CHAPTER - VII
B) ECOLOGICAL PARAMETERS

Ecologists have often used the term 'habitat' in general as well as in a more limited sense (Weaver and Clements, 1938; Odum 1971). In the present work the term has generally been used to indicate the kind of places in which the liverwort lives. Thus, the heterogenous collection of liverwort from varied substrates and localities is classified artificially for the sake of convenience into two synhabitats viz; (A) Terrestrial and (B) Aquatic. Terrestrial habitat is divided into habitats like epilithic and non-epilithic (Tewari and Pant, 1994).

Liverworts growing on the semi-rocky surface are called 'epilithic' bryophytes (Kalgaonkar, 1990). Liverworts differ very much in the range of conditions under which they live. There are few wide-ranging species found in a great variety of habitats and in all kinds of situations, extending from rocks, semirocks, stone and soil. In Panhala varied habitats are found for liverworts because of their diverse mircoclimate and the variety of substrata available for them. All of these are influenced by the relative humidity and by the physical and chemical characters of substrata (Richards, 1954).

Unlike most of the higher plants liverworts are not found as single individuals but in group of individuals which have characteristic feature depending on their family, genus or species. These features enable the experienced bryologist to identify many genera and often even species from quite a distance.

In rainy season water runs off and concentrates in the crevices. These crevices and different types of substrates support many types of liverworts. According to Tewari and Pant (loc. cit.) liverworts like *Asterella wallichiana, Cyathodium tuberosum* and *Plagiochasma appendiculatum* found in between the gaps of the cementing material of the stone walls. According to Scott (1982), bryophytes flourish well in the crevices where shade and moisture may be more frequently available. In Panhala liverworts like *Plagiochasma* spp., *Asterella angusta* and *Targionia hypophylla* are found in the same habitats.

Bryophytes are growing at uppermost soil surface and are particularly sensitive to microenvironmental changes. From recent studies on epilithic communities between microenvironmental and microclimatic factors it is observed that microtopography does not affect the distribution of bryophyte directly but the micrometerology and the chemical nature of substrate as affected by the microtopography as are found to be controlling factors (Smith, 1982).

The ecology of aquatic bryophyta has been little studied. According to H. Fuchsig, Tewari and Pant (loc. cit) also located floating species of *Riccia*, *R. fluitans* near shallower margins of the lakes of Kumaun Himalaya. According to Richards (1932) aquatic bryophytes are affected by light, temperature and pH in much the same way as terrestrial one.

According to Tewari and Pant (loc. cit.) it is found that during rainy season few thalli of *R. frostii* and *R. crystallina* flourish well on non-irrigated soils as well as on foot-paths.

Targionia hypophylla is found to be well known humus loving bryophyte (Tewari and Pant, loc. cit). In Panhala *T. hypophylla* also grows on humus enriched substrate. Not only it loves humus but also loves more humidity.

There are very few bryophytes which also grow in caves. The best known out of those is *Cyathodium cavernarum* (Richards loc. cit). The habitat of *Cyathodium tuberosum* is considered to be congested niche, because of occurrence of it along the wet rocky edges in the interior of caves. The *C. tuberosum* is also collected from the cave where the light intensity is 2 mW/Cm^2 and shade was deep. Humidity and moisture content in this cave is found to be 42% and 28.5% respectively. It is well adapted to the shade and moist conditions of caves. The glossy, yellowish green plants with their complanate leaves may facilitate enough light absorption surfaces for effective phytosynthetic activity. This shade adapted feature justify the presence of this genus in a specialised environment of caves.

According to Richards (loc. cit) the CO_2 concentration in caves in considerably higher than in the atmosphere. Due to presence of high CO_2 concentration light becomes the limiting factor for assimilation in *Cyathodium tuberosum.* The low light intensity is probably partly compensated by high CO_2 concentration (McLean, 1919). It also flourishes well in the exposed sheltered areas (Gopaltirth bag) where also high intensity is found to be less (8 mW/Cm^2) which requires more humidity and moisture. Cannon, 1914 found *plagiochasma* Spp. living in the arid regions. All the three species of *Plagiochasma* are found to be epilithic growing on exposed cemented cracks of the walls. In the rainy season, humidity ranges from 39 to 44%. But the organic matter percentage where *P. articulatum* grows found to be exceedingly high. As far as moisture content is concerned it is also considered to be high. An interesting observation is that although the rainy season is over, at the sporophytic stage *Plagiochasma* spp. were found to be under drought conditions. It may be because of the great drought resisting powers these have adapted. This has been discussed earlier also. Habitat *of P.*

articulatum shows presence of high organic matter (38%) and higher moisture content.

On the Nursery wall *Asterella angusta* is found to be flourishing exceptionally well, closely associated with pteridophytes viz., *Selaginella* spp., *Adiantum* spp., *Cheilanthes* spp. and *Pteris* spp. occupying large areas. The microenvironment in that area may be the reason for this. According to Tewari and Pant (loc. cit) the soil covered substrate and boulders is considered as an ideal harbour for diversified assemblage of liverworts especially *Asterella* spp. The habitat located at Panhala is found to be completely covered by the soil. The microenvironment present indicates the habitat specificity.

Range of *Fossombronia himalayensis* is narrow with restricted distribution, indicates it's rare occurance. It is found in humid areas where moisture content is moderate (22.8%). It might be requiring specific habitat. Koponen (1982) suggests that the accurate habitat and ecological data is a great help in the routine identification of bryophyte specimens.

It is a well established fact that bryophytes grows exclusively on certain habitats such as rock, soil or humus under appropriate conditions of moisture, exposure and hydrogen ion concentration (Crum, 1972).

As useful pioneer attempts regarding the ecological parameters must be mentioned by the work of Amann (1928); Schade (1912) on the temperature factor; Toda (1918) on the light factor and Allorge, Oleson et.al. on hydrogen ion concentration. The zonation of life forms on a partly shaded wall could be related to humidity and light intensity (Gimingham and Birse, 1957). Except under controlled conditions, it is hardly possible for the light intensity to vary without changing the rate of evaporation. It is therefore a little use to discuss the ecological effect of light on liverworts unless the other conditions are also known. The statements regarding the shade loving or light loving are drawn only on the basis of light intensity measured in the field. Light plays an important role in photosynthesis. Generally the liverworts described are found to be shade and moist loving than higher plants, where light becomes a limiting factor. To compensate they develop adapted features to that specialised environment. The cells of the upper epidermis of *Cryptomitrium himalayensis* and *Cyathodium tuberosum* are mainly composed of light reflecting 'lens" cells markedly distended on their lower side, enabling them to catch the last limit of light (Tewari and Pant loc. cit). Regarding the adaptation of *C. tuberosum* for the compensation of light has already been discussed above.

Hepatics are found to be fairly good indicators of humidity and soil quantity (A.H. Brinkman, 1929). According to Udar (1976) in the Himalayas, South India and Ceylon there are vast areas rich in hepatics. The largest number of species being found in territories with abundant rains and high humidity. The humidity is found to be an essential and important factor for the growth of the liverworts from Panhala.

For each species there is a range of pH to which it will tolerate under natural conditions and also an optimum pH which vary with other factors. According to Tewari and Pant (loc. cit) substrate pH is clearly basic ranging from 7.6-7.9 at the places where gypsum get accumulated in the soil. Substrate pH from 7.3-7.6 is also observed in the substrate containing Ca, Mg and Fe. Steere (1976) has emphasized the importance of pH in that habitat is clearly influenced in the distribution of bryophytes. The distribution of bryophytes in relation to pH of the soil has also been discussed by Amann (1918). The pH of the substrate of the liverworts from Panhala is also found alkaline. Tewari and Pant (loc.cit) have found that in Kumaun Himalaya 22 species of bryophytes were seen to be flourishing well in a highly entrophic calcarious substrate of pH 8.0 - 9.1 suggesting a calcicole nature of substrate.

As the mineral contents of the substrates are still unknown it is very much difficult to justify the basic nature of the substrates from Panhala.

Electrical conductivity is a measure of soluble ionized salts present in the sample. It denotes the capacity of a substrate to conduct the electric current. For the analysis of substrate characteristics the EC is most important parameter. It is found that substrates of the liverworts show variations in their ionic strength. Out of 10 liverworts majority of them shows high EC (10.80 - 26.60 mMhos/cm) while few of them shows low EC (0.30 - 8.01 mMhos/ cm). In case of aquatic *Riccia, R. fluitans*, the EC of water is 6.80 mMhos/ Cm^2 while that of muddy substrate is 20.40 mMhos/ cm which is higher. If shows that muddy substrate has more ionic strength as compared to the water.

Humus is also found to be essential factor for the growth of bryophytes (Verdoorn, 1932). Grebe (1918) has pointed that many mosses usually set to grow on rocks or soil really always grow on humus. *Bryum capillare*, which is often supposed to be different to the nature of the substratum, always grown on a layer of humus (Richards, loc. cit). Dabhade (1998) has also showed the affinity of some mosses humus-rich soil. From our observations it is found that liverworts also loves humus-rich soil substrates for their growth.

The terrestrial bryophyta having no roots, one more dependent that higher plants on atmospheric moisture and seen to be more sensitive to the saturation deficit, the wind velocity and other factors affecting the rate of evaporation of their habit. Owing to their power of absorbing water from a saturated atmosphere and of holding large amount of it by capillarity, they have important reactions on the habitat (Richards, loc. cit). Many bryophyta have narrowly and sharply defined water requirements.

According to Smith (loc. cit.) aggregation of bryophyte shoots into colonies may substantially enhance capillary uptake and retention externally hold water and thus, indirectly affect the internal water content of the plants. Gimingham and Smith (1971) were able to demonstrate that the most widespread life-form types differ in their degree of influence on water relations in a manner corresponding with their habitat preferences. Thus, small compact cushions from dry habitats showed the greatest effect of life form in reducing evaporation rates. Possibly because of these reasons liverworts of Panhala might be showing colonial life form to maintain the moisture which is badly required for their growth.

From this discussion, it is worth emphasizing that ecological range of a species observed in nature is determined by competition with the others as well as by the physical and chemical factors of the habitat.