwarf-shrub thicket = branches interlocked;

dwarf-shrubland = individual dwarf-shrubs more or less isolated or in clumps;

cryptogamic formations with dwarf-shrubs = surface densely covered with mosses or lichens (thallo-chamaephytes); dwarf-shrubs occurring in small clumps or individually. In the case of bogs locally dominating graminoid communities may be included.

A. Mainly evergreen dwarf-scrub. Most dwarf-shrubs evergreen.

1. Evergreen dwarf-shrub thickets. Densely closed dwarf-shrub cover, dominating the landscape ("dwarf-shrub heath" in the proper sense).

a. Evergreen caespitose dwarf-shrub thicket. Most of the branches standing in upright position, often occupied by foliose lichens. On the ground pulvinate mosses, fruticose lichens or herbaceous life forms may play a role (e.g. *Calluna* heath).

b. Evergreen creeping or matted dwarf-shrub thicket. Most branches creeping along the ground. Variously combined with thallo-

chamaephytes in which the branches may be imbedded (e.g. *Loiseleuria* heath).

(Subdivisions possible).

2. Evergreen dwarf-shrublands. Open or more loose cover of dwarf-shrubs.

- a. Evergreen cushion shrubland. More or less isolated clumps of dwarf-shrubs forming dense cushions, often equipped with thorns (e.g. *Astragalus*- and *Acantholimon* "porcupine"-heath of the East-Mediterranean mountains).
- b. Evergreen mosaic dwarf-shrubland. Colonies or clumps of dwarf-shrubs interrupted by other life forms, bare soil or rocks (e.g. *Erica tetralix* swamp heath). Transitions into D and E possible.

3. Mixed evergreen dwarf-shrub and herbaceous formations. More or less open stands of evergreen suffrutescent or herbaceous chamaephytes, various hemicryptophytes, geophytes etc.

- a. Truly evergreen dwarf-shrub and herb mixed formation (e.g. *Nardus-Calluna*-heath).
- b. Partially evergreen dwarf-shrub and herb mixed formation. Many individuals shed parts of their shoot systems during the dry season (e.g. *Phrygana* in Greece).

B. Mainly deciduous dwarf-scrub. Similar to A, but mostly consisting of deciduous species.

1. Facultatively drought deciduous dwarf-thickets (or dwarf-shrublands). Foliage is shed only in extreme years.

2. (Obligatory) drought-deciduous dwarf-thickets (or dwarf-shrublands). Densely closed dwarf-shrub stands which lose all or at least part of their leaves in the dry season.

- a. Drought-deciduous caespitose dwarf-thicket. Corresponding to A 1 a.
- b. Drought-deciduous creeping or matted dwarf-thicket. Corresponding to A 1 b.
- c. Drought-deciduous cushion dwarf-shrubland. Corresponding to A 2 a.
- d. Drought-deciduous mosaic (or mixed) dwarf-shrubland. Deciduous and evergreen dwarf-shrubs, caespitose hemicryptophytes, succulent chamaephytes and other life forms intermixed in various patterns.

(IVB)

3. Mixed cold-deciduous and evergreen dwarf-thickets (or dwarf-shrublands).

(Subdivisions similar to 2).

4. Cold-deciduous dwarf-thickets (or dwarf-shrublands).

Physiognomically similar to 2, but shedding the leaves at the beginning of a cold season. Usually richer in cryptogamic chamaephytes.

(Subdivisions similar to 2. Transitions into D and E possible).

(In A and B, further subdivisions are possible, e.g. subdivisions based on the distribution pattern and height of woody phanerophytes in the dwarf-scrub matrix, similar to VA).

C. Extremely xeromorphic dwarf-shrublands. More or less open formations consisting of dwarf-shrubs, succulents, geophytes, therophytes and other life forms adapted to survive or to avoid a long dry season. Mostly sub-desertic.

(Subdivisions similar to III C).

D. Moss, lichen and dwarf-shrub tundras. Slowly growing, low formations, consisting mainly of dwarf-shrubs and cryptogams, beyond the subpolar tree line. (Except in boreal regions, dwarf-shrub formations above the mountain tree line should not be called tundras, because they are as a rule richer in dwarf-shrubs and grasses, and grow taller due to the greater radiation in lower latitudes). Often showing plant patterns caused by freezing movements of the soil (cryoturbation).

1. Mainly bryophyte tundras. Dominated by mats or small cushions of chamaephytic mosses. Groups of dwarf-shrubs are as a rule scattered irregularly and are not very dense. General aspect more or less dark green, olive green or brownish.

a. Caespitose dwarf-shrub — moss tundra.

b. Creeping or matted dwarf-shrub — moss tundra.

2. Mainly lichen tundras. Mats of fruticose lichens dominating, giving the formation a more or less pronounced grey aspect. Dwarf-shrubs mostly evergreen, creeping or pulvinate.

a. Dwarf-shrub — lichen tundra.

(Other tundra types more or less rich in chamaephytes may be distinguished).

E. Mossy bog formations with dwarf-shrubs. Oligotrophic peat accumulations formed mainly by *Sphagnum* or other mosses, which as

a rule cover the surface as well. Dwarf-shrubs are concentrated on the relatively drier parts or are loosely scattered. To a certain extent they resemble dwarf-shrub formations on mineral soil. Graminoid hemicryptophytes, geophytes with rhizomes and other herbaceous life forms may dominate locally. Slowly growing trees and shrubs can grow as isolated individuals, in groups or in woodlands, which are marginal to the bog or may be replaced by open formations in a cyclic succession. The following subdivisions correspond to the classification of bog types adopted in Europe.

- 1. Raised bogs.** By growth of *Sphagnum* species raised above the general ground water table and having a ground water table of their own. Therefore no more supplied by "mineral" water (i.e. water having been in touch with the inorganic soil), but only by rain water (truly ombrotrophic bogs).
 - a. Typical raised bog (suboceanic, lowland and submontane). Mosses dominating throughout, except on locally raised dry hummocks, which are dominated by dwarf-shrubs. Trees rare and, if present, concentrated on the marginal slopes of the convex peat accumulation. Mostly surrounded by a very wet, but less oligotrophic sedge swamp (Swedish "lagg", see V D).
 - b. Montane (or "subalpine") raised bog. Growing slower than the typical raised bog (or formed in an earlier period with a warmer climate and actually "dead" or being destroyed by erosion). Often covered with sedges or evergreen dwarf-shrubs. Micro- or nanophanerophytes (e.g. *Pinus montana*) locally dominating.
 - c. Subcontinental woodland bog. Temporarily covered by open wood of low productivity, which in a sequence of wetter years may be replaced by *Sphagnum* formations similar to a.
(Various subdivisions of a, b and c possible).
- 2. Non-raised bogs.** Not or not very markedly raised above the mineral-water table of the surrounding landscape. Therefore in general wetter and not as oligotrophic as 1. Poorer in mosses than 1 a, to which various forms of transitions are possible.
 - a. Blanket bog (oceanic lowland, submontane or montane). The micro-surface of the bog is less undulating and less rich in actively growing mosses than in 1a. Evergreen dwarf-shrubs are scattered as well as caespitose hemicryptophytes (sedges or grasses) and some rhizomatous geophytes.

(IVE2)

- b. String bog (Finnish "aapa" bog). Flat oligotrophic bog with strings in the boreal lowlands. The Finnish name indicates an open bog without or with only a few trees of very poor vigour, which grow on narrow and low elongated hummocks, the so-called strings. These peat strings are formed by pressure of the ice covering the more or less flooded bog from early fall to late spring. Only these strings are covered by dwarf-shrubs and are rich in *Sphagnum*. The main part of the bog is similar to a wet sedge swamp.

(Subdivisions of a and b possible).

V. TERRESTRIAL HERBACEOUS COMMUNITIES. Grasses, graminoid and other herbaceous plants are predominant in the cover, but woody plants may be sparingly present. (i.e. covering not more than 30%).

A. Savannas and related grasslands (tropical or subtropical grasslands and parklands). Trees or shrubs almost regularly present, often fire-scarred (fires frequent in the dry season).

1. Mainly flat-leaved savannas. Dominated by broad-leaved and tall grasses (corresponding to relatively humid conditions within the tropics and subtropics). Hemicryptophytic caespitose grasses most frequent, yellowing during the dry season. In general without cryptogams. Subdivisions are based on the distribution pattern and height of woody phanerophytes in the grassy matrix.¹

- a. Woodland with patches of flat-leaved savanna (woodland savanna). Tree stands with isolated crowns which are interspersed by small patches of grassland.

(Subdivisions according to woodland formation, see II).

- b. Flat-leaved savanna with isolated trees (treesavanna). Isolated trees dispersed more or less regularly over the grassy matrix.

(1) *with evergreen broad-leaved trees,*

(2) *with palms,*

(3) *with deciduous trees,*

(4) *with extremely xeromorphic trees or succulents.*

¹ Recent studies have shown that these patterns are largely related to human influence, except in the case of the flood savanna. Savannas may form various mosaics with either forest, woodland or fourré, often fire-scarred.

c. Flat-leaved savanna with shrubs (scrub savanna). Stands of shrubs alternating in various patterns with grassland.

(Subdivisions similar to b).

d. Flat-leaved savanna (grass savanna). Practically without woody phanerophytes, in general due to anthropogenic influence. Normally called "tropical grassland", but the grass cover is physiognomically identical with above mentioned units.

e. Flood savanna. Periodically inundated in various mosaic patterns, with either palms or groups of other trees on raised positions.

(1) *with trees*,

(2) *with fourré*,

(3) *without woody plants*.

2. Mainly narrow-leaved savannas. Dominated by narrow-leaved and more or less short grasses (indicating relatively drier conditions). In addition to perennial grasses annuals more frequent than in 1, in some places even predominant.

Subdivisions based on patterns formed by woody plants.

a. Narrow-leaved savanna with isolated trees.

(1) *with evergreen trees*,

(2) *with deciduous trees*,

(3) *with xeromorphic trees* except succulents,

(4) *with tree-succulents*.

b. Narrow-leaved savanna with shrubs.

(Subdivisions as in a).

c. Narrow-leaved grassland savanna (grass savanna). Without trees or shrubs (e.g. tropical montane grassland, like "puna" grassland of the Andes).

B. Steppes and related grasslands (e.g. North American "prairies" etc.; temperate, with late summer drought and winter frost season). Trees or shrubs absent as a rule, except on wetter sites¹, e.g. along rivers, in ravines and in the forest border ecotone. Seasonal change of physiognomic-floristic aspects very pronounced. In spring therophytes and geophytes are most conspicuous, later hemicryptophytes dominate the aspect.

¹ Only in anthropogenic steppes trees or shrubs and steppe-grassland may occur on the same physical habitat.

(VB)

- 1. Tall grass steppes** (or prairies). Caespitose grasses taller than 1 m dominate (indicating a more humid climate).
 - a. Tall grass steppe with trees.
 - b. Tall grass steppe with shrubs.
 - c. Tall grass steppe without woody plants.
- 2. Mid grass steppes** (or prairies). Intermediate between 1 and 3. Medium-sized grasses locally frequent.
(Subdivisions as in 1).
- 3. Short grass steppes** (or prairies). Mostly composed of mat-forming, more or less low grasses.
Subdivisions as in 1; furthermore:
 - d. Short grass steppe with suffrutescent plants.
- 4. Forb-rich steppes.** Broad-leaved forbs, mostly hemicryptophytes, are frequent (in a climate transitional to forest climate, e.g. in Russia). These "meadow steppes" resemble the meadows under C.
(Subdivisions as in 1).

C. Meadows, pastures or related grasslands (temperate or sub-polar grasslands in a forest climate with no marked dry season). Mesophytic hemicryptophytes dominating as a rule. Below the snow cover many plants remain green at least partially during the whole winter.

- 1. Meadows and pastures below tree line.** Anthropozoogenic formations in the forest climate belt (except avalanche grassland). As a result of different management distinguished as:

meadow = grassland mainly used for hay production, growing rhythm and aspects largely determined by mowing once or several times per year;

pasture = grassland mainly used for grazing. No marked seasonal aspects; by selective grazing, the animals produce small scale mosaics of tall and low groups of plants.

The following subdivisions are based on distribution patterns of woody phanerophytes:

- a. Woodland pasture. Woodland opened up through grazing practice, consisting of isolated irregularly grouped trees.
- b. Tree meadow (or pasture). Grassland with isolated trees.
- c. Scrub pasture (or meadow). Shrub groups in grassland.

- d. Grassy pasture without trees or shrubs. Frequently grazed. Height of grasses, legumes and other forbs varies with region and management.
 - (1) *extensively grazed* (German "Triftweide", not fertilized); hard, thorny or other plants on which animals do not feed ("grazing weeds") are most frequent;
 - (2) *intensively grazed* (German "Standweide" or "Umtriebsweide", fertilized); kept in closely cropped condition, forms a dense grass carpet; soft feed plants dominating throughout, "grazing weeds" usually rare.
- e. Grassy meadow without trees or shrubs. Mowed and only exceptionally grazed. More or less tall caespitose grasses and tall, mostly scapose herbs dominating.
 - (1) *litter meadow* (German "Streuwiese", mowed for obtaining straw for bedding animals in the stables. Generally not fertilized and mowed only in the fall, after the shoots have dried). As a result the slowly developing bunch grasses become dominating.
 - (2) *hay meadow* (German "Futterwiese", generally fertilized. Mowed for making hay to feed animals). Rapidly developing in the early growing season, therefore rich in malacophyllous grasses and forbs, mowed several times a year. This management produces a very marked change in aspect.
- (a) poor in spring geophytes (lowland or submontane),
- (b) rich in spring geophytes (montane or subalpine). Snow cover disappears late in spring and prevents grasses from growing up earlier than geophytes (e.g. *Crocus* or *Narcissus*).
- f. Sedge-rush meadow. More or less sclerophyllous graminoid herbs dominate, indicating periodically water-logged soil (transition to D).
- g. Avalanche grassland. (The only non-anthropogenic meadow. Occurring as narrow strips of grassland between forests on steep slopes of high mountains, where avalanches, descending annually in spring, prevent forest establishment). Composition of herb cover similar to d (1), but very variable. Major variations:
 - (1) *with shrubs* or damaged trees,
 - (2) *without shrubs*.

2. Pastures and meadows above mountain tree line (or beyond northern tree line). Only exceptionally with shrubs or gnarled trees. Covered with snow more than 6 months of the year.

(VC2)

- a. Closed alpine (or subpolar) mat. Without snow cover at least 4–5 months.

(1) *rich in graminoids,*

(2) *rich in forbs,*

(3) *with dwarf-shrubs.*

- b. Alpine (or subnival) mat-patches (upper alpine or subnival). More or less open formation, covers the soil unevenly. (Subdivisions similar to a).

- c. Snow bed formation. (Covered by snow more than 8–9 months yearly; waterlogged by melting snow). Open formation, rich in small forbs or forb-like dwarf shrubs (e.g. *Salix herbacea*). (Subdivisions possible).

D. Sedge swamps and flushes. Open formations on constantly or mostly water-logged ground, without or with only a few woody plants.

1. Sedge peat swamps and similar swamps. Dominated by sedges (i.e. graminoid hemicryptophytes or geophytes), seasonally flooded.

- a. Tall sedge swamp. (Frequently flooded, and commonly for long periods; as a rule natural). Foliage taller than 30–40 cm, sedges dominating throughout; very few other life forms.

(1) *with creeping sedges,* forming large homogeneous stands (e.g. *Carex gracilis*),

(2) *with caespitose sedges,* forming tufts or hummocks (e.g. *Carex elata*).

- b. Low sedge swamp. (Flooded only little or only for short periods; mostly anthropogeneous). Small sedges (*Carex*, *Juncus*, *Scirpus*, etc., foliage not higher than 30 cm) of low productivity dominating, intermixed with many other herbaceous life forms.

- c. Hard hummock swamp. Formed by very hard-leaved, mostly small sedges, therefore more compact and easier to walk on than a (2). Rare (e.g. in the tropical Andes).

2. Flushes (German “Quellfluren”). Evergreen herbaceous or cryptogamic vegetation growing on habitats where seepage water crops up at the surface. (Constantly wet, but rarely flooded).¹

- a. Forb flush. Mostly dominated by small forbs.

¹ Covering only very small areas, often forming mosaics with graminoid formations.

(1) *calcareous*; older parts of plants covered by a white or brownish crust of precipitated carbonate;

(2) *non-calcareous*.

b. Moss flush. Dominated by mosses.

(Subdivisions like a).

E. Herbaceous and half-woody salt swamps. Halophilous or salt-tolerant plants building more or less dense permanent formations. Most species are suffrutescent (half-woody). Shrubs or trees absent or only exceptionally present.

1. Halophytic half-woody shrub formations. Dominated by more or less succulent half-woody shrubs up to 1 m high, at least partially evergreen.

a. Marine half-woody salt marsh. (Growing near the sea coast on marine deposits. Flooded from time to time, but in any case for only a short period). Rich in microscopic algae growing on the soil surface.

(1) *succulent*. Dominated by succulents (e.g. *Salicornia*),

(2) *non-succulent*; poor in truly succulent plants, frequently rich in more or less nitrophilous, quickly growing half-shrubs (e.g. *Obione* or *Artemisia* spp.); often forming narrow strips or bands along the rills on the seashore, where organic matter has been deposited.

b. Inland half-woody salt marsh. Similar to a (but growing in continental depressions, flooded in wet seasons and drying out during the less rainy ones). In general more xeromorphic than a. Poor in algae.

(1) *succulent*,

(2) *non-succulent*.

2. Salt meadows. Mainly herbaceous. More or less closed formations of hemicryptophytes, herbaceous chamaephytes and other non-woody life forms, but poor in annuals.

a. Marine salt meadow. (Within the tidal range of temperate sea shores, but not flooded daily). More or less densely closed stands of quickly growing grasses and (or) succulent forbs.

(1) *rich in succulents*,

(2) *poor in succulents*.

b. Inland salt meadow. Similar to a (but growing in continental conditions). In general less vigorous and less dense.

(VE2b)

- (1) *closed*; physiognomically similar to a (2), but more xeromorphic;
- (2) *open*; most plants growing isolated or in tufts; soil with a more or less thick salt cover, at least in the dry season; Transitional to VI B.

F. Forb vegetation¹ and similar communities. More or less broad-leaved herbs dominating, normally mesophyllous and deciduous. Woody life forms only exceptionally present.

1. Mainly perennial forb communities. Dominated by non-graminoid hemicryptophytes and geophytes. Annuals sometimes present, but of little importance.

- a. Forest margin herb formation. Between adjoining phanerogamic and herbaceous vegetation areas as a narrow transitional band, consisting of hemicryptophytes, geophytes and therophytes. Growing more vigorously than the adjacent pasture or meadow.
- b. Tall forb formation (German "Hochstauden" formation). Dense stands of broad-leaved, mostly dicotyledonous herbs taller than 50 cm, mesophyllous, well provided with nitrogen and other nutrients.
- c. Bracken thicket (or heath). *Pteridium aquilinum* or *Gleichenia* sp. dominating and forming nearly pure stands on pastured heathlands within forest regions. (The only forb formation covering large areas).
- d. Perennial forb formation on organic deposits at the flood lines. Consisting of broad-leaved herbs, growing abundantly on more or less decomposed organic deposits, which are often renewed by floods.
- e. Perennial ruderal and clearing herb formation. More or less broad-leaved herbs (growing on debris, ruins and other places strongly influenced by man).
- f. Mainly perennial weed formation on cultivated land. Mostly hemicryptophytic or geophytic weeds, growing more or less abundantly in the shade of cultivated perennial plant stands. Annual weeds are present, but not predominant (see 2 d). The significance of weed formations greatly diminished by use of herbicides.²

2. Mainly ephemeral forb communities. Therophytes more frequent than perennial herbs. Vegetation cover often not as dense as in A.

¹ In general covering small areas which cannot be represented on small scale maps. "Forb" (American) means "non-graminoid herb" (German "Kraut").

² On small scale maps, crops rather than weed formations are to be shown.

- a. Tropical or subtropical ephemeral cloud desert forb formation. (Best developed on the coastal hills of Peru and northern Chile, where, from fall to spring, moving clouds moisten the vegetation and the soil by condensed water). Dominated by annual broad-leaved herbs, which germinate at the beginning of the cloudy season and grow abundantly until the end of it, giving the landscape a fresh and green look. In the dry season the aspect is desert-like. Phanerophytes may be present as relicts of natural cloud-woodland. Geophytes and cryptogamic hemicryptophytes or chamaephytes are constantly present and may become dominant locally.
 - b. Ephemeral halophytic formation. (Growing normally in more extreme conditions than salt meadows, see V E 2.) More or less open formation of annual halophytes. Some permanent herbs and grasses may be present.
 - c. Ephemeral ruderal and clearing forb formation. Like 1e, but dominated by annuals.
 - d. Mainly ephemeral weed formation on cultivated land. Similar to 1f, but rich in annuals or species that germinate in fall and die after fructification during the next vegetation period.
- 3. Episodical forb communities.** Very unstable ephemeral plant groupings appearing not regularly every year, but only when the growing conditions are favourable.
- a. Episodical desert forb formation ("flowering desert"). Mostly broad-leaved, rapidly developing herbs with hardy seeds that germinate after episodical rain fall. Often concentrated in depressions, some of them hardly visible, where the surface water accumulates. Sometimes this formation may fill in the gaps between permanent subdesert plants, e.g. xeromorphic shrubs or succulents belonging to formations III C or IV C.
 - b. Episodical formation on pond muds and similar sites. (Developing, when the pond water has been drained—every year or after some or several years). Dominated by forbs, whose seeds neither decay nor germinate while the bottom of the pond is inundated, but germinate and grow rapidly after the mud has emerged again.
 - c. Episodical forb formation on organic deposits at the flood lines. Similar to 1d, but less permanent and mainly composed of annuals, whose seeds have been carried along together with organic deposits. Perennials may be present.

(VF3)

- d. Episodical river bed formation. Ephemeral herbs, grasses or sedges developing in the dry parts of river beds during low water periods of more than two months. Depending upon seeds supplied by the river; therefore very unstable not only in density but also in species composition and pattern.

VI. DESERTS AND OTHER SCARCELY VEGETATED AREAS. (Sub-deserts are included in the formation classes III to V). Bare mineral soil determines the aspect more or less constantly. Plants are scattered or may be absent.

A. Scarcely vegetated rocks and screes.

1. Scarcely vegetated rocks.

- a. Chasmophytic vegetation. Permanent plants rooting in fissures of rocks or walls.
(Subdivisions according to life forms in different latitudes and altitudes).
- b. Adnate Bromeliaceae on rocks (only in the neotropics).
- c. Cryptogamic mat on rocks.

(1) *foliose lichens and mosses* dominant.

(2) *crustose lichens* dominant,

(3) *blue algae* dominant ("ink-strips", German "Tintenstriche"). Dark strips on rocks caused by Cyanophyceae that grow actively when the water is trickling down.

2. Scarcely vegetated screes. (More or less unstable, steep slopes of stones beneath weathering rocks). Mostly permanent herbs or half-woody plants adapted to survive the movement of stones at the scree surface, sometimes even stopping them. Subdivisions mainly according to the length of the vegetation period:

- a. Lowland and submontane scree formation,
- b. Montane scree formation,
- c. High mountain scree formation.

B. Scarcely vegetated sand accumulations. (Wood, scrub, grassland and other more or less closed formations on fixed dunes are treated in the formation classes listed above.) Moving quicksand with isolated plants that are contributing to its fixation; or bare shifting sand dunes. Vegetation covering not more than one third of the surface.

1. Scarcely vegetated sand dunes.

- a. Tall grass dune. (Coastal "white dune". Mostly rich in carbonates and nutrients.) Built up and partially covered by geophytic grasses or grasslike plants which are able to adapt their root and shoot system to new accumulations of sand that bury them in stormy periods.

(1) *tropical and subtropical*,

(2) *temperate*, showing a marked annual growing rhythm.

- b. Low grass dune. (Mostly continental, more or less acid and poor in nutrients). Low hemicryptophytic or geophytic grasses and sedges fixing the quicksand.
- c. Forb dune (possibly existing).

2. Bare sand dunes. Only exceptionally with some isolated plants.

- a. Shifting dune in desert climate (natural).
- b. Shifting dune in forest climate (anthropozoogenic).

C. True deserts. Vegetation largely absent.

(Subdivisions possible only according to geological and morphological criteria. Desert valleys may be classified into one of the preceding formations).

VII. AQUATIC PLANT FORMATIONS (except marine formations¹). Composed of rooted and (or) floating plants that endure or need water covering the soil constantly or at most times of the year.

A. Floating meadows. Densely interwoven forbs and (or) mosses covering permanent fresh water accumulations. Most of the phanerogams being helophytes, not true water plants.

1. Mainly herbaceous floating meadows. Dominated by sedges or herbs with rhizomes. Chamaephytes and even phanerophytes may be present.

- a. Tropical and subtropical herbaceous floating meadow.
- b. Temperate and subpolar herbaceous floating meadow, with pronounced seasonal aspects.

2. Mainly mossy floating meadows. Mosses dominating throughout, but phanerogams may be present.

- a. Mossy floating meadow (temperate or subpolar).
(Further formations possibly exist).

¹ To be worked out later.

(VII)

B. Reed-swamps. Tall helophytes rooting in the soil at the bottom of shallow lakes, slowly flowing rivers or similar waters.

1. Reed-swamp formations of fresh water lakes. Mostly broad-leaved plants which cannot endure high salt concentration. All shoots upright, only exceptionally floating in the water.

a. Tropical and subtropical fresh water reed-swamp. Seasonal aspects not pronounced.

b. Temperate and subpolar fresh water reed-swamp.
In winter time most plants yellow or dormant.

2. Reed-swamp formations of salt water lakes. More or less scleromorphous plants resisting high salt concentrations. Normally not as tall as 1.

a. Tropical and subtropical salt water reed-swamp.

b. Temperate salt water reed-swamp.

3. Reed-swamp formations of flowing water. Shoots more flexible than in 1 and 2, sometimes with floating leaves.

a. Tropical and subtropical reed-swamp on river banks.

b. Temperate reed-swamp on river banks.

C. Rooted floating-leaf communities.

(Subdivisions more or less similar to B).

D. Rooted underwater communities.

(Subdivisions possible).

E. Free-floating fresh water communities.

1. Broad-leaved free-floating communities.

a. Tropical and subtropical broad-leaved free-floating formation (e.g. *Pistia*, *Pontederia* and *Eichhornia*).

b. Temperate broad-leaved free-floating formation. Disappearing in the cold season (e.g. *Stratiotes*).

2. Lemna-type free-floating communities.

(Subdivisions similar to 1).

3. Free-floating macroscopic algal communities.

(Subdivisions possible).

Deutsche Namen

der Formationsklassen (I usw.), Formations-Unterklassen (A usw.), Formations-Gruppen (1 usw.), Formationen (a usw.), Subformationen und sonstigen Untereinheiten.

I. (Dichtgeschlossene) Wälder

A. Vorwiegend immergrüne Wälder

1. Feuchttropenwälder

- a. Tieflands-Feuchttropenwald
- b. Submontaner Feuchttropenwald
- c. Montaner Feuchttropenwald
 - (1) laubholzreich
 - (2) nadelholzreich
 - (3) bambusreich
- d. («Subalpiner» Feuchttropenwald)
- e. Feuchttropen-Nebelwald
 - (1) laubholzreich
 - (2) nadelholzreich
- f. Feuchttropen-Auenwald
 - (1) weichholzreich (häufig überflutet)
 - (2) hartholzreich (selten überflutet)
 - (3) lange Zeit überschwemmt
- g. Feuchttropen-Sumpfwald
 - (1) laubholzreich
 - (2) palmenreich
- h. Feuchttropen-Moorwald
 - (1) laubholzreich
 - (2) palmenreich

2. Tropische und subtropische immergrüne Saisonwälder

- a. Tropischer (oder subtropischer) immergrüner Tieflands-Saisonwald
- b. Tropischer (oder subtropischer) submontaner immergrüner Saisonwald
 - (1) laubholzreich
 - (2) nadelholzreich
- c. Tropischer (oder subtropischer) montaner immergrüner Saisonwald
- d. Tropischer (oder subtropischer) «subalpiner» immergrüner Saisonwald

3. Tropische und subtropische halbimmergrüne Wälder

- a. Tropischer (oder subtropischer) halbimmergrüner Tieflandswald
- b. Tropischer (oder subtropischer) halbimmergrüner Berg- oder Nebelwald

4. (Immergrüne) Wälder der feuchten Subtropen

5. Mangrove-Wälder (tropisch oder subtropisch)

(IA)

6. Immergrüne Wälder der feuchten gemässigten und subpolaren Zonen
 - a. Immergrüner Laubwald feucht-gemässigter grundwasserfreier Lagen
 - (1) ohne Nadelhölzer
 - (2) mit Nadelhölzern
 - b. Immergrüner Auenwald feucht-gemässigter Gebiete
 - c. (Immergrüner Sumpfwald feucht-gemässigter Gebiete)
 - d. Immergrüner Laubwald feucht-subpolarer Gebiete
7. Immergrüne Saisonwälder der gemässigten Zonen
(Unterteilung ähnlich 2 a–d)
8. (Immergrüne) Winterregen-Hartlaubwälder
 - a. (Immergrüner) Tieflagen-Hartlaubwald
 - b. (Immergrüner) Auen- oder Sumpf-Hartlaubwald
9. Immergrüne Nadelwälder gemässigter und subpolarer Zonen
 - a. (Immergrüner) Riesen-Nadelwald
 - b. Immergrüner (normalhoher) Rundkronen-Nadelwald
 - (1) mit Hartlaub-Unterwuchs (mediterran)
 - (2) ohne Hartlaub-Unterwuchs
 - c. Immergrüner (normalhoher) Kegelkronen-Nadelwald
 - d. Immergrüner (normalhoher) Schmalkronen-Nadelwald (boreal)

B. Vorwiegend laubwerfende Wälder

1. Trockenkahle Wälder
 - a. Trockenkahler Tieflagenwald
 - (1) normalblättrig
 - (2) kleinblättrig
 - b. Trockenkahler Berg-(und Nebel-)wald
2. Kältekahl-immergrüne Mischwälder
 - a. Kältekahler Wald mit immergrünen Lianen
 - b. Kältekahler Wald mit Hartlaubunterwuchs
 - c. Kältekahler Wald mit immergrünen Nadelbäumen
3. Kältekahle Wälder (mit wenig Immergrünen)
 - a. Kältekahler Tieflagenwald der gemässigten Breiten
 - b. Montaner (oder borealer) kältekahler Wald
 - (1) laubholzreich
 - (2) vorwiegend aus laubwerfenden Nadelhölzern
 - (3) aus laubwerfenden Laub- und Nadelhölzern gemischt
 - c. Subalpiner (oder subpolarer) kältekahler Wald
 - (1) reich an Hemikryptophyten
 - (2) reich an Chamaephyten
 - d. Kältekahler Auenwald
 - (1) hartholzreich (selten überflutet)
 - (2) weichholzreich (öfters überflutet)
 - e. Kältekahler Sumpf- oder Moorwald

C. Extrem xeromorphe Wälder (in offene Wälder übergehend)

1. Hartlaubreiche extrem xeromorphe Wälder

2. Dornwälder

- a. Gemischt hartlaubig-trockenkahler Dornwald
- b. Trockenkahler Dornwald

3. Sukkulente reiche Trockenwälder

II. Offene Wälder (ohne Parklandschaften und Savannen)

A. Vorwiegend immergrüne offene Wälder

- 1. Immergrüne offene Laubwälder
- 2. Immergrüne offene Nadelwälder
 - a. Rundkroniger immergrüner offener Nadelwald
 - (1) mit Hartlaub-Unterwuchs (mediterran)
 - (2) ohne Hartlaub-Unterwuchs
 - b. Kegelkroniger immergrüner offener Nadelwald (subalpin)
 - c. Schmalkroniger immergrüner offener Nadelwald (boreal)

B. Vorwiegend laubwerfende offene Wälder

- 1. Trockenkahle offene Wälder
(Unterteilung wie I B 1)
- 2. Kältekahl-immergrüne offene Mischwälder
(Unterteilung ähnlich I B 2; häufig ist insbesondere:)
 - c. Kältekahler offener Wald mit immergrünen Nadelbäumen
- 3. Kältekahle offene Wälder (mit wenig Immergrünen)
 - a. Kältekahler offener Laubwald
 - b. Kältekahler offener Nadelwald
 - c. Kältekahler offener Laub-Nadel-Mischwald

C. Extrem xeromorphe offene Wälder

(Unterteilung entsprechend I C)

III. Gebüsche (offen oder dicht)

A. Vorwiegend immergrüne Gebüsche

- 1. Immergrüne Laubgebüsche
 - a. Bambus-Gebüsch (dicht oder offen)
 - b. Immergrünes (meist offenes) Schopfbäum-Gebüsch
 - c. Immergrünes Halbhartlaub-Gebüsch (dicht oder offen)
 - d. Immergrünes Hartlaub-Gebüsch (offen oder dicht)
 - e. Immergrünes Halbstrauch-Gebüsch (dicht oder offen)
- 2. Immergrüne Nadel- und Zwergblatt-Gebüsche
 - a. Immergrünes Nadelgebüsch (dicht oder offen)
 - b. Immergrünes Zwergblatt-Gebüsch (offen oder dicht)
(weitere Unterteilungen möglich)

B. Vorwiegend laubwerfende Gebüsche (offen oder dicht)

1–3. (unterteilt wie I bzw. II B 1–3)

(IIIB)

4. Kältekahle Gebüsche (offen oder dicht)
 - a. Kältekahles Gebüsch in gemässigtem Klima (dicht oder offen)
 - b. Subalpines oder subpolares kältekahles Gebüsch (dicht oder offen)
 - (1) reich an Hemikryptophyten
 - (2) reich an Chamaephyten
 - c. Kältekahles Auengebüsch (offen oder dicht)
 - (1) lanzettblättrig
 - (2) zwergblättrig
 - d. Kältekahles Moorgebüsch (offen oder dicht)

C. Extrem xeromorphe (Halbwüsten-)Gebüsche (offen)

1. Vorwiegend immergrüne Halbwüsten-Gebüsche (offen)
 - a. Immergrünes Halbwüsten-Gebüsch (offen)
 - (1) grossblättrig
 - (2) zwergblättrig oder blattlos
 - (3) sukkulent
 - b. Halbimmergrünes Halbwüsten-Gebüsch (offen)
 - (1) fakultativ laubwerfend
 - (2) aus immergrünen und laubwerfenden Arten
2. Laubwerfendes Halbwüsten-Gebüsch (offen)
 - a. Sukkulentenarmes laubwerfendes Halbwüsten-Gebüsch (offen)
 - b. Sukkulentenreiches laubwerfendes Halbwüsten-Gebüsch (offen)

IV. Zwergstrauchreiche Formationen

(entweder dichte oder offene Zwerggesträuche oder Kryptogamen-Formationen mit Zwergsträuchern)

A. Vorwiegend immergrüne Zwerggesträuche (dicht oder offen)

1. Dichte immergrüne Zwerggesträuche
 - a. Dichtes immergrünes eigentliches Zwerggesträuch
 - b. Dichter immergrüner Zwergstrauch-Teppich
(Unterteilungen möglich)
2. Offene immergrüne Zwerggesträuche
 - a. Immergrüne Zwergstrauchpolster-Formation
 - b. Offenes immergrünes (eigentliches) Zwerggesträuch
3. Mischformationen aus immergrünen Zwergsträuchern und Kräutern
 - a. Immergrüne Zwergstrauch-Kraut-Mischformation
 - b. Halbimmergrüne Zwergstrauch-Kraut-Mischformation

B. Vorwiegend laubwerfende Zwerggesträuche (dicht oder offen)

1. Fakultativ trockenkahle Zwerggesträuche
2. (Eigentlich) trockenkahle Zwerggesträuche (dicht oder offen)
 - a. Trockenkahles eigentliches Zwerggesträuch
 - b. Trockenkahler Zwergstrauchteppich
 - c. Trockenkahle Zwergstrauchpolster-Formation
 - d. Trockenkahle Zwergstrauch-Kraut-Mischformation

3. Gemischt kältekahl-immergrüne Zwerggesträuche (dicht oder offen)
(Unterteilung wie 2)

4. Kältekahle Zwerggesträuche (dicht oder offen)
(Unterteilung ähnlich 2)

C. Extrem xeromorphe Zwerggesträuche (offen)
(Unterteilung ähnlich III C)

D. Moos- und Flechten-Tundren

1. Moosreiche Tundren
 - a. Zwergstrauch-Moos-Tundra
 - b. Teppichstrauch-Moos-Tundra
2. Flechtenreiche Tundren
 - a. Zwergstrauch-Flechten-Tundra
(weitere Unterteilungen möglich)

E. Moosreiche Moore mit Zwergsträuchern

1. Hochmoore
 - a. Echtes Hochmoor
 - b. Montanes (oder subalpines) Hochmoor
 - c. Subkontinentales Wald-Hochmoor
2. Nichtgewölbte oligotrophe Moore
 - a. Terrainbedeckendes Moosmoor
 - b. Strangmoor

V. Krautige Landpflanzengemeinschaften

A. Savannen und ähnliches Grasland (Tropisch-subtropisches Gras- und Parkland)

1. Vorwiegend breitblättrige Savannen
 - a. Offener Wald mit Flecken von Breitblatt-Savanne
(Unterteilung entsprechend der Waldformation, siehe II)
 - b. Breitblatt-Savanne mit Einzelbäumen (Baum-Savanne)
 - (1) mit immergrünen Bäumen
 - (2) mit Palmen
 - (3) mit trockenkahlen Bäumen
 - (4) mit stark xeromorphen Bäumen
 - c. Breitblatt-Savanne mit Gebüsch (Busch-Savanne)
(Unterteilung möglich)
 - d. Gehölzfreie Breitblatt-Savanne (Gras-Savanne)
 - e. Breitblättrige Überschwemmungs-Savanne
 - (1) mit Bäumen
 - (2) mit Gebüsch
 - (3) ohne Holzpflanzen
2. Vorwiegend schmalblättrige Savannen
(Unterteilung ähnlich 1 oder einfach:)
 - a. Schmalblatt-Savanne mit Bäumen

(VA 2a)

- (1) mit immergrünen Bäumen
- (2) mit laubwerfenden Bäumen
- (3) mit stark xeromorphen Bäumen
- (4) mit Baumsukkulenten
- b. Schmalblatt-Savanne mit Büschen
(Unterteilung wie a)
- c. Schmalblatt-Savanne (ohne Holzgewächse)

B. Steppen und ähnliches Grasland (Trockengrasland der gemässigten bis subpolaren Breiten)

- 1. Hochgras-Steppen
 - a. Hochgras-Steppe mit Bäumen
 - b. Hochgras-Steppe mit Büschen
 - c. Hochgras-Steppe (ohne Holzgewächse)
- 2. Mittelgras-Steppen
(Unterteilung wie 1)
- 3. Kurzgras-Steppen
(Unterteilung wie 1, ausserdem:)
 - d. Kurzgras-Steppe mit Halbsträuchern
- 4. Krautreiche Steppen (Wiesen-Steppen)
(Unterteilung wie 1)

C. Wiesen, Weiden und ähnliches Grasland

- 1. Wiesen und Weiden unterhalb der Baumgrenze
 - a. Offener Weidewald mit vergrasten Lichtungen
(Unterteilung nach der Natur des gelockerten Waldes)
 - b. Baum-Wiese (oder -Weide)
(Unterteilung nach der Lebensform der Bäume)
 - c. Strauch-Wiese (oder -Weide, Laubwiese)
(Unterteilung nach der Lebensform der Sträucher)
 - d. (gehölzfreie) Weide
 - (1) extensive Weide («Triftweide»)
 - (2) intensive Weide («Standweide» oder «Umtriebsweide»)
 - e. (gehölzfreie) Wiese
 - (1) Streuwiese (ungedüngte einschürige Wiese)
 - (2) Futterwiese (gedüngte, meist mehrschürige Wiese)
 - (a) grasreich
 - (b) krautreich
 - f. Seggen- und Binsen-Wiese
(Übergang zu D)
 - g. Lawinenrasen (im Gegensatz zu a–f von Natur aus waldfrei)
 - (1) mit Büschen
 - (2) gehölzfrei
- 2. Grasland oberhalb der Baumgrenze (oder jenseits der subpolaren Baumgrenze, stets natürlich)
 - a. Geschlossene alpine Matte

- (1) reich an Grasartigen
- (2) krautreich
- (3) zwergstrauchreich
- b. Alpine (oder subnivale) Rasenflecken
[Unterteilung wie a; (3) fehlt]
- c. Schneeboden-Formation

D. Seggenrieder und Quellfluren

- 1. Seggenrieder
 - a. Großseggenried
 - (1) rasig
 - (2) horstig oder bultig
 - b. Kleinseggenried
 - c. Hartpolster-Sumpf
- 2. Quellfluren
 - a. Krautige Quellflur
 - (1) kalkreich
 - (2) kalkarm
 - b. Moos-Quellflur
(Unterteilung wie a)

E. Krautige und halbstrauchige Salzpflanzenfluren

- 1. Halbstrauchige Halophyten-Fluren
 - a. Halbstrauchige Seemarschflur
 - (1) sukkulent
 - (2) nicht sukkulent
 - b. Halbstrauchige Binnenland-Salzflur
(Unterteilung wie a)
- 2. Salzwiesen
 - a. Seemarschwiese
 - (1) sukkulentenreich
 - (2) ohne Sukkulanten
 - b. Binnenland-Salzwiese
 - (1) geschlossen
 - (2) offen

F. Krautfluren

- 1. Staudenfluren (vorwiegend ausdauernde Krautfluren)
 - a. Waldsaum-Flur
 - b. Hochstaudenflur
 - c. Adlerfarn-Dickicht
 - d. Spülsaum-Staudenflur
 - e. Ausdauernde Ruderal- und Kahlschlagflur
 - f. Vorwiegend ausdauernde Unkrautflur in Pflanzenkulturen
- 2. Vorwiegend annuelle Krautfluren
 - a. Kurzlebige tropisch-subtropische Nebelwüstenflur

(VF2)

- b. Kurzlebige Salzkrauterflur
 - c. Einjährige Ruderal- und Kahlschlagsflur
 - d. Kurzlebige Ackerunkrautflur
3. Episodisch auftretende Krautfluren
- a. Episodische Wüsten-Krautflur
 - b. Episodische Teichbodenflur
 - c. Episodische Spülsaumflur
 - d. Episodische Flussbettflur

VI. Zerstreuter Bewuchs wüstenähnlicher Standorte (Halbwüsten sind in den vorhergehenden Gruppen enthalten)

A. *Bewuchs von Felsen und Steinschutthalden*

1. Felsbewuchs
- a. Felsspalten-Bewuchs
(Unterteilung nach Lebensformen und Höhenlage)
 - b. Bromelien-Felsaufwuchs
 - c. Kryptogamen-Überzug von Felsen
 - (1) Blattflechten und Moose
 - (2) Krustenflechten
 - (3) Tintenstriche (Blualgen)
2. Steinschutthalden-Bewuchs
- a. Tieflands-Steinschuttflur
 - b. Montane Steinschuttflur
 - c. Hochgebirgs-Steinschuttflur

B. *Offene Flugsand-Formationen*

(Busch- und Zwergstrauchdünen sowie Rasen und andere Formationen auf bereits festgelegten Dünen sind in den vorhergehenden Gruppen enthalten)

1. Locker bewachsene Dünen
- a. Hochgras-Düne
 - (1) tropisch-subtropisch
 - (2) aussertropisch
 - b. Niedergras-Düne
 - c. Kraut-Düne
 - d. Tillandsien-Sandflur (tropisch)
2. Kaum bewachsene Dünen
- a. Wanderdüne im Waldklima
 - b. Wanderdüne im Wüstenklima

C. *Eigentliche Wüsten*

(Unterteilung nicht nach der Vegetation, sondern nur nach geologisch-morphologischen Kriterien möglich. Die Wüstentäler müssen je nach Bewuchs in eine der vorstehenden Formationen eingeordnet werden.)

VII. Wasserpflanzen-Formationen (ausserhalb der Meere)

A. Schwimmende Wiesen

1. Vorwiegend krautige Schwingrasen
 - a. Tropisch-subtropischer Kraut-Schwingrasen
 - b. Kraut-Schwingrasen der gemässigten Breiten
2. Vorwiegend moosige Schwingrasen
 - a. Moos-Schwingrasen
(vielleicht weitere Unterteilungen möglich)

B. Röhrichte

1. Röhrichte an süssen Stillwassern
 - a. Tropisch-subtropisches Süsswasser-Seeröhricht
 - b. Gemässigtes (und subpolares) Süsswasser-Seeröhricht
2. Röhrichte an salzigen Stillwassern
 - a. Tropisch-subtropisches Salzwasser-Röhricht
 - b. Gemässigtes Salzwasser-Röhricht
3. Fliesswasser-Röhrichte
 - a. Tropisch-subtropisches Flussröhricht
 - b. Gemässigtes Flussröhricht
 - c. Bachröhricht

C. Wurzelnde Schwimmblatt-Formationen (Unterteilungen ähnlich 1)

D. Wurzelnde Unterwasser-Formationen (Unterteilungen ähnlich 1)

E. Freischwimmende Wasserpflanzen-Formationen

1. Freischwimmende Breitblatt-Formationen
 - a. Tropisch-subtropische freischwimmende Breitblatt-Formation
 - b. Gemässigte freischwimmende Breitblatt-Formation
2. Wasserlinsenähnliche Formationen
(Unterteilung wie 1)
3. Freischwimmende Fadenalgen-Formationen
(Unterteilungen möglich)

Anmerkung: Manche Formationen sind nur kleinflächig verbreitet und können deshalb auf kleinmaßstäbigen Karten nicht dargestellt werden. Sie wurden hier trotzdem aufgeführt, um die Klassifikation über den Kartierungszweck hinaus brauchbar zu machen.

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