Facets of Ecology

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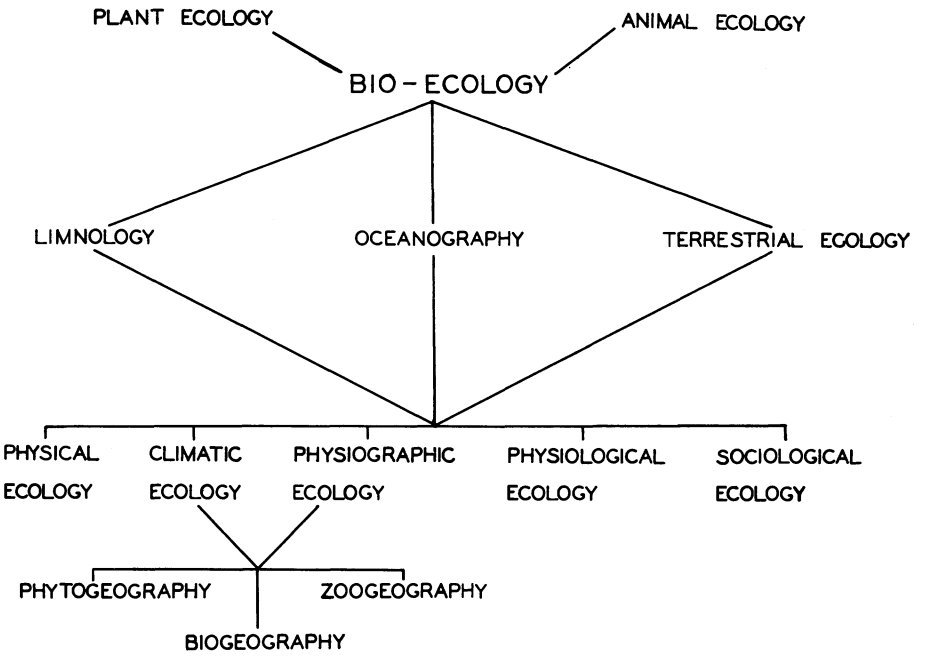
Ecology has been defined as the science of communities (Shelford 1930). Some biologists believe it is more a point of view than it is a separate science. In either case, the study of ecology is a broad over-view of the interrelationships of living things with each other and with their external surroundings. The writer has shown in the pages of this journal (Dexter 1945) how the science of ecology forms the very hub of the pure and applied natural sciences. Being so comprehensive in character, embracing the cause and effect relations of natural processes of the living world, it is a hub of many facets.

The modern science ecology first developed as plant ecology under the direction of botanists who became interested in the study of plants living in their natural habitats (Warming 1909). Zoologists soon followed the lead and founded the modern study of animal ecology (Adams 1913), first adopting the general methods of the plant ecologists and later introducing techniques for the specialized study of animal populations. The two main pillars of ecology have remained as separate compartments of study (Weaver and Clements 1938, Pearse 1939) to the present day for the reason that most students of the life sciences are either botanists or zoologists with specialized interests. In recent years an attempt has been made to synthesize the plant and animal aspects of ecology into a unified science of *bio-ecology* (Clements and Shelford 1939). The name bio-ecology might seem redundant, but it serves the purpose of emphasizing the unified character of the science. Biologists in general have not yet developed the concept of ecology as a unit, but rather think of it in terms of the sister sciences of plant and animal ecology. Of course, there is still a place and a need for the development of each as a separate field in the prosecution of specialized research, although it is most desirable to further research and study along lines which integrate the relations of plants and animals living in a common group.

The study of external relationships of a single species or a restricted taxonomic group is *autecology*. This may take the form of such studies as the ecological relations of the burroweed (Humphrey 1937), of the field mouse (Hamilton 1937), as insect ecology (Balduf 1935), or bird ecology (Twomey 1945). In some cases, a portion of an organism may be studied with respect to its environment, in such a specialized science as root ecology (Nedrow 1937). When the whole mass of vegetation or the entire animal population form the basis of the problem, the science is labelled *synecology*. Examples here may be drawn from such works as the survey of animal communities of a particular region (Shelford 1937) or the vegetation of a certain locality (Braun 1942). In its broadest sense, synecology becomes synonomous with bio-ecology (also called general ecology and bionomics). A community study may be made on a large scale, covering an extensive area with a diversity of ecological situations (Davis 1943), or it may involve the inhabitants of micro-habitats, such as treeholes (Lackey 1940). In the final analysis, a com-



plete understanding of ecological phenomena and principles depends upon the viewpoint of bio-ecology inasmuch as all organisms, plants and animals, live in communities (Phillips 1931).

Bio-ecology can be divided into three domains according to the sphere in which the communities exist.

1. The study of fresh water ecology is known as *limnology* (Welch 1935). Many specialities have developed in this field—lake ecology (Hutchinson 1941), river ecology (Butcher 1933), fish ecology (Pearse 1934), *etc.*

2. The study of marine communities and their salt water environments is called *marine ecology,* a phase of *oceanography* (Bigelow 1931; Sverdrup, Johnson and Fleming 1942). Intertidal ecology (Colman 1940), salt marsh ecology (Chapman 1938), subtidal ecology (Kitching 1941) are some of its branches. The latter two provinces (limnology and oceanography) are sometimes spoken of collectively as hydrobiology or aquatic ecology.

3. Land organisms are studied in the name of *terrestrial ecology.* Here again many subdivisions occur. The research may be concerned with a particular type of community such as forest (Williams 1936), grassland (Weaver and Fitzpatrick 1934), or desert (Shreve 1934) ecology. Special situations appear as mountain (Darlington 1943), cave (Ives 1927), or soil ecology (Jacot 1936).

The process of *succession* (i.e., the development of a climax community) has been studied intensively (Clements 1928). Successional communities are dealt with in the name of bog and swamp (Aldrich 1943) or marsh (Penfound and Hathaway 1938) ecology. In some cases a regional point of view may obtain (Dice 1943), such as arctic (Cooper 1942), or tropical (Beard 1944) ecology. Community activities and the behavior of animals at night receive the special title of nocturnal ecology (O. Park 1938). With man as the central theme, we have a new and unexplored field—human ecology (Bews 1935). This phase, however, is practically the same as certain aspects of anthropology on one

hand and of modern geography on the other. Many hold to the opinion that as such the investigation of human ecology should be left in the hands of the social scientists.

Any of the three domains of ecology may be approached from the field of botany or zoology; or an entire community may be viewed from the combined discipline, bio-ecology. Studies of any type of community or interrelationship may be based upon a few selected factors. Thus, the study of the effects of temperature or moisture or of a combination of such factors on organisms or a group of organisms is designated as physical ecology (Sweetman 1938). If the physical factors of the atmosphere are considered together in their influence on plants and animals in determining local and geographical distribution, we are dealing with climatic ecology (Hopkins 1938). Climatic conditions of the geological past as indicated by fossil remains is the new but rapidly developing field of *paleo-ecology* (Cain 1939). Hydroclimatic ecology is concerned with the "climate" or sum total of physical characteristics of aquatic environments and their bearing on water life.

The topographic features of the earth and the physiographic processes in operation thereon bear certain relationships to the distribution of plants and animals as species and as biotic communities. The organisms in turn react upon their physical surroundings. These aspects fall in the category of *physiographic ecology* (Braun 1916). Climatic and physiographic ecology unite in the provinces of *phytogeography* (Cain 1944), *zoogeography* (Hesse, Allee, and Schmidt 1937), and their combination in the new synthesis of *biogeography* (Newbigin 1936) which is the study of the geographical distribution of biotic communities.

Organisms make precise requirements of their environments and are able to adjust themselves within limits to the existing conditions. Temperature, moisture, light intensity, acidity, *etc.*, affect the metabolism and behavior of plants and animals. This adjustment of internal functions to the external conditions is the concern of physiological ecology (Odum 1941). A recent development and extension of this field is known as biogeochemistry (Hutchinson 1943).

Relationships between living things are defined as *coactions*. This phase of ecological science is sociological ecology. Here are studied community organization (Clements 1936), food chains and food cycles (trophic ecology—Lindeman 1942), aggregations and mass physiology (Allee 1931), parasitism (Clausen 1936), disease transmission (Leach 1940), symbiosis (Cleveland 1926), and peck dominance and peck right (Bennett 1939). Comparative ecology aims to show similarities of structures and processes in related communities and their environments (Brown 1931). Experimental ecology brings the field problems into the laboratory for detailed analysis under controlled conditions (T. Park 1937), or devises simple field experiments for testing cause and effect relationship under natural conditions (Hiesey 1940). Conservation is in essence applied ecology (Hanson 1939). This phase was discussed in the writer's earlier article.

Any field study demands precise sampling. Some studies are concerned chiefly with sampling techniques and their interpretation (quantitative ecology—Ashby 1936). *The Ecological Society of America* has a special committee which is studying quantitative ecology. One aspect of this of economic importance is the study of the dynamics of animal populations (Errington 1945).

Often an investigation may be a com-

bination of any two or more of the facets mentioned here. There are no sharp boundaries between related angles; there is, in fact, overlapping throughout. A question in one field may find its answer in another. Thus, climatic differences associated with a change of physiographic type may explain the phytogeographic pattern of a region, and through experimental analysis a given physical factor may be singled out to be the controlling one according to Leibig's law of the minimum. Or again, the decline of a population may depend upon an increase of its enemies through successful reproduction brought about by favorable environmental circumstances during the breeding season coupled with increased fecundity. Ecologists include representatives from nearly every other branch of biology. Every biologist interested in an organism as an entity is an ecologist of a kind. Most ecologists have a special interest in some other field of biology such as entomology, ornithology, or algology. Sometimes a study defies classification in any recognized branch of ecology; sometimes a new facet is added to this new, expanding field of ecology.

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Biology and Conservation Education

A Contribution to the Conservation Program from the Administrator's Viewpoint*

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Although I have dabbled in the teaching of college classes, Sunday School classes, Boy Scout troops, 4-H club groups and others, I do not assume to come before this group as an educator or even a trained teacher. I speak merely as a present administrator of conservation affairs, and as one who has spent a good many years trying to get done the practical job of conservation of some of our natural resources. A great deal of that effort has been in connection with the forest and wildlife resources. Regardless of some of the common conceptions of those fields, especially wildlife, we are coming to know that conservation of these resources is identical with conservation of all other resources. It is only fair to state that my viewpoint here centers around the management phase of wild forms.

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