UNIT 9 NATURE AND STRUCTURE OF COMMUNITY

Structure

9.1 INTRODUCTION

Every place on earth — grasslands, forests, ponds, edge of the river or sea is shared by many coexisting organisms. Plants, animals and microorganisms which occur together are related to one another by their feeding relationships and many other interactions, forming a complex whole, generally referred to as a biological community. Interrelationships between the organisms in a community determine several functional attributes of the ecosystem such as : flow of energy and cycling of elements. Therefore, to have a better understanding of an ecosystem, we should have a clear idea about the nature and structure of community. Thus, in this unit, we shall discuss with you some main features of the community level of organisation, with emphasis on some important community characters. After studying the section 9.2, you should be able to develop a clear understanding of the terms individuals, populations, community and stands and the distinction between a community and an ecosystem. Having understood the above terms, it would be easier for you to follow the remaining sections. After studying this unit you should be able to understand the various terms and concepts pertaining to the study of biotic communities. Go slowly, and try to relate each of it to your surroundings. This will help you to build a clear picture of a biotic community in your mind.

Objectives

After studying this unit you would be able to :

- explain the concept of a biological community
- describe the main features of a biotic community
- define and describe the various analytical characters used to study a biotic community
- define and describe the different synthetic characters used to study a biotic community

9.2 WHAT IS COMMUNITY?

In nature different kinds of organisms occur in association with each other, sharing the same habitat. Let us consider the example of a field to illustrate this point further. In a field different kinds of grasses, insects, worms, birds and mammals interact in various ways. Grasses provide food for certain insects and mammals; insects provide food for birds; and birds prey on small mammals and worms. The various kinds of organisms in this field thus constitute a community, which is also known as field community. Similarly a forest, desert, pond, marsh and stream — are examples of natural communities. After discussing briefly what a community is, we would now discuss six main features of a community.

nonliving part of environment + COMMUNITY } = ECOSYSTEM

First, a community represents the biotic or living component of the ecosystem. If the non-living (abiotic) factors, together with the living (biotic) entities are considered, then we would be dealing with an ecosystem rather than a community.

Secondly, considering the functional aspect, communities are made up of organisms with interlocking food chains and each species depends on many other species in a community which are taxonomically unrelated. Try to recall a food web, this will help you to understand this concept more effectively. Food web is a representation of the food relationships between various types of species found in an ecosystem, and as you know these biotic components constitute a community. While a species may not relate to every other species directly in a community, nevertheless, they all are indirectly interrelated. This situation can be compared with an engine in which various components are interrelated and they together make the working of an engine possible.

Fig. 9.1 : A deodara *(Cedrus deodara)* tree

Thirdly, a community may be of any size. A temperate forest of deodar trees is an example of a large community. (Fig. 9.1 shows a deodar tree). In contrast to this, a rotting log of wood harbouring many insects and worms represents a small community. So the size of a community may vary widely.

Fourthly, just like the concept of ecosystem, that it can be applied to any scale, that is, the earth as a whole can be considered as a large ecosystem, on the other hand, a bowl of water with various living organisms in it is an example of a small ecosystem. Similarly, a forest is a community, so is a rotting log in that forest containing fungus, insects like termites, and even mice. Similarly, a large number of microorganisms within the gut of termite, that occurs in the rotting log of wood, also constitute a community. This suggests that there is a community within a community, and the situation is just like the toys shown in Fig. 9.2.

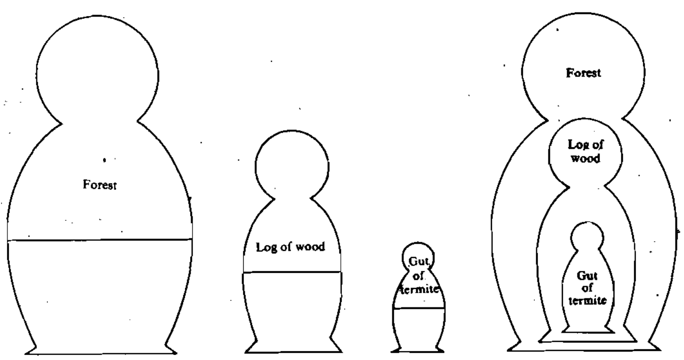


Fig. 9.2 : Wooden toys used as an example of community within a community

Fifthly, some communities may be autotrophic, in the sense that they include photosynthetic plants and obtain their energy from the sun. Other communities such as those found in springs and caves are heterotrophic, as they depend upon organic material such as detritus as a source of energy.

Sixthly, interrelated with the idea of community is that of the *stand*. In some situations these two terms mean *different* things; and in some other situations these two terms mean the *same* thing, and are used interchangeably. In order to avoid any confusion in the usage of these two terms, we shall illustrate these two situations with the help of two examples, that are discussed below.

The first example is of a temperate forest consisting of deodars, pines and rhododendrons (see Fig. 9.3). Have you noticed in the figure, that at places, the plants of a particular species are forming groups. These groups are indicated in the figure by the areas enclosed by the dotted lines. So each of this area containing plants of same species and almost of the same age is called a *stand*. You can also observe

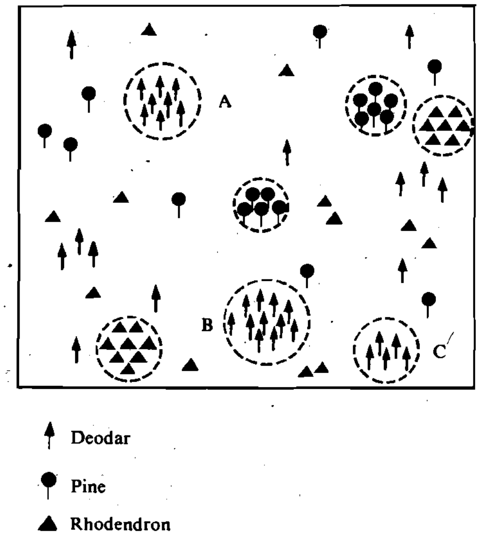


Fig. 9.3 : Diagrammatic representation of a temperate forest

from the figure that stands A, B and C of deodar trees are different from each other as far as their number is concerned. The term stand is applied to a more or less uniform area of vegetation. *While studying a community, when we talk of a stand, it means we are talking about a group of plants of a species in that community.* After going through this example, you would have seen that, here community and stand refer to different things.

The second example is of a cultivated wheat field. The wheat plants in this field constitute the wheat field community. Since, this field has a uniform vegetation, and plants are of the same age, this can also be called as a *stand of wheat.* This example shows one of the situations where the term stand and community mean the same thing and can be used interchangeably.

SAQ 1

i) A biotic community is an assemblage of :

a) food webs

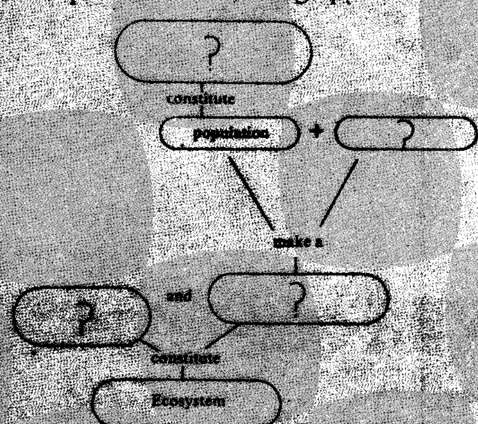
b) interacting populations

c) closely related species

d) ecosystems

(Tick the correct one)

ii) Fill in the spaces with question mark, using a[illegible]te word(s).



iii) What are the salient features of a Community?

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9.3 COMMUNITY GRADIENTS AND BOUNDARIES

It is often difficult or impossible to determine where one community ends and the next begins. Many communities, in fact, grade continuously into each other with no sharp boundaries. For example, if two forests, pine forest and spruce forest are nearby, one cannot see the boundaries between them. But if one moves from one end of the pine forest to the other end of spruce forest, one can observe difference in species composition between the two; yet one cannot demarcate a sharp boundary between these two forest communities. There are, however, instances where sharp boundaries between the communities are seen, especially where the physical environment changes abruptly — for example, at the transition between aquatic and terrestrial habitats between distinct soil types, or between north-facing and south-facing slopes of a mountain.

Ecotone — The zone of vegetation separating two different types of communities is called ecotone. It is also known as a transition zone. The border between forest and grassland, the bank of a stream running through a meadow are examples of ecotones.

Ecotone is a region where the influence of two different patterns of environment work together and hence the vegetation of ecotones are highly specialised. An ecotone may be narrow or wide. For instance, the ecotones between adjacent plots—one fenced and protected from grazing, and other without fence and openly exposed to grazing; or between a pond and an adjacent upland are quite sharp and narrow whereas among many other types of communities ecotones are very wide and community boundary differentiation is not easy.

A general characteristic of ecotone is that it has sufficiently greater number of species and the diversity of most of the species at times is higher than that in the neighbouring communities (also see Fig. 9.4). The phenomenon of increased variety of plants at the boundary is called the *edge effect* and is essentially due to wider range of suitable environmental conditions. The ecotone area contains organisms from both of the adjoining communities and besides there are organisms which are confined to the ecotone and can exploit the special conditions there.

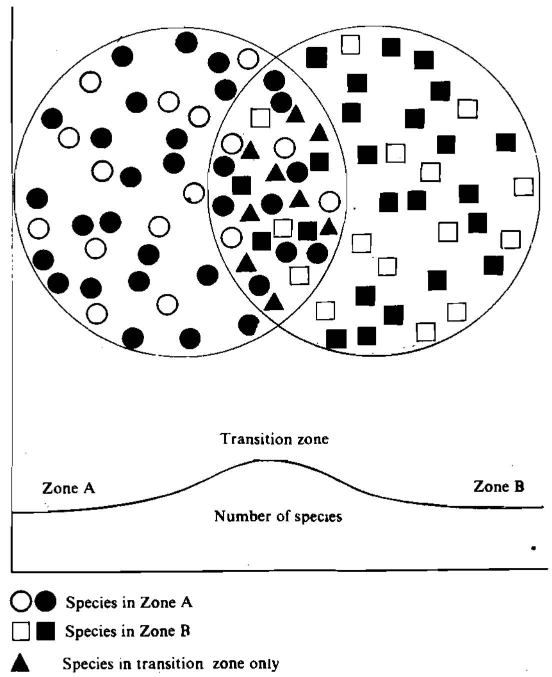

Fig. 9.4 : Ecotone — where two community types come together, such as a forest and field, species in the zone between them include both forest and field species and some additional species that do not exist in either forest or field

Some ecologists have introduced the *continuum concept* that means that there are no distinct communities with well defined boundaries but there is a gradual change in space and time along a gradient which may be of moisture, temperature, soil type, altitude or any combination thereof. There are no sharp borders or changes in species composition in areas, according to the continuum concept.

9.4 ANALYTIC CHARACTERS

As you know, a community has its own characteristics, which are not shown by its individual component species. These characteristics have meaning only with reference to community level of organisation and are discussed in this and the subsequent sections.

The community characters, mainly are of two types: analytic and synthetic. In this section we shall discuss the analytic characters. These are categorised as : *qualitative* and *quantitative*. Qualitative characters are difficult to measure, whereas the quantitative characters can be measured readily. We shall now take up these characters one by one.

In each community there are diverse species. All these species are not equally important, but there are only a few overtopping species which by their bulk and growth modify the habitat and control the growth of other species in the community, thus forming a sort of characteristic nucleus in the community. These species are called dominants. Generally, in most of the communities, only a single species due to being particularly conspicuous, is dominant, and in such case the community is called by the name of dominant species as for example, Spruce forest community. In other communities, there may be more that one dominants as in Oak-Hickory forest communities.

9.4.1 Qualitative Characters

Given below is a discussion on six important qualitative characters of a community. Let us take them up one by one.

i) **Floristic Composition** — One of the important qualitative characteristics of a community is its floristic composition. This broadly refers to the kind of species occurring in a community. Here, we would like to make a point. Most communities are named after the dominant plant species that occur there.

You may be thinking that why plants and not animals? The reason is that the plants are stationary, they remain at a particular place throughout their life. In contrast, the animals are mobile and they do not stay at a place for long, so they are not taken as representatives for naming a community.

The next aspect that we will take up for discussion is how to study the floristic composition of a community. The first thing done is to prepare a list of species comprising that particular community. In practice, it is nearly impossible to name each and every organism, as some of them are very minute. Amongst plants, usually the *vascular* plants are counted. In order to make a complete list, species appearing in different seasons are also considered. Although all the species in a community are significant, but only a single species or a few species are often used in naming a community, because of its (their) abundance or dominance.

Vascular Plants — plants having a well developed conducting system, having xylem and phloem elements.

The next point is what does one know or learn from these floristic lists? It gives the idea about the following : *One,* the relationship of a particular species to the environment and to other species; *two,* the habitat of different species, *three,* the ecological amplitude of species, and *four,* the present conditions and future trends of the community.

Ecological Amplitude — it is the range of the environmental factors that a particular species can tolerate.

Now we shall take up these four points one by one. Let us now take the first point. We shall elaborate this with the help of an example, that is of *Adhatoda vasica* (Fig. 9.5a) it is a winter annual. It normally occurs with a co-dominant shrub *Capparis sepiaria* (Fig. 9.5b). So, as far as the relationship of *Adhatoda* species to environment is concerned, it grows when temperature is low and it grows in association with *C. sepiaria.* So this shows its relationship to the environment and to another species. Sometimes, the association between two species is so strong that a certain species may indicate the presence of other species, so prediction is possible to some extent, i.e., if species A is found in a certain area, then species B can also be expected there.

Second point is, *A. vasica* occurs on hilly tracts and similar rocky areas. This indicates its habitat.

Third point, each species has its own range of tolerance to certain environmental conditions. The abundance or sparseness of certain species indicates the prevailing favourable or adverse conditions in relation to their ecological amplitudes. Association of species may be brought about by the similarity in the ecological amplitudes of two or more species.

Fourth point, such floristic lists not only tell us about the absence or presence of species in a particular community, but also indicate the present conditions and future trends. For instance, a decline in the number of species from one area as compared to other, may indicate increasingly adverse conditions.

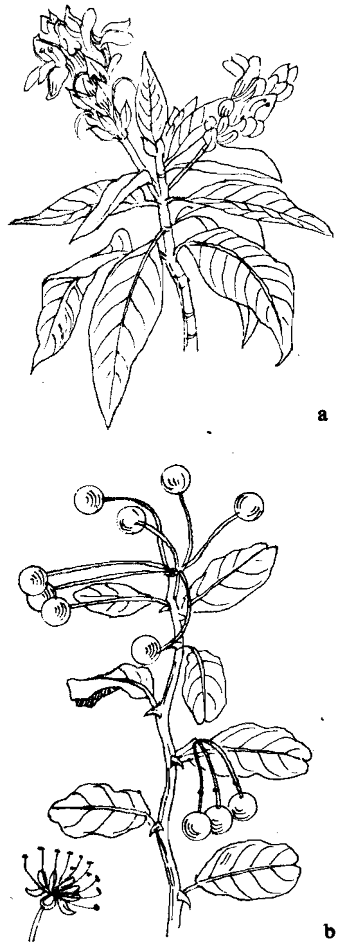

Fig. 9.5 : a *Adhatoda vasica*, and b. *Capparis sepiaria*.

ii) **Stratification of Vegetation** — Stratification of vegetation is another important feature of plant communities. There are different vertical strata in different communities. You have already some idea about this from the Course FST-1, Unit 15, Section 15.4, wherein we have discussed the example of a forest in this context. You might recall that in forests, we find several storeys or layers of plant species. Stratification usually occurs because of life forms such as trees, shrubs, herbs and mosses differ in their requirements and ecological amplitudes with regard to light intensity, temperature, moisture conditions, soil and biotic factors.

Now let us have a closer look at the vegetation of a forest. A well developed forest may have four to five layers of vegetation. (See Fig. 9.6). From top to bottom, they are : the canopy, the understory, the shrub, the herb or ground layer and the forest floor.

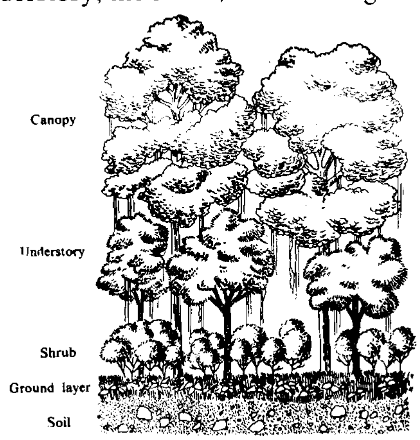

Fig 9.6 : Segment of Forest depicting vertical stratification diagrammatically

In a tropical rain forest, vertical stratification is very clearly seen. In addition to the different layers described above, there are lianas and climbers that twine around the trees. A forest with four or five strata can support a greater diversity of life forms as compared to a grassland with only two strata. Stratification is also seen in the underground plant parts, that is, the root and the rhizome systems. Root systems of different plant species tap moisture and nutrients from different soil depths. This enables them to avoid competition and too much exploitation of a particular soil layer.

Coming back to the above-ground parts of vegetation, the canopy which is the primary site of energy fixation, it has a major influence on the rest of the forest community.

A canopy is said to be *open* when considerable sunlight reaches the lower layers. In such cases the shrubs and understory tree strata are well developed. In a *closed* forest, most of the sunlight is intercepted by tree canopies. The understory plants remain deprived of direct sunlight consequently the lower strata is comprised of shade tolerant species with poor growth of herbaceous layer. In such situations species requiring intense sunlight are absent or flourish only in the gaps created by the death of top canopy trees.

Aquatic ecosystems also exhibit marked stratification. In lake and ocean ecosystems light penetration, temperature and availability of oxygen varies with depth, (also see Unit 8, of this course). In summer, a well stratified lake has a layer of freely circulating surface water with uniform temperature known as the *epilimnion*. A second layer called *metalimnion* which is characterised by a thermocline (a very steep and rapid decline in temperature). The third layer — the *hypolimnion*, is a deep, cold layer of dense water, often low in oxygen; and a layer of bottom mud. In terms of availability of light, a water body is divided into two layers: an upper lighted zone which is dominated by phytoplanktons and where photosynthesis occurs vigorously, and a lower layer in which decomposition is most active. The lower layer roughly corresponds to the hypolimnion and the bottom mud.

Let us now see what is common between a terrestrial and an aquatic ecosystem. Both have similar type of trophic structure. They possess an autotrophic layer concentrated where light is most available, which fixes energy of the sun and manufactures food from inorganic substances. In forests this layer is represented by tree canopies; in grasslands by herbaceous vegetation; and in lakes and seas by the upper layer of water.

Ecosystems also possess a heterotrophic layer that utilises food stored by autotrophs, transfers energy and circulates matter by means of herbivory, predation and decomposition.

We shall now discuss the vertical stratification in relation to animal life. The degree of vertical stratification has a pronounced influence on the diversity of animal life in the community. A strong correlation exists between foliage height diversity and bird species diversity. Increased vertical stratification increases the availability of resources and living space, which favours a certain degree of specialisation. Grassland with their two strata, hold about 6 to 7 species of birds, all ground nesters. A deciduous forest may support 30 or more species occupying different strata. Like birds, insects too show similar stratification.

iii) **Periodicity** (Phenology, Aspection) — It refers to the study of seasonal changes in the community, that is, the periodic phenomena of organisms in relation to their climate. Periodicity is a strongly fixed characters in plants. Different species of plants have different periods of seed germination, vegetative growth, flowering and fruiting, leaf fall, seed and fruit dispersal, and dissemination of seeds. Such data for each species in a community is recorded. A study of the data and time of these events is termed as *phenology*. In other words, phenology is the calendar of events in the life history of a plant. Diagrammatic representation of such events is known as *phenograms*. In Fig. 9.7 phenograms of some Indian grasses and sedges are shown.

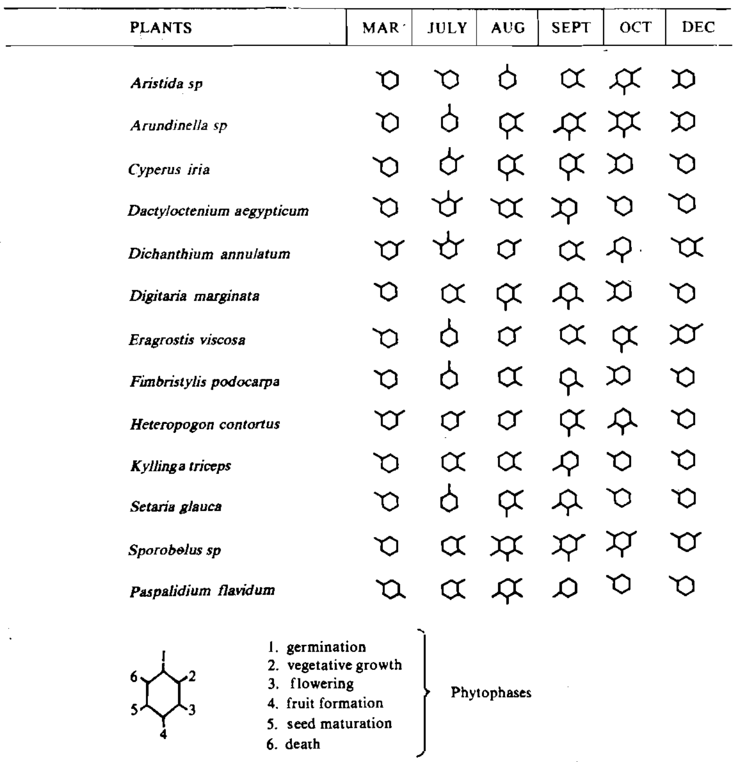

Fig. 9.7 : Phenograms of some Indian grasses and sedges

The phenology of different species present in a community may differ from each other significantly. It is these phenological changes which give a definite look to a community. *Aspection* is the appearance or aspect of the community as a whole at different seasons. We shall further elaborate this point by an example. There is a community having four different plant species. And these four component species flower in the months of January, April, July and August successively. So the community has a characteristic appearance during the different months of the year. And in the subsequent year too, the same pattern can be seen. But now if somehow another species, i.e., the fifth species comes in this community, and it flowers in June, the whole appearance of the community would be markedly different now. After going through the above example it may be clear to you now that the appearance of two different communities may be different.

So, what does one learn or know by studying such seasonal shifts in a community? Firstly, we come to have a calendar of different events in the life of the component species. From this calendar we can deduce as well as predict the appearance of the community during different periods of the year. We can also know about favourable and unfavourable seasons for the different phases of plant life.

So far we have talked about plants only. The animals in the community are directly or indirectly dependent on the plants also time their activities in such a manner that it coincides with the maximum activity of plants. For example, associated with the tree *Terminalia arjuna* is a psyllid (an insect) *Trioza fletcheri minor*. This insect forms galls on the leaves and flowers of this plant. During the season, when the plant puts on new leaves, this psyllid too grows actively. If forms new galls on the young, tender plant parts. The young ones of the insects develop in the galls thus formed. This example shows how the insect has timed its reproductive phase with that of the plant. It also shows the association of an insect with a plant. But in nature there are instances, where more than one species of insects and other organisms are associated with a species of plant.

iv) **Vitality and Vigour** — Vitality is related to the condition of a plant and its capacity to complete its life cycle, while vigor refers more specifically to the health or development within a certain stage. We can say that a seedling or a mature plant may be vigorous or it may be feeble or poorly developed. A number of criteria may be used in determining the vigour of plants such as the rate and total amount of growth especially in height; rapidity of growth renewal in spring or following mowing or grazing; area of foliage, colour and turgidity of leaves and stems; degree of damage caused by diseases or insects; time of appearance and number and height of flower stalks; rate of growth and extent of root system, appearance and development of new stems and leaves. For classification of vitality the following groups as given by Daubenmire (1968) are used :

V_1 — Plants whose seedlings die

V_2 — Seedlings grow, but unable to reproduce

V_3 — Reproduce only vegetatively

V_4 — Reproduce sexually, but are uncommon

V_5 — Reproduce sexually and grow regularly.

v) **Life Forms** — The form and structure of terrestrial communities are determined by the nature of vegetation. Vegetation may be classified according to growth form. The plants may be tall or short, herbaceous or woody, evergreen or deciduous. We might speak of trees, shrubs, and herbs, and then further sub-divide these categories into needle-leaved evergreens, broad-leaved evergreens, broad-leaved deciduous, shrubs, ferns, grasses and so on and so forth.

A more useful system was proposed by a Danish botanist, Christen Raunkiaer in the year 1903. In this system, instead of considering plants' growth form, he classified plants by life form, the relation of their height above ground to their perennating organ. A perennating organ is one that survives from one growth season to the next, remaining inactive over winter or dry periods. Perennating tissue is the embryonic or meristeimatic tissue of buds, bulbs, tubers, roots and seeds. Raunkiaer recognised five principal life forms that we shall discuss below :

The five life form classes (see Fig. 9.8) are : a) Phanerophytes, b) Chamaephytes, c) Hemicryptophytes, d) Cryptophytes, and e) Therophytes. We shall take up these five classes one by one:

Fig. 9.8 : Raunkiaer's Life Forms : a) Phanerophytes, b) Chamaephytes, c) Hemicryptophytes, d) Cryptophytes, and e) Therophytes.

a) **Phanerophytes** (Greek word, Phaneros — 'visible') : The perennating buds in this case are present on erect, negatively geotropic shoots, much above the ground (see Fig. 9.8a). These buds are naked or least protected and are exposed to varying climatic conditions. These life forms include trees, shrubs and climbers. These are generally common in tropical climates, and their number progressively decreases when we move from tropics to polar regions.

b) **Chamaephytes** (Greek word, Chamai — on the ground) : The perennating buds and organs are borne on shoots close to but just above the ground (see Fig. 9.8b). The buds receive protection from fallen leaves and snow cover. These life forms include creepy, woody plants and herbs. These plants are typical of cool dry climate, that is the arctic and alpine regions.

c) **Hemicryptophytes** (Greek word, hemi — partly; kryptos — hidden) : In this case the perennating buds or organs are situated at the soil surface (see Fig. 9.8c) where they are protected by soil and fallen leaves. These include herbs growing in rosettes and tussocks. These plants are found in cold, temperate zones, where aerial parts die at the onset of unfavourable conditions. Most of the biennial and perennial herbs come under this category.

d) **Cryptophytes** (Greek word, kryptos — hidden) : Perennating buds or shoot apices are buried in the ground at a distance from the soil surface (see Fig. 9.8d) that varies in different species. The buds are buried where they are protected from freezing or drying. Examples are tuberous and bulbous herbs. Many of these are found in arid zones. Hydrophytes are the cryptophytes whose buds are found below the water surface.

e) **Therophytes** (Greek word, theros-summer) : These are annual plants of the summer season or of the favourable season. They complete their life cycles in a single favourable season and overwinter as seeds (see Fig. 9.8e), which remain dormant during the unfavourable period of the year. Therophytes complete their life cycle within a few months only and occur commonly in deserts and grasslands.

The relative proportion of different life forms in a vegetation, tells us about the geo-climatic conditions. For example phanerophytes comprise about 60-90% of the flora of humid tropics. Chameophytes are characteristic of arctic and alpine regions. and in cool temperate regions about 50% species are hemicryptophytes.

vi) **Sociability** (Gregariousness) : Sociability refers to the nature of grouping of individual plants, that is, whether they grow singly, in patches, in colonies or evenly intermixed. This is dependent upon the life form and vigor of the plants, habitat conditions, and competitive and other relations between the individuals. Sociability expresses the degree of association between species. The five sociability groups given below are used for rating the sociability of species.

S_1 — Plant (stems) found quite separately from each other, thus growing singly

S_2 — A groups of 4-6 plants at one place

S_3 — Many smaller groups at one place

S_4 — Several bigger groups of many plants at one place

S_5 — A large group occupying larger area

9.4.2 Quantitative Characters

i) Population Density — Density denotes the average number of individuals of a particular species in a unit area. In other words, it represents the numerical strength of a species in a community. A study of density makes it possible to have accurate and direct comparisons of the **abundance** of species between different areas. Density also gives an idea of the degree of competition between the members of the same species as well as of one species with the other. It is calculated as follows :

$$\text{Density} = \frac{\text{Total number of individuals of a species in all the sampling units}}{\text{Total number of sampling units studied}}$$

The value thus obtained is expressed as number of individuals per unit area.

Crude density — is the density of individuals of a species throughout the habitat and is determined by random sampling.

Ecological density — refers to the density of individuals of a species, dete· ...ed at the place where they actually occur in a community.

We shall elaborate it with an example, consider a small patch of land where there are a few water-filled ditches, and rest is dry land. Now, if we want to determine the density of frogs in that area, we would select a few sampling units distributed throughout the area and determine the density. In areas that are dry, the number of frogs would be very less, or they may be absent. This is crude density. And if we determine the density of frogs in areas that are moist and near water, then it is called as ecological density.

ii) **Cover** (area occupied) : Cover or specifically **herbage cover** refers primarily to the area of ground occupied by the leaves, stems and inflorescence i.e. the above-ground parts of the plants, as viewed from above (see Fig. 9.9). Each layer of vegetation is considered separately, since overlapping usually occurs, so that a tall plant is rated apart from one growing under it. *Basal area,* refers to the ground actually penetrated by the stems (see Fig. 9.9). This can be readily seen when the leaves and stems are clipped at the ground surface. (see Fig. 9.9).

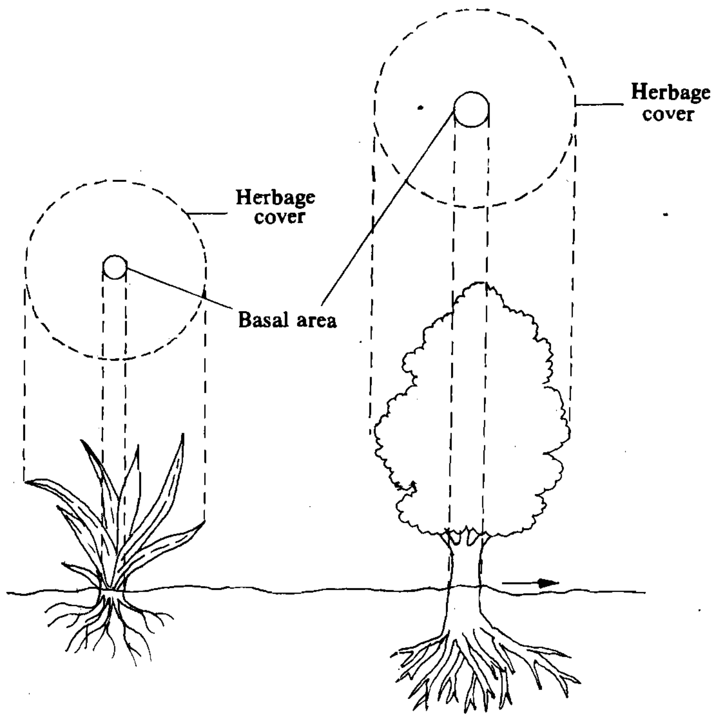

Fig. 9.9. : Diagrammatic sketch showing herbage cover and basal area in different plants

Herbage area or vegetation cover is an important aspect of vegetation study in understanding the nature of a community particularly in evaluating quantitative relationship between species. When the herbage covers of individual plants are in lateral contact and form a continuous cover, the vegetation is said to be closed. When the vegetation cover has gaps, which could be colonised by other individuals, it is said to be open, and if the amount of space is much greater than that occupied by plants the term sparse is used. Periodic record of herbage cover provides extremely valuable information in determining the nature and trend of changes in a community. This is illustrated very clearly in Fig. 9.10. It shows the basal area over a considerable period of time changes.

iii) **Height of Plants** — The height of a plant is a very good indicator of their general performance and therefore, can be employed as a criterion of the success of a species in various habitats. It can also be used as a measure of the favourableness of the environment and is much used by foresters as an index of site quality for various species of trees.

iv) **Weight of Plants** — Weight is one of the most important quantitative characteristics of plants. Quantitatively growth is best measured on the basis of dry weight, since it expresses the total mass of the vegetation or the biomass.

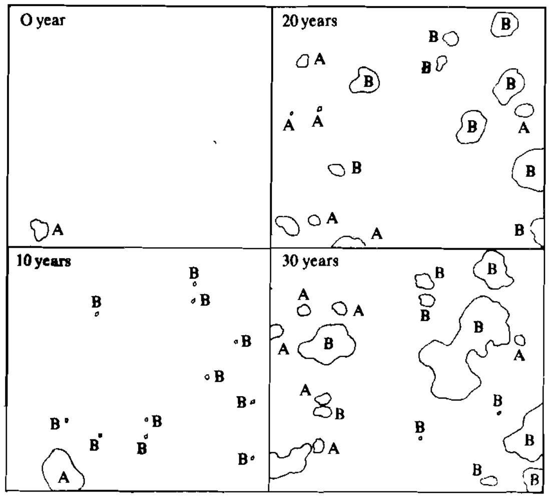

Fig. 9.10 : Changes in species composition and basal area in a sampling unit, over a period of 30 years

Biomass or the weight of plants can be measured separately for the above ground plant parts and for underground parts, i.e., by drying them at 80°C in an oven. The data from such studies provide us valuable information about the yield of that species. For example evaluation of the above ground plant parts that are useful provide an accurate idea about the availability of forage in a community.

SAQ 2

Given below are some analytic characters. Write in brief, what information does each one give.

i) Floristic composition

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ii) Stratification

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iii) Periodicity

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iv) Vitality and vigour

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v) Life forms

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vi) Sociability

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vii) Population density

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viii) Cover

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ix) Height

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x) Weight

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9.5 SYNTHETIC CHARACTERS

To make comparisons between different communities, one needs to make a study of their synthetic characters. What are these synthetic characters? We shall discuss them now.

9.5.1 Presence and Constancy

15/20 × 100 = 75%

Presence and constancy refer to how uniformly a species occurs in different stands in a community. For example, when a species is found in 15 out of the 20 stands in a community the presence or constancy is 75 per cent.

The terms presence and constancy are used in more or less in the same sense but they are however not synonyms. The term constancy is used when equal, measured sample areas are used for study, and presence is used when the area of sampling unit varies from stand to stand and especially when it is not measured. Many times, the sampling units do not have the same area, because of the nature of vegetation, as for example, small irregular stands in rock crevices or on sand deposits along a stream.

Species in a community can be classified into five classes of constancy, according to the percentage of occurrence in sampling units or stands. These classes are:

Class I — 1-20% of the sampling units of a community

Class II — 21-40% of the sampling units of a community

Class III — 41-60% of the sampling units of a community

Class IV — 61-80% of the sampling units of a community

Class V — 81-100% of the sampling units of a community

You might have noticed that Classes IV and V include those species that occur in a large number of stands. The species that occur in over 80-90% or in more sampling units are called *constant species*. These species are important as they characterise and help to distinguish a community type. The species belonging to class IV and V indicate two possibilities : i) the species have a wide ecological amplitude and are therefore capable of growing in various micro-habitats, and ii) the various sampling units are very similar in environmental conditions, so that species of narrow amplitude can grow in all of them.

9.5.2 Fidelity

Fidelity refers to the degree to which a species is restricted in its occurrence to a particular kind of community. The species with low fidelity occur in a number of different communities, and species with high fidelity are restricted to few or only one community. The following five fidelity classes can be recognised:

A) Characteristic species (Character, faithful species)

Fidelity 5 — *Exclusive,* completely or almost completely restricted to one kind of community

Fidelity 4 — *Selective,* occurring most frequently in one kind of community, but also, though rarely, in other kinds

Fidelity 3 — *Preferential,* occurring more or less abundantly in several kinds of communities but with optimum conditions for abundance and vitality in one kind of community.

B) Companion Species
Fidelity 2 — *Indifferent,* occurring without pronounced affinity or preference for any particular kind of community

C) Accidental Species
Fidelity 1 — *Strange, rare and accidental intruders* from another community or relicts from an earlier stage of succession

You have seen that some species cannot grow or are not found in other communities, because species differ in their ecological amplitude or in their capacity to tolerate a wide range of ecological conditions. Some species are able to associate with others, whereas others are not.

Fidelity and constancy are independent characteristics. Fidelity being concerned with the occurrence of a species in different kinds of community types, constancy with various stands in the same community. Fidelity is primarily a sociological quality. A species which has high fidelity or belonging to class 5 is known as *indicator species.*

9.5.3 Dominance

It is a characteristic of vegetation which expresses the predominating influences of one or more species in a stand so that the population of other species is more or less repressed, or is reduced in number and vitality. Dominants are those species which are highly successful in a particular habitat. Cover and population density are the chief qualities determining dominance, but parameters like frequency, height, life form and vitality are also important. The dominants exercise a controlling influence in the habitat while modifying the microhabitat which permits the growth of many different species which otherwise cannot survive in the absence of dominants.

Let us consider an example, a dominant species occurring in pastures, say *Cynodon dactylon.* It owes its success to excellent vitality, rapid multiplication and growth, possessing deep penetrating root system. All these features make it a dominant species in many grasslands.

9.5.4 Physiognomy and Pattern

Physiognomy is the general appearance of vegetation as determined by the growth form of dominant species. It may be considered a synthetic character because the appearance is based on a number of qualitative characteristics such as the kind of dominant species, life form, population density, cover, height, sociability, stratification, and association of species. For example, if we look at a community where large trees are dominant and some shrubs are also present we would immediately say that it is a forest. Similarly on the basis of appearance one can identify a community as grassland or desert community.

Pattern refers to whether the vegetation occurs in the form of groups or clumps of individuals or in any other non-random arrangement.

9.5.5 Frequency

This term refers to the degree of dispersion of individual species in an area, and is usually expressed in terms of percentage. Frequency can be studied by sampling the study area at several places at random or in a desired pattern, so that the site is covered adequately and the names of the species that occur in each sampling unit are recorded. Let us now see how frequency of a species is determined. Consider a species that occurs in five sampling units out of a total of 20 sampling units, then its frequency (F) is 25%. It is calculated by the following formula :

$$F = \frac{\text{Number of sampling units in which that species occurred}}{\text{Total number of sampling units studied}} \times 100$$

A species most abundantly spread all over the area will have chance of occurring in all the sampling units, and therefore, its frequency will be 100%. A poorly dispersed species, with large number of individuals aggregated in one place will have a chance of occurrence in only a few sampling units and its frequency value will be low. Thus a high frequency value shows a greater uniformity of its dispersion. Have you noticed that for determining the frequency, the presence or absence of a species in the sampling units is recorded and not the number of individuals of each species, and thus, you should be able to differentiate it from density for which the number of individuals per unit area is recorded.

Frequency of a species relative to other species in a community is called relative frequency, and is calculated as :

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Total frequencies of all species}} \times 100$$

9.5.6 Importance Value Index (IVI)

In any study of community, the quantitative value of each of the frequency, density, and cover has its own importance. But the total picture of ecological importance cannot be obtained by any one of these alone. For instance, frequency gives an idea as to how a species is dispersed in an area but we do not get any idea about its number or the area covered. Density gives an idea about the numerical strength and so on. To have an overall picture of ecological importance of a species with respect to the community structure, the percentage values of the relative frequency, relative density and dominance are added together and this value out of 300 is called the Importance Value Index or IVI of the species.

IVI can also be ascertained by using diagrammatic representation in the following manner. Draw a circle and divide it into four equal segments by drawing two lines at right angles to each other passing through the centre. (See Fig. 9.11).

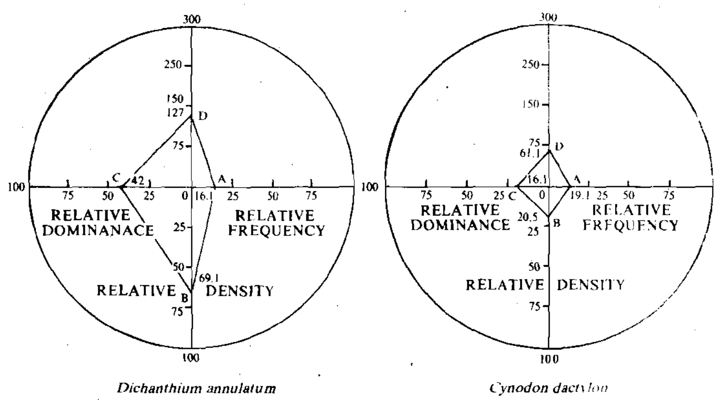


Fig. 9.11 : Polygraphic method of showing sociological characters of individual species (after Ambashth, R.S., 1986).

Each of the three radii is divided into 100 parts from the centre to the circumference and the fourth into 300. On the 0-100 scales are marked the values of relative frequency on A, relative density on B, relative dominance on C, and the IVI value as the 0-300 scale on D. All these points are joined as shown in the figure. Such illustrations help to appreciate sociological features and IVI of a species at a glance.

The IVI as such, gives the composite picture of sociological status of a species in a community but it does not provide an idea of relative values of frequency, density and dominance.

9.5.7 Species Diversity

It is one of the most important and basic characteristics of a community. There are various ways of measuring species diversity, the simplest is to enumerate the number of species present in a given area. This is relatively easy to achieve for plants, and large or sedentary animals but it is generally difficult to enumerate the various insect species accurately. For large areas such as forests, islands etc., it may take many years to prepare a reasonable estimate of species numbers. Assessment of species diversity on the basis of species list is not fully satisfactory because drawing of an exhaustive and accurate species list is often an involved exercise. And, unless an elaborate exercise is undertaken there is a good possibility that a number of species may be left out. Since so many species in a sample are likely to be rare, we should not ignore this fact while measuring diversity. For example, compare two imaginary samples of

100 individuals each with two species A and B. The details of number of species of each sample are given in Table 9.1.

Table 9.1 : Number of Species in Two Sampling Units

Sample	Number of Species	
	A	B
I	50	50
II	99	1

In sample I there are 50 individuals of A and 50 individuals of B, but in sample II there are 99 A and 1 B. Is the diversity of these two samples really same? If we choose to measure diversity as the numbers of species present in each sample then the answer is yes, but most ecologists would consider the community with 50A and 50B to be more diverse than the one with 99A and 1B. Let us see how.

To determine species diversity, the most widely used index is Shannon's Index of Diversity (H') and it is calculate as below :

$$H' = -\sum_{i=1}^{i=S} p_i \log_e p_i$$

H' = Index of species diversity

S = Number of species

p = Proportion of the total sample belonging to the *i*th species (in rank), which is calculated by dividing the number of individuals in species *i* by the total number of individuals in the sample.

e = base of natural logarithms ($\log_e p_i = 2.302 \times \log_{10} p_i$)

(Remember that $\sum_{i=1}^{i=S}$ means that — add up the following expression, for values of *i* from i = 1 to *i* = *S*).

The larger the value of H', the greater the uncertainity about predicting the next species to be encountered and so the greater the diversity. Let us now compare the two samples I and II, each of 100 individuals, and see whether sample I has higher index of diversity H' or sample II?

Sample I :

$$\begin{aligned} H' &= -[(0.50 \times \log_e 0.50) + (0.50 \times \log_e 0.50)] \\ &= -[2\,(0.50 \times -0.69)] \\ &= 0.69 \end{aligned}$$

Sample II :

$$\begin{aligned} H' &= -[(0.99 \times \log_e 0.99) + (0.01 - \log_e 0.01)] \\ &= -[(0.99 \times -0.01) + (0.01 \times -4.61)] \\ &= -[(-0.01) + (-0.05)] \\ &= 0.06 \end{aligned}$$

Sample I has the higher index of diversity.

SAQ 3

What information does each of the following synthetic character give?

i) Presence and constancy

....

....

ii) Fidelity

....

....

iii) **Dominance**

....

....

iv) **Physiognomy and pattern**

....

....

v) **Frequency**

....

....

vi) **Importance Value Index**

....

....

vii) **Species diversity**

....

....

9.6 SUMMARY

In this unit you have learnt some aspects of nature and structure of community. So far you have learnt that :

- Communities are made up of populations of organisms, occupying and interacting in a given area. They constitute the biotic component of ecosystems.
- Communities have several group characteristics which are not exhibited by either its individuals or populations.
- The size of community may vary. Just like an ecosystem, a bigger community too may be sub-divided into smaller communities.
- Based on the source of energy, a community may be autotrophic or heterotrophic.
- Rarely, can different communities be sharply delimited, because they blend together to form a continuum along some environmental gradient. Sometimes, because of severe environmental disturbance(s), sharp boundaries between the communities can be seen.
- The area where two communities blend is an ecotone. This zone has a high species richness. It not only supports the species of the adjoining two communities, but also a few species found exclusively in this zone.
- To get a complete picture of a community, a study of its analytic and synthetic characters is necessary.
- Qualitative analytic characters include : floristic composition — kinds of species occurring in a community; stratification — layering of vegetation, that influences the nature and distribution of animal life; periodicity — periodic changes in a community in a year; vitality and vigour — the rate and amount of growth; life form — the location of perennating tissue in plants; sociability — nature of grouping of plants.
- Quantitative analytic characters include : Population density — the number of individuals of a species within a unit area; Cover-area of ground covered by the above-ground plant parts (herbage cover), and the area of ground actually covered by stem (basal area); height of plants; weight of plants — measured as biomass.
- The synthetic characters are : presence and constancy — the uniformity with which a species occurs in different stands in a community; fidelity — egree to which a species is restricted in a particular community; dominance — the ecological success of species in a community, and influencing the occurrence of other species in the

community; physiognomy and pattern — the general appearance of vegetation based on a number of qualitative and quantitative characters; frequency — the degree of dispersion of species in an area; Inportance Value Index — complete picture of sociological structure of a species in a community; species diversity — number and kind of species in a community.

9.7 TERMINAL QUESTIONS

1) Comment on the following statement :
"Community is an association of interacting populations."

....

....

....

....

....

....

2) Fill in the blank spaces with appropriate words :

a) The area where two adjacent communities blend is an ....

b) A .... refers to an area of vegetation having species of same kind and age.

c) In situations where there is a wide range of environmental conditions at the junction of two communities .... is seen.

d) The .... concept implies that there is no distinct community with well defined boundaries, but there is a gradual change in space and time, along some environmental gradient.

e) .... have four or five layers of vegetation and .... have two layers.

f) .... of plant species in a community can be made only after we have the complete calendar of events of their life history.

g) .... plants have high fidelity and occur in a particular type of community only.

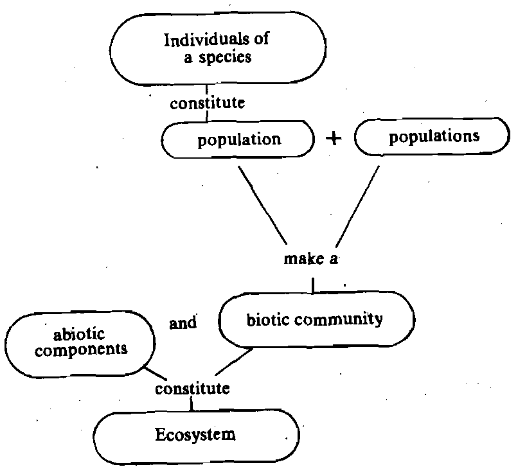
h) For determining the Importance Value Index of species, data of relative ...., ..., and .... is required.

9.8 ANSWERS

SAQ I

1) i) b

ii)



iii) a) represents biotic components of an ecosystem
b) consists of organisms with interlocking food chains
c) may vary in size
d) concept can be applied to any scale
e) may be autotrophic or heterotrophic
f) may consist of stand(s)

2) i) species of a community
ii) different layers of vegetations, and dependent animal life
iii) changes in vegetation in a year
iv) rate and amount of growth
v) kind of vegetation based on the position of perennating bud
vi) nature of grouping of plants
vii) the numerical strength of species in an area
viii) area of ground, and above ground regions covered by plants
ix) tells about the suitability of plants to its environment
x) total biomass of vegetation.

3) i) how uniformly a species occurs in a community
ii) to what degree a species is restricted to a community
iii) the predominant influence of one or more species in a community
iv) the general appearance and kind of distribution of organisms in a community
v) the degree of dispersion of individual species in an area
vi) total picture of the ecological importance of a species
vii) the number and kinds of species in a community.

Terminal Questions

1) **Hint :** Community is an assemblage of populations of various kinds of organisms in a prescribed area. Community is the biotic component of an ecosystem. And in an ecosystem, the various kinds of organisms are related in terms of food and they form a food web. So the populations interact with each other directly or indirectly not any for food, but also influence the existence of other populations.

2) a) ecotone
b) stand
c) edge effect
d) continuum
e) forests, grasslands
f) phenograms
g) indicator
h) density, frequency, dominance