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Special Lecture

SOME ECOLOGICAL CONCEPTS

by R. V. SESHIAH, F.N.A., *Retired Director, U.G.C. Advanced Centre for Marine Biology, Porto-Novo*

Ecology has shown increasing adoption of conceptual approach. Ecology had its origin in old natural history and subsequently developed into scientific natural history. The emphasis in this was on the individual organism, and it came to be known as autoecology. Elton's work (1933) shifted the emphasis from the individual organism to populations. It is necessarily involved quantification—the adoption of statistical and mathematical procedures. Ecology now came to be known as synecology. The concept of ecosystem was first recognized by Tansley, and ecosystem came to be regarded as the functional unit in ecology. Ecology is the biology of ecosystems. Margalef has shown that the cybernetic model and information theory can be applied in ecological studies. The development of rigorous conceptual framework is a measure of the maturity of a scientific discipline. Ecology is now a scientific discipline in its own right.

The first step in science is observation and collection of facts or data. Facts are not an end in themselves ; they are only the bricks for the construction of concepts and models. It is the union of the empirical and conceptual [the analogies of experience as Kant (1881) said] that constitute science. Highly developed branches of science, such as Physics, have achieved considerable rigour in the construction of conceptual framework models. Biology is still concerned to a large extent with collecting facts. It is in fact overloaded with facts. However, the Mendelian hypothesis and the gene concept, the evolutionary hypothesis and the concept of Natural Selection illustrate remarkable achievements in biology through the conceptual approach. A field of biology which is basically conceptual and shows increasing adoption of the conceptual approach is ecology. Ecology is a comparatively young branch of biology as till recently there have been "as many definitions as there are ecologists". Today there is a generally accepted definition of ecology as the study of the interaction between organisms and environment. Environment is everything that is not an intrinsic part of the organisms and includes living as well as non-living components. This definition, it may be observed, is an expression in general or abstract terms, and accordingly rather conceptual.

The history of ecology is in a sense the development of concepts. The origins of ecology are traceable to the old natural history. Great naturalists like Charles Darwin had remarkable insight into ecological principles. It may be observed that marine biology is intrinsically ecological. In dealing with associations of organisms, marine biology emphasizes ecological grouping rather

than phylogenetic classification. Phytoplankton, zooplankton, pelagic and littoral organisms, benthos, are ecological concepts.

During the early part of the present century, ecology remained as natural history. Subsequently it developed into what was termed scientific natural history. These ecological studies were concerned chiefly with recording of occurrences of organisms, their habits and distribution, and sometimes the conjectured relationship to some of the environmental factors. Scientific natural history provided valuable information relating to food relations of organisms, microclimates, limits of tolerance of some of the environmental factors. The emphasis, however, was entirely on the individual organism and this approach came to be known as autoecology. Experimental analysis of a few of the environmental factors and their influence on the organisms are included in autoecological work. But there is little qualification. The concept of autoecology is essentially qualitative.

A new era in ecology was ushered by Elton, when he shifted the emphasis of ecological investigations from the individual organism to the population. Emphasis on populations necessarily involved quantification. At first this was mostly taking census of populations, recording relative abundance of species. Later other concepts were developed such as biomass, population structure, regulation of members, predator-prey relationships ecological efficiency, population efficiency, diversity indices and succession. These concepts required statistical and mathematical treatment. In fact, no other branch of biology has seen such increasing application of 'constructive' mathematics as ecology. Studies of population growth, migrations and epidemics stochastic models are involved. Investigations in population ecology, synecology as it came to be known, have been conducted on natural populations as well as laboratory populations. The principles of population ecology have found fruitful application in fishery biology.

For investigations in synecology, single or at the most two species populations and analysis of only a very limited number of factors are convenient and manageable. But in nature we meet with communities of organisms and intricate interactions with a network of environmental factors. The recognition of this situation stimulated the development of a new concept, the concept of the ecosystem. This term was coined by Tansley (1938). It implies a holistic or 'systems' thinking. In this concept, it is not only the influence of the environment on the community that is taken into account, but also the influence of the organisms on the environment. The two components, organism and community evolve together and form a single system. Thus the emphasis in ecological investigations shifted from population to the ecosystem. Ecosystem is now regarded as the functional unit in ecology. The aim of ecological studies has come to be the understanding of what goes on in the ecosystem. This knowledge helps us to anticipate or predict the outcome of changes in the ecosystem, as for example, when new organisms are introduced into an environment with ecosystem as the functional unit, several component aspects can be investigated such as energy flow, plant nutrients and their recycling competition, succession, self-regulation or homeostasis of the ecosystem, stability and maturity

of the ecosystem. It is the whole ecosystem this is studied into which all components, spatial as well as temporal, are integrated.

With this historic concept, ecology has become a study of system in which the elements are organisms which interact among themselves and with environmental factors in space and time. In a system the state of any one element affects and is affected by the state of every other element. Ecology is now the biology of ecosystems.

The understanding of the whole in terms of the relationship of the parts requires sophisticated intellectual tools. Margalef (1968) has shown the cybernetic model and information theory can find an illuminating application in ecology. In a cybernetic system elements linked by reciprocal influences constitute a feedback loop.

This system's approach excludes from ecology, much of physiology, behaviour and geographical distribution, which aspects were included in the old ecology.

The cybernetic approach opens new perspectives in ecology. Margalef has interpreted in terms of information theory several aspects of ecology such as competition, niches, diversity, succession and evolution and ecological organization.

From the brief survey of the development of concepts in ecology, it will be seen that ecology is a scientific discipline in its own right. The development of rigorous conceptual framework is a measure of the maturity of a scientific discipline.

In conclusion, I exhort my young friends to adopt quantitative and conceptual approach in their ecological investigations. Intertidal ecology offers excellent opportunities for this, and I hope you will explore new paths in dynamic intertidal ecology.

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