mals than the presence of distinctive ones, and the restricted variety would make it difficult to construct a firm classification of habitats—if this is desirable.

The most important point that emerges is that little progress can be made with ecological work until the composition of the New Zealand fauna is better known. For instance, of the 30 orders of cryptozoic animals we know little of 22, including such important groups as mites, spiders, false scorpions, beetles and millipedes. Until the basic taxonomic work is attacked I feel that no major advances will be made in the detailed study of terrestrial ecology in New Zealand.

The Classification of Fresh-water Habitats

K. Radway Allen

Habitats are places where animals live; their essential characteristics are therefore those which enable the animals to survive, grow and breed there. These characteristics may be either positive or negative. The positive ones are those which provide some essential requirement; the negative ones are those which denote the absence of some condition which would make it impossible for the animal to survive.

The outstanding characteristic of fresh-water habitats, when compared with terrestrial ones, is the far greater basic significance of the physico-chemical conditions. While these are of great importance to a land animal, they are largely the result of the biotic conditions, particularly the vegetation, among which it is living. In the water, the relation is very different; the physico-chemical factors are the result of the topographic and geological structure of the locality and are virtually uninfluenced by vegetation or other biotic features. The physico-chemical factors therefore provide a much better basis for habitat classification in water than they do on land.

A factor of great biological importance is water movement. This may vary in intensity from virtual absence to great violence, and may be unidirectional and more or less constant, or variable both in direction and in intensity. It has both harmful and beneficial effects on animals—harmful when it tends to detach a bottom-living animal and carry it seaward—beneficial when it brings to an animal such requirements as food. In habitats where movement is continuous, the animals must be able to resist it but may or may not be dependent on it; where movement is intermittent, dependent animals are excluded. Thus, among the movement-resistant animals are forms which are found impartially in places of continuous and of intermittent movement, and others only in place of continuous movement.

Temperature is another factor which must be considered more directly in dealing with aquatic than with terrestrial habitats, since it is less completely dependent on the local climate. For instance, cold and warm springs may provide temperature conditions entirely different from those on the surrounding land, or even in adjacent waters more subject to direct climatic influence. Such localities provide a habitat for many animals which are unable to survive in other waters of the same region which are more directly subject to climatic control.

On land, oxygen supply is rarely, if ever, a problem, but in fresh water there are many localities where the amount of oxygen available is extremely limited, either permanently or seasonally. Some aquatic animals possess devices which enable them to survive under these conditions. Animals without such devices cannot survive where oxygen is not plentiful and thus we can arrange habitats in a series with decreasing oxygen concentrations.

Other chemical factors may also be of significance to aquatic animals and call for consideration if the habitats of some species are to be fully understood.

The substratum is important to aquatic animals in many ways. For bottom-living

forms it must provide the right kind of surface; burrowers, for instance, need a fairly soft and fine substratum; animals living in moving water need a firm surface to which to attach themselves, and some require also crevices or other recesses in which they can take shelter.

The biotic features of a habitat are complex and less easily understood than the physico-chemical ones. Obviously the right kind of food must be available in adequate quantity. Many animals require different foods at different stages in their lives, and in their habitats all must be available to them at the appropriate times. Negative biotic characters include predation and inter-specific competition. These must obviously not exceed certain critical limits if a species is to survive. Inter-specific competition seems to play an important part in limiting the habitat range of species which are adapted to withstand unfavourable environmental factors such as water movement.

Although size of the water-body has been suggested as a basic criterion in classifying freshwater habitats, the chief effect of increasing size is to increase the variety of habitats which can occur in the body of water.

The purpose of this paper is to urge that any scheme for the classification of freshwater habitats should be based on the environmental factors which are of the greatest direct influence on the animals concerned. These factors include water movement, temperature, oxygen concentration, pH, substratum and food supply.

Marine Environments

R. K. Dell

The idea behind this symposium stems from a general paper by Elton and Miller on the ecological survey of animal communities in which a practical scheme for classifying habitats by structural characters is discussed. In this paper outline classifications are given for terrestial and freshwater habitats and it is inferred that a classification of marine habitats based upon the same principles could easily be built up. It is my task in this symposium to attempt to stimulate discussion upon the possibilities of evolving a scheme of classification for marine habitats that will be acceptable to all ecologists.

The difficulties arise from the qualification—"acceptable to all ecologists."

We all know the difficulties involved in drawing up any ecological scheme that involves definition, and of course a habitat classification is one long definition. Part of the difficulty arises because working ecologists often mix two aspects of the study. We all try to be descriptive and interpretative at the same time. Interpretations of data are as varied as are the workers in the field and it is because descriptive schemes do not fit the varied interpretations that much of the criticism is levelled at them.

Habitat classification must fit into place with biogeographical classification. There is perhaps no need to stress this aspect but mention should be made that there are at least four major types of habitat in the sea whose biogeographical classifications are largely independent:—

1. *Littoral* in the wide sense, forms confined to coasts and shallow water habitats where the classification is based on coastlines and shallow water areas.
2. *Deep Sea Benthos,* forms confined to the deep water basins of the world.
3. *Pelagic forms,* classification based largely on water masses.
4. *Bathypelagic forms.*

Broad biogeographical subdivisions of these four habitat types are fairly well accepted and Ekman's book deals mostly with the subdivision of these types. The habitat classification as sketched by Elton and Mil-