The Structure and Dynamics of Cone Spring

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THE STRUCTURE AND DYNAMICS OF CONE SPRING[1]

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TABLE OF CONTENTS

INTRODUCTION

"Ecosystems" are unit ecological systems comprised of organisms interacting within their particular environments, cycling matter and transforming and

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degrading energy (Odum, 1959). Communities are the biotic components of ecosystems (Macfadyen, 1963) and are in turn comprised of ". . . populations coexisting in time and space, mutually regulative and interdependent, and depending ultimately upon some common energy source" (Engelmann, 1961).

The ecological analysis of ecosystems has recently occupied the attention of a number of workers (Hairston & Byers, 1954; Odum, 1957; Teal, 1957, 1962; Englemann, 1961; MacArthur, 1957). Most of these studies may be categorized as being either "structural" or "functional" in their approach.

Traditionally and practically, the two approaches to community study have remained separate, but gradually a body of theory has emerged which permits and demands unification of the two points of view. For example, Hairston, Smith & Slobodkin (1960) and Hairston (1964) have advanced a series of generalizations relating community organization to energy flow and competition. They propose that most if not all aspects of (terrestrial) community organization are a consequence of the fundamental energy limitation of the biosphere and, further, deduce from available evidence that the abundance levels maintained among the member species of terrestrial communities are determined largely by food chain considerations in which herbivores are predator limited.

MacArthur (1957) has suggested a series of biologically based mathematical models describing the organization of the community in terms of possible arrangements of niches (Hutchinson, 1957). MacArthur's models require that all the species of a community be included in an analysis.

Structural approaches in general require that as much as possible be known about the relationship between numbers of species, numbers of individuals and patterns of dispersion. Functional studies require metabolic information. It is essential, therefore, in order to test or formulate hypothesis about the functional and structural organization of communities to collect a body of data including both kinds of information about all the species found in one community. Hairston (1959), in stressing the importance of measuring relative species abundance in studies of community structure, remarks ". . . there is no justification other than convenience for omitting any species from an analysis of a community."

The purpose of the present study, therefore, was to keep sight of species while combining features of both the structural and functional approaches to secure data for use in the analysis of a simple community.

The suitability of springs as objects of ecological study has been discussed by Teal (1957) and Odum (1957), both of whom worked with relatively constant temperature systems to develop pictures of community metabolism.

Because of its small size, discrete character and promise of providing relatively constant physical and chemical conditions, an isolated and unnamed cold spring near Conesville, Iowa, was selected as the site for study during the interval from July, 1961 through December, 1964 and named for purposes of this study "Cone Spring." A description of the conditions characteristic of this ecosystem follows in a later section.

MATERIALS AND PROCEDURES

Physical and Chemical Factors

Bimonthly or weekly measurements were made of dissolved oxygen, pH, CO_2, total alkalinity, water and air temperatures, rate of discharge and export of particulate organic matter. Measurements of other chemical factors, (notably ortho-phosphate and nitrate nitrogen) were made with sufficient frequency to estimate seasonal levels.

Except for measurements of discharge and particulate organic matter all procedures were conventional ones as outlined by Welch (1948) or "Standard Methods" (APHA, 1960). All determinations were made in the field when practicable or completed at the laboratory within several hours of the time of collection.

The rate of discharge was measured directly by collecting the entire outflow of the spring in a calibrated pan and determining the time necessary to secure ten liters. The outflow could be collected because a plywood and aluminum flume had been constructed at the point where the spring basin narrowed to become a brook. The flume did not alter the flow gradient within the spring basin since it was placed at the original grade level and only the stream bed immediately downstream was excavated to permit insertion of the collecting pan below the flume.

Particulate organic matter in the outflow collected was measured by the method of Pennak (1949) using a Sharples Model T1 continuous flow centrifuge at 35-50,000 rpm. No correction was necessary for loss of carbonates since none were present.

Biotic Sampling

Starting in October, 1962, and continuing at about 5-day intervals during the study period, core samples were removed from randomly-selected sites in the spring basin. The corer used was a rectangular sheet metal box having open square ends 5 cm on a side. Since the water was shallow and the substratum sandy, it was possible to enclose and remove a complete vertical section of the habitat with this device. The cores were usually 15 cm and never less than 5 cm long. Earlier tests had shown that none of the organisms with which this study is concerned were found at depths greater than 5 cm below the surface of the sand.

Cores were extruded into plastic boxes, covered with strained spring water and transported in insulated containers to the laboratory. In the laboratory sample boxes were held at spring temperature until within a day extraction procedures were begun.

Removal of macroscopic organisms from the sample units involved screening, elutriation and hand