Instructions for use of the indicator values

INSTRUCTIONS FOR USE OF THE INDICATOR VALUES

A. The Statement Potential of the Indicator Values

Due to physiological limitations and the competition of other living organisms it is only possible for plants to flourish in their natural surroundings under certain specific conditions.An attempt is made to characterize these conditions with the indicator values. The advantage of indicator values as opposed to a written characterisation lies in their brevity and in the possibility of comparison. A disadvantage is that sometimes a misleading exactitude is suggested and that many ecological circumstances cannot be expressed in figures.

In general, indicator values cannot be measured. They depend largely on the experience and observations of the botanist in the field. Even physiologically more or less identical species may vary in their indicator values, according to their position in their distribution area. As different species are found in each area the competition is not always the same. Often the ecological factors are interdependent. For instance, plants can show different humidity values according to the climate with respect to temperature. In the center of their area of distribution many species are not dependent on a certain soil and many occur on siliceous or on calcareous soil. On the northern boundary of their distribution area one finds them only on calcareous soil, because this is often warmer than other substrates and because the competition there is relatively small on account of the generally very dry conditions in calcareous situations. One must therefore bear in mind that the indicator values usually to not simply express the physiological possibilities of the plants. Especially in positions where competition is small (e.g. on rubbish dumps, in freshly exposed places) a plant may behave differently than its indicator values suggest. For a more or less accurate judgement of a habitat the

indicator values of as many species as possible should be considered.

The indicator values given here apply only to Switzerland and cannot be used indiscriminately in other geographical areas. It must also be born in mind that many species develop geographic-ecological races which are often difficult to distinguish morphologically but require different indicator values.

When using indicator values one must know that a species gives information only for the layer in which it grows. Mosses are only informative for a layer of maximum 5 cm directly over and under the surface of the ground. On the other hand, trees may indicate the quality of the habitat up to several metres above and below the ground. It can happen that mosses and shallow rooting dwarf shrubs show a poor, acid soil whilst the bushes and shrubs with deeper roots indicate a rich, basic soil.

The ecological factors evaluated here are in part the same as those of ELLENBERG (1974). Only the resistance to heavy metals which plays a relatively insignificant role in Switzerland and about which only little is definitely known, has been omitted. In addition a value for the humus content (H) and one for the average size of grain or the dispersity (and deficiency of aeration) of the soil (D) have been introduced.

All the values for ecological factors, with the exception of the salt value which is indicated by +, vary between 1 an 5, similarly as in ELLENBERG (1965) whereby only round figures are used and the humidity value also has 5 not 6 degrees. Plant species which occur almost over the whole spectrum have been indicated by x. In the case of some indicator values additional symbols have been introduced to define ecological conditions impossible to express in figures, so for instance in the case of the humidity value. As in ELLENBERG (1974) the life form is defined by a letter. The sociological behaviour, however, is not mentioned, as especially for many species in the region of the Alps, too little is known in this field.

B. Definition of the Individual Indicator Values

F 1. *Humidity value*

The humidity value indicates the average humidity of the soil during the vegetation period. Low values show little, high values great humidity.

1 : Plants chiefly occurring on very dry soil; not found on wet soil, cannot compete on humid soil. Distinct indicators of dry situations.

2 : Plants chiefly occurring on dry soils; usually avoiding very dry and very wet areas; in general not able to compete in damp situations. Indicators of medium dryness.

3 : Plants on medium dry to damp soils, generally of broad ecological amplitude; usually avoiding both dry and wet soils. Indicators of medium ("not extreme", "more or less fresh") humidity conditions.

4 : Plants chiefly occurring on damp to very damp soil; occasionally found on wet soil; avoiding dry soil. Indicators of humidity.

5 : Plants on wet, water soaked soil; avoiding medium damp and dry situations. Indicators of wet situations.

In addition to these figures the following symbols are used to define the various conditions of humidity:

: Plants occurring in the region of flowing ground water (e.g. beside brooks or rivers, in riverine areas or under the influence of slope seepage).

w : Plants chiefly occurring on soil with varying humidity; the humidity value shows the average humidity, w means that the soil can be much wetter after rain and much drier after a dry period than is indicated by the humidity value.

u : Plants as a rule submersed (only together with the humidity value 5).

v : Plants with submersed and floating organs (only together with the humidity value 5).

s : Plants with leaves that float on the water (only together with the humidity value 5).

i : Plants rooted in the water but with most of their leaves protruting into the air (only together with the humidity value 5w or 4w).

Some examples of combinations:

5 ↑u : Plants submersed in flowing water. Indicators of permanent flooding.

5 wi : Plants very often in the water but at times also above water-level. Indicators of varying water-level.

5 s : Plants floating on the surface of the water. Indicators of still water.

3 ↑w : Plants on soils that are sometimes within the reach of flowing ground water but nevertheless can sometimes dry out. Indicators of drier regions of brook and river banks.

2 w : Plants growing on rather dry soils which can periodically become wet during long rainy periods, and can dry out entirely during long, warm, dry periods. Indicators of changeable wet-dry soils.

Soils of average humidity are most advantageous for plants, as there is usually less oxygen in wetter soils so that plants can only root superficially so as to obtain enough oxygen for the respiration of their roots, or are specially developed to supply enough oxygen to the plant (i.e. airspace systems). Plants with a high humidity value are therefore specialists. On the other hand plants which grow in dry situations must be specialised to reduce the loss of water ("xeromorph" characteristics). The less the water supply, the less the supply of nourishment, and the less the production of assimilates (interruption of assimilation when the stomata are closed). The competition is greatest on soils with average humidity (fresh) as these are most advantageous.

The humidity value can depend on other indicator values or be coupled with them in the following cases:

- In situations rich in nutrients a plant may grow on soil which is drier than that indicated by its humidity value, as it can still

obtain enough nutrients in spite of reduced stomatal transpiration. On poor soil the reverse applies. If a species has a wide amplitude with respect to the nutrient content of the soil (N 3 or x) it must be considered that the humidity value is calculated for average nutrient conditions, and that the species populates more humid situations if the soil is poor, and drier situations if the soil is rich, than is expected on the basis of its humidity value.

- There is a certain reverse relationship between the humidity value and the continentality value, in that plants with a high continentality value (K 4 or 5) generally colonise dry soils or such of varying humidity, whilst plants with a low continentality value (K 1 or 2) are rather found on humid soils.
- Soils with varying humidity are very often dense, with a dispersity value of D 5.

R 2. *Reaction value*

The reaction value is characteristic for the content of free H-ions in the soil. Low reaction values show acid soils poor in bases, high values correspond to soil rich in bases (neutral to alkaline soils).

1 : Plants occurring chiefly on very acid soils (pH 3 - 4.5); never found on neutral or alkaline soils. Definite acid soil indicators.

2 : Plants occurring chiefly on acid soils (pH 3.5 - 5.5); hardly ever found on neutral or alkaline soils. Acid soil indicators.

3 : Plants occurring chiefly on weakly acid soil (pH 4.5 - 7.5); never found on very acid soil but occasionally encroaching on neutral or weakly alkaline soils.

4 : Plants occurring chiefly on alkaline soil (pH 5.5 - 8); never found on very acid soil. Indicators of soils rich in bases.

5 : Plants found pratically only on alkaline soil (pH over 6.5) avoiding acid soils. Distinct indicators of alkaline soils (usually indicators of lime).

x : Plants occurring on very acid or alkaline soils; often avoiding average conditions as they are not able to compete there.

The amount of free H-ions present influences the plants in many different ways. As a rule, acid soils contain little Ca, Mg, and K; also Mo is hardly present in soluble form. On the other hand Fe, Al, and Mn are present as easily soluble salts which are poisonous for certain species. When the pH is higher than 6.5 Fe and Mn become almost insoluble and are no longer available in sufficient quantity for many species. In alkaline soils also B, Cu, and Zn become deficiency elements for many species. Therfore weakly acid soils (pH 5.5 - 6.5) are the most advantageous with regard to the supply of nutrients for almost all plant species. For this reason the competition on such soils is greatest.

The reaction value can be related to other indicator values as follows:

- On soils with flowing water (humidity value F↑3 ,↑4 ,↑5) a plant can occur on less alkaline soil than its reaction value indicates, as the necessary bases (e.g. Ca-salts) are supplied by the flowing water.
- Acid soils are, in general, also poor in nutrients. Plants with the reaction value R 1 or 2, therefore, usually have a low nutrient value (N 1 or 2).

N 3. *Nutrient value*

The nutrient value defines the content in nutrients (especially nitrogen) of the soil. Low values show few, high values many nutrients.

1 : Plants occurring chiefly on very poor soils; not found on rich soils. Distinct indicators of poor soil.

2 : Plants occurring chiefly on poor soils; usually not found on rich to over rich soils, or not able to compete there. Indicators of

poor soil.

3 : Plants occurring chiefly on medium poor soil to medium rich soil; neither found on very poor soil nor on over fertilized soils.

4 : Plants occurring chiefly on rich soils, hardly found on poor soils. Indicators of rich supply of nutrients.

5 : Plants occurring chiefly on soils with over-rich supply of nutrients (usually nitrogen); never found on poor soil. Indicators of over fertilization; in water, indicators of pollution.

x : Plants occurring on both rich and poor soil.

In general rich soils are more advantageous for the plants and allow luxurious growth. However, it is important that the nutrients are present in balanced proportions. This applies especially to N, P and K which are used in the greatest quantities. As soon as one of these elements is not present in sufficient quantity the soil is "poor", and the vegetation found on it is sparse. As very often nitrogen is the least plentiful element the nutrient value is usually, although not always, the indicator of the nitrogen content of the soil. Over fertilized soils contain one of the three nutrients mentioned (again this is usually nitrogen) in a concentration that is already too high for many plants (e.g. at camp sites, new dunghills, and at the edges of paths). The competition is greatest on average to rich but not over fertilized soils.

The nutrient value has the following relationship to the humidity value:

- On soils with flowing ground water or with good general water supply the plants can thrive on poorer soil than that which corresponds to their nutrient value, because the greater stream of water (high rate of transpiration) supplies more nutrients.

H 4. *Humus value*

The humus value is characteristic for the content in humus of the soil at the site of the plant. High humus values indicate good humus

content in the region of roots of the plants, low values show poor or missing humus content.

1 : Plants occurring chiefly on raw soils (without humus top layer); avoiding thick layers of humus. Indicators of raw soils.

2 : Plants occurring chiefly on soils with little humus cover; not found on peat or mould. Indicators of soil rich in minerals.

3 : Plants occurring chiefly on soils with average humus content (usually in the form of mull); only rarely growing on raw or peaty soils.

4 : Plants occurring chiefly on humus rich soils (mull or mould) also with preference on raw humus but with roots reaching partly into the mineral soil. Indicators of humus.

5 : Plants rooting almost solely in soil rich in humus; avoiding mineral soils. Indicators of raw humus or peat.

x : Plants growing in both raw soils and humus soils.

Humus is an important vehicle for nutrients for plants as it has a great capacity for the exchange of bases and can also release nutrients in the course of its deterioration. It becomes acid when the bases are washed out. It is the nutrient substrate for mycorrhiza and other microorganisms associated with phanerogams. Finally it augments the water holding capacity of the soil so that, in general, soils rich in humus supply water more evenly.

The humus value has the following relationship to the dispersion and aeration value:

- Soils with great humus content are mostly compact in a humid climate. The humus value H 5 is therefore coupled with the dispersion value D 5.

D 5. *Dispersion (and deficiency of aeration) value*

The dispersion value defines the size of the particles

and the aeration (above all with oxygen) of the soil at the site of the plant. Low values characterize soils with very coarse particles, high values those with very fine particles and/or poor oxygen supply.

1 : Plants occurring chiefly on cliffs, rocks and walls. Rock plants.

2 : Plants occurring chiefly on soils with coarse particles, rubble, scree, or gravel (diameter of a large part of the stone particles in the region of the roots over 2 mm). Scree, gravel, and rubble plants.

3 : Plants occurring chiefly on permeable, gravelous, or sandy well ventilated soils (average diameter of stone particles in the region of the roots often 0.05 - 2 mm).

4 : Plants occurring chiefly on usually fine sandy, dusty, more or less well ventilated soils (poor in gravels; average diameter of the fine earth particles usually 0.002 - 0.05 mm); not occurring on coarse rubble or cliffs.

5 : Plants occurring chiefly on very fine grain, clayey or peaty, usually watertight, or at least poorly ventilated (poor in oxygen) soils (average diameter of fine earth particles usually less than 0.002 mm); avoiding sandy, pebbly, or rocky soils. Often indicators of clay (if the humus value is lower than 5) or of peat (at humus value 5) or general oxygen deficiency indicators.

x : Plants growing both on rocky and clayey or peaty soils.

† : Plants growing in unstable soils. Indicators of movable rubble.

The dispersion value shows the degree of permeability and ventilation of the soil. Soils with coarse stone particles usually contain less water available to the plants, but are well ventilated. The plants can root correspondingly deeply. Soils with very fine particles are impermeable, poorly ventilated, and dry out in periods of dry weather. Also soils that are submersed for long periods are poor in oxygen.

The dispersion value shows the following relationship to other indicator values:

- The dispersion value D 5 is often coupled with varying humidity (F 5 w, 4 w, 3 w, or 2 w) or with wet soils (F 5).
- A low dispersion value is, if there is no influence of outside water, usually paralleled by a low humidity value.

S 6. *Salt symbol*

The salt symbol indicates wether the plant can also thrive in salty soil.

+ Plants also growing on salty soil.

- Plants avoiding salty soil.

L 7 *Light value*

The light value is characteristic for the average light intensity at which the plant can grow well during its vegetation period. Low values show little necessity of light, high values a great necessity of light.

1 : Plants growing in very shady positions (up to less than 3 % of the relative strength of illumination); if in half-shade or in sun then only in situations with little competition. Definite indicators of shade.

2 : Plants occurring chiefly in shady situations (hardly under 3 % but often under 10 % relative strength of illumination); in strong light only in situations with little competition. Indicators of shade.

3 : Plants often growing in half-shade (but usually not under 10 % relative strength of illumination); more rarely met with in full light.

4 : Plants occurring chiefly in full light, but sometimes surviving in slight shade. Indicators of light.

5 : Plants only growing in full light, incapable of surviving in shade.

Definite indicators of light.

Full light is in general more advantageous, also for shade plants, than poor illumination, and one can find plants with low light values in full light if the competition there is not very great and the conditions otherwise good for the plants. Dog's Mercury (*Mercurialis perennis*) or Herb Robert (*Geranium Robertianum*) for instance which both have the light value L 2, occasionally grow on calcareous scree slopes where the competition is small. Often shade plants require more humidity and can therefore not thrive in direct sunlight in regions with dry air. Trees can grow in full light even if they have a low light value. The light value refers to the conditions under which the young plants are capable of developing. The beech (*Fagus silvatica*) for instance has the light value 2 because the young plants can survive in relatively deep shade. The crowns of the full-grown trees, however, are usually in the full sun. Similarly, meadow plants and tall herbaceous plants often reach the full light when fully grown, when young however, have to manage with little light and therefore have a low light value. Herbaceous plants in the woods which show their chief development in spring before the trees are in leaf have, as woodland plants, a relatively high light value as their growth ceases and their leaves wither as soon as the leaves of the trees shut off the light, for example Winter Aconite (*Eranthis hiemalis*) L 4, Spring Snowflake (*Leucojum vernum*) L 3, or Squill (*Scilla bifolia*) L 3. Other plants, however, which bloom early but keep their leaves after the trees have come into leaf, have low light values. Many plants with low values generally need more light to bloom than is shown by their light value. The beech (*Fagus silvatica*) with the light value L 2 needs as much light to bloom as a plant with the light value L 4. Saprophytes and parasites do not need great light intensities. As, due to their association with certain soil types or host plants, they occupy sites with easily definable light conditions they are given a light value all the same.

The light value has only little relationship to other indicator values.

- Illuminated soils are less likely to become acid than shaded soils

because they become warmer and the organic substance deteriorates more quickly; they are also more intensely turned over by ground animals.

T 8. *Temperature value*

The temperature value is characteristic for the average temperature that the plant receives during its vegetation period. It is given chiefly by the altitude at which the plant grows. Low values correspond to distribution at higher altitudes, high values indicate plants growing in the lowlands.

1 : Plants occurring chiefly in the alpine zone; also found in lower regions in cool areas or where the competition is small. Typical alpine and arctic plants. In low regions indicators of cold situations.

2 : Plants occurring chiefly in the subalpine zone; found also in the alpine zone in sunny places and in cool situations with little competition, occasionally even in low regions. Alpine and boreal plants.

3 : Plants occurring chiefly in the montane zone; often also in the colline and subalpine zones. Usually widely distributed plants.

4 : Plants occurring chiefly in the colline region in sunny places also higher. Plants widely distributed in the lower regions of Central Europe.

5 : Plants occurring only in the warmest situations. Plants chiefly found in Southern Europe.

The warmth obtained by a plant is not only dependent on the average temperature, but also on the solar radiation. Therefore plants often grow at considerably higher altitudes in southern expositions and in situations protected from the wind than their temperature value indicates; in north expositions and local cool places (e.g. in places cov-

ered by snow for long periods in ravines and in cold hollows) they are to be found in lower regions.

The temperature value shows a close relationship to the continentality value. Plants with a high continentality value generally have a greater amplitude, with respect to their distribution in altitude, than those with a low continentality value (see also under continentatity value).

K 9. *Continentality value*

The continentality value indicates the difference in temperature during the course of the day and of the year and the humidity of the air. Low values show slight temperature variations and high humidity, high values great changes in temperature and often very dry air conditions.

1 : Plants occurring chiefly in regions with oceanic climate; mild winters, very humid air necessary. Plants with high temperature value cannot stand frost, plants with low temperature values require long periods in which they are covered by snow. Plants occurring only in the Insubrian and western part of the region and in bogs and places where the snow lies for long periods.

2 : Plants occurring chiefly in regions with sub-oceanic climate; they cannot stand late frosts or great extremes of temperature. In areas with a continental climate (e.g. lower regions of the Central Alps) only found in locally advantageous positions if at all.

3 : Plants occurring chiefly outside extreme continental regions. Found almost everywhere in the region.

4 : Plants occurring chiefly in regions with relatively continental climate; capable of withstanding extremes of temperature, low winter temperatures and slight air humidity; not found in places where the snow lies for long periods. Chiefly found in the continental, dry parts of the region, otherwise only in exposed places.

5 : Plants occurring only in areas with continental climate; found chiefly in situations exposed to the wind and the sun. Only found in the most continental parts of the region.

The continentality is related to the temperature, to the humidity of the ground, to the length of the vegetation period, and to the soil reaction. The relationship to the temperature is particularly close.

- Plants with a high continentality value differ in general from those with a low value, even when they have the same temperature value, in that they grow at higher altitudes, in the interior of the Alps than the latter whereas the situation is reversed in the outer ranges and in the Jura. Plants with a low continentality value grow to near the same altitude in the outer and inner ranges of the Alps. The continental Scots Pine (*Pinus silvestris*) with T 3, K 4 grows in the Jura only to an altitude of 1000 m above sealevel, in the Wallis in the inner ranges of the Alps to about 2000 m above sealevel. The Sycamore (*Acer Pseudoplatanus*) with the values T 3, K 2, on the other hand, grows in the Jura as high as 1500 m above sealevel and in the inner Wallis to 1850 m above sealevel. These differences are due to the fact that in oceanic areas the sunshine is not strong enough to allow continental species to grow in higher regions. In the inner Alps, on the other hand, oceanic species can survive only on north facing slopes and in local situations with greater air humidity, and therefore cannot benefit from the greater radiation of the sun.
- Plants with high continentality values usually have low humidity values, whereas plants with low continentality values often have average or high humidity values (less sunshine, less exposure to the wind, longer snow cover, greater humidity of the air).
- Plants with low continentality values often have low reaction values, whilst those with high continentality values often have high reaction values. (Elutriation of the bases in humid climate, concentration of the bases on the surface of the soil in arid climates).

W 10. *Type of growth, life forms*

The life form in the sense of RAUNKIAER defines the position of the surviving buds during the least advantageous season of the year. The groups. The groups are listed in a similar manner to that of ELLENBERG (1974), but two groups have been subdivided (p and i instead of p, n and j instead of n) and one new group created (u).

p : Deciduous phanerophytes: woody plants reaching more than 4 m in height, trees which lose their leaves or needles in autumn.

i : Evergreen phanerophytes: woody plants reaching more than 4 m in height, trees which retain their green leaves or needles also in winter.

n : Deciduous nanophanerophytes: woody plants 0.4 to 4 m in height, bushes which lose their leaves or needles in winter.

j : Evergreen nanophanerophytes: woody plants 0.4 to 4 m in height, bushes with evergreen leaves or needles in winter.

z : Woody chamaephytes: dwarf shrubs with buds above the surface of the soil in winter, lignified parts less than 0.4 m high.

c : Herbaceous chamaephytes: herbaceous plants without lignified parts which spend the winter with buds above the surface of the soil.

e : Epyphytes: plants that grow on trees.

h : Hemicryptophytes: plants that spend the winter with buds on or directly under the surface of the soil.

g : Geophytes: plants that spend the winter with the buds below the soil (e.g. on rhizomes, corms, bulbs, underground runners, shoots lying in rubble).

i : Therophytes: plants which live for only one vegetation period, their seeds surviving the disadvantageous season.

u : Therophyt/hemicryptophytes: plants that can behave as therophytes in warm regions and good years, in our region generally biennials and passing the winter as rosettes, more rarely surviving for several years in cool areas through the formation of side rosettes.

a : Hydrophytes: plants with buds that spend the winter in the water; plants that sometimes grow on dry ground and form rhizomes or corms are counted as geophytes, for instance reeds (*Phragmites communis*).

It must be mentioned here that many plants can be met with in more that one life form, according to the locality in which they grow.So for instance ivy (*Hedera helix*) which in many forests grows only as a woody chamaephyte (W z) on the ground and in other climbs as an evergreen phanerophyte (W i) up to the tops of the trees. In the life form W i it is an indicator of a rather warm sub-oceanic climate (T 4, K 2), as a creeper on the ground (W z) it would receive the continentality value K 3, because in this situation it is much less exposed and therefore has a greater distribution. As, however, it generally only blooms and bears fruit in the life form W i (at most also W j) only this is noted. In the evaluation of phytosociological surveys the life form in which the plant occurs must be considered. Sometimes a species is capable of surviving an extremely hard winter or an extremely mild one in a different life form than usual. In this manner evergreen phanerophytes (W i or W j) may freeze above the ground and then renew growth from sub-surface parts (as geophytes W g, or hemicryptophytes W h) for exampple Cherry-Laurel (*Prunus Laurocerasus*) when growing in gardens north of the Alps. Many hemicryptophytes and geophytes (W h and W g) behave as chamaephytes (W c) in protected situations or mild winters, as then the parts above the ground do not all die off and can resume growth in spring. Also otherwise, overlapping often occurs between two types. Various rosette forming plants such as species of Saxifrage (*Saxifraga*) and Rock Jasmine (*Androsace*) can be counted as hemicryptophytes (W h) or as chamaephytes (W c),according to wether the rosette is close to the ground or has a short stalk and is therefore slightly over the ground. Plants which sometimes occur as hemicryptophytes (W h) and sometimes as therophytes (W t) are designated by W u. There are annuals or biennials (seldom perennials) and spend the winter as seeds or rosettes. No doubt this applies to many of the plants here still defined as therophytes (W c).

C. Possibilities of Application

As already stressed, the indicator values of individual plants can only have a conditional meaning as the individual species can sometimes flourish, according to the competition met with, under different conditions than those corresponding to their indicator values. On the other hand the circumstances can be quite well characterized if all the species of an ecological communnity are considered.It is clear that plants can occur in profusion, or covering large areas, must carry more weight than rare species. It is simplest to classify plants with a covering value of + as once, such with 1 as twice, with 2 as three times,with 3 as four times, with 4 as five times, and with 5 as six times. In this way the average value of any phytosociological survey can be compared with any other (differing in time and place) and the differences in the localities can be arrived at. The average value for w (changeable humidity) is expressed as a fraction. If the species of changeable humidity are represented by less than 1/8 th the w-value is neglected (for examples see pp. 28 - 45).