EPIZOOTIC ECOLOGY IN THE TRAINING PROGRAM OF THE VECTOR-BORNE DISEASE SECTION

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SUMMARY

To fulfill the primary objective of the Vector-Borne Disease Section of NCDC - to reduce the incidence of vector-borne diseases - a series of courses on vertebrates and arthropods and their role as reservoirs, vectors, and disease-causing agents is presented. Literature is prepared and a museum is maintained. One of these courses, Epizootic Ecology, illustrates some of the aspects dealt with in these courses. Definitions and concepts are presented followed by a brief review of principles of epidemiology and ecology. Specific examples constitute the bulk of the course. One of these, tularemia, is especially useful for the purposes of this course in that it occurs in many nidal centers throughout the world, each nidus having different hosts, vectors, and cycles in nature, which affect man differently. The course concludes with a classroom discussion dealing with ecologically oriented control measures.

PART 1: The Total Program

The program of the Vector-Borne Disease Section, Training Program, National Communicable Disease Center, consists mainly of presenting courses, publishing and distributing literature, operating a museum and a diagnostic reference service, providing individual training in vector-borne diseases and disease vectors, and operating a special service which is called "instant training."

During the past three years, courses on 27 different subjects have been presented. These may be divided into four categories, namely; (1) taxonomy, (2) those dealing with rodent and arthropod-borne diseases, (3) those concerned with individual diseases, and (4) those which emphasize ecology and epidemiology. The basic taxonomic course is "Identification and Biology of Arthropods of Public Health Importance." It is of two weeks duration. The two 2-week courses, "Rodent-Borne Diseases" and "Arthropod-Borne Diseases" are the basic ones in the second group. Two other courses in this series are "Mosquito-Borne Diseases" and "Tick-Borne Diseases." Specific vector-associated and zoonotic diseases are presented as separate courses or as lectures in other courses. The individual disease courses include arthropod-borne encephalitis, spotted fever, tularemia, plague, leptospirosis, relapsing fever, rat bite and rat bite fevers, American trypanosomiasis, malaria, myiasis, and envenomation. "Epidemiology of Vector-Borne Diseases," "Techniques for Investigation of Vector-Borne Diseases," and "Epizootic Ecology" are those in which ecology and epidemiology are particularly emphasized.

The literature produced by the Vector-Borne Disease Section provides substantial support for the lecture material given in courses. These publications are given wide distribution to institutions and government agencies throughout the world. First in importance in the literature are pictorial keys. Their primary purpose is for use in teaching the identification of arthropods and other pests. Nearly all specimens that have immediate public health importance in the United States can be identified with the aid of these pictorial keys.

The arthropod-borne-disease manual, a series of 15 chapters, was developed to characterize the major taxonomic groups -- spiders, mites, ticks, lice, mosquitoes, flies, etc. -- their biology, control, and association with diseases. The rodent-borne-disease manual consists of a series of 7 chapters dealing mostly with "domestic" rodents, rodenticides, control measures, and rodent biology. One major publication deals with wild rodents and lagomorphs, their characteristics, disease agents they harbor, and methods of estimating their density. A new series deals with specific rodent-borne or arthropod-borne diseases. Only four articles have been prepared so far -- the arthropod-borne encephalitides, spotted fever, tularemia, and plague. Other specific disease subjects are receiving most attention at present. Another series deals with solid and sewage waste disposal, composting, and related subjects. The remaining literature includes a series of booklets on pesticides, their formulation, application, and safe use; a series on insect allergens and envenomation; another on stored-food product pests; and several reports of original research.

A unique innovation in our training program is "Instant Training." With prepackaged training literature ready for shipment and a kit containing lecture material and teaching aids at hand, a response to short-term training needs may be made within 24 hours. The principal purpose is to provide a one- or two-day course to assist in an emergency situation. Encephalitis and plague courses have been requested most frequently, although training in 8 different disease topics is available.

The museum holds one of the world's largest collections of arthropods that are vectors of diseases, including identified specimens from various parts of the world. The collection is used as a teaching aid and as an identification reference service. Specimens are received from specialists throughout the world and are catalogued as time permits. Tours of the Communicable Disease Center usually include a trip through the museum. The museum needs rodent skins and reptile specimens.

PART 2: Excerpts from "Epizootic Ecology" As An Example of a Training Course

This preceding overview of the general program of the Vector-Borne Disease Section will be followed by a brief discussion of one of the newer courses. "Epizootic Ecology" has been presented several times, but is still in formative stages of development. The subject material is aimed at the experienced health department worker who wishes to participate in a theoretical course. Some objectives are (1) to decompartmentalize the students' thinking, (2) to inform students of factors in nature which support disease-causing agents, and (3) to gain from and discuss with students details and objectives in their programs.

To date instruction has been carried out through lectures, class discussions, and the use of audiovisual aids. Literature must yet be developed, and laboratory and field sessions will also be incorporated into future courses on this subject. Three of the several components of this course are presented.

The course begins with descriptions of subject material in ecology and epidemiology. Nomenclature and definitions in these two fields are presented next. These two portions of the course are intended to stimulate the student's thinking. A study of diseases in nature comprise the remainder of the course. Consider the related interests, but different objectives of the fields (1) public health and (2) ecology. Both deal with animal (including human) populations and both study relations between the environment and the population. However, public health has had the humanitarian objective of immediate preservation of human life, especially in underdeveloped countries. An ecological view is a substantially different one. Long before the crisis in world human population was evident, concern was expressed over the lack of understanding about an exploding population and its effect on the environment. Even though the ecologist regards the abundance of human life of negative value in the biosphere (i.e., an individual human life is therefore cheap, not precious), both public health and ecologic objectives are altruistic in their quest for a "better world." Furthermore, the human being is not only "devalued" on a unit basis, but collectively has fouled its "nest" (habitat) as has no other animal. Nevertheless, public health has succeeded, by and large, in reducing epidemics in the face of such problems as unplanned urbanization. The ecologist is concerned with cleaning up the "nest" by population control, as well as control of other environmental factors.

At this point in the course, it is intended that the student has been brought to a frame of mind where he is ready to ask questions and to contribute. He is led on to define the role of the ecologist and public health worker in sylvan areas.

Another problem due to overlapping interests between ecology and public health is determining who and which agency (university or government) should be responsible for study, program development, and control. Most of us are specialists. Now visualize a "biospectrum" in which realms of study lead from the smallest physical unit to the largest: atom, molecule, cell, tissue, organ, organ system, organism, population, community, ecosystem, biosphere. An ecologist usually concerns himself with the latter four. A public health worker deals with populations, often with only human populations; a physician deals with the organ system and organism; a cytologist with cells and tissues; and a biochemist is concerned mostly with the molecular level. Some individuals span a number of levels, such as the immunochemist who deals with molecules as well as the organism. But we all try to work around the artificial boundaries we have set up. We consider the good effect of wholism as illustrated by the "Biology Layer Cake" conceived by Eugene P. Odum in his text Fundamentals of Ecology.

To illustrate how organizations are sometimes confined to single slices of cake, the water pollution program was recently removed from the U. S. Public Health Service (May 1966) and placed in the Federal Water Pollution Control Administration in the Department of the Interior. This reassignment certainly does not mean that water pollution is not a major public health problem. While it is necessary to define and confine agencies and people, the thinking of people should not be confined.

Another interesting illustration is that a lot of early literature on "domestic" rodents came from some state agencies, the U. S. Department of Agriculture, and the U. S. Fish and Wildlife Service, most of it from the latter. The U. S. Public Health Service has a very active program today. Tomorrow an entirely different agency or agencies may be involved in rodent control and preparation of literature and also may be involved in related sociological programs. Shifts in emphasis and changes of programs and whole concepts are inevitable just as are changes in word usage. In word usage the term "grower" is replacing farmer and rancher in our everyday language. All three are equally acceptable, but this is not always the case. Fine divisions of meaning are insisted upon, and this brings us to the second major area of discussion - a proper attitude toward naming things correctly.

Semantics involves nomenclature. Much of our disagreement over dogmas and semantics results from misuse or at least different use of names. Rats (Rattus spp.) have been called many things, and few of us seem willing to accept the many current adjectives which refer to and therefore define these rodents. At least eight terms are available; four are sociologic, three ecologic, and one taxonomic.

"Domestic" rodents has greatest usage and is therefore probably most acceptable. Since these rats are neither pets nor tamed for human use, "domestic" meets with some opposition. "Urban," "suburban," and "rural" rats occur in their respective environments, but exactly when and where does one give way to another?

The often-used symbiotic terms, "commensal" and "parasitic," are definitely not applicable to associations of rats and man when these terms are considered in a strict sense. The true symbiotic association between rats and man (or between roof rats and Norway rats) is "competition." Of all terms available, "competing" rodents is scientifically most accurate, but this term has much usage and many meanings outside of ecologic circles.

The taxonomic adjective "murine" or "muridine" is fine to use in the Western Hemisphere for this group of rodents, but meaningless in Asia where there are hundreds of species in this family. No conclusion is presented to the student. Rather the thought is left with him that permissiveness is required in his acceptance of terms, and no one should attempt rigid definitions.

There are many recent examples of rigid definitions and systems of classification. The terms "domestic" and "commensal" are used among others to assign arbitrarily species of Mus and Rattus to artificial categories. It seems best to avoid too rigid or complicated definitions so that our understanding and texts are not burdened with more terms than are needed to explain a given concept.

How does one define "vector"? Originally the term meant anything which carried germs, including fomites. Gradually the term became narrowed to the definition given in the handbook Control of Communicable Diseases in Man. In this definition "vector" is limited to those arthropods or other invertebrates which transmit infection to humans (and to other vertebrates). At the other extreme, Biological Abstracts under the public health section places inert carriers (such as water, food, milk, air currents, etc.) under "Disease Vectors - Inanimate." In the former handbook these are divided between the words "vehicle" and "airborne."

Ordinarily we do not provide an answer for the student, and the choice for a definition of vector is left to the student. Initially the lecture ties down a definition acceptable and usable in our teaching. We limit vector to anything animate (including a vertebrate) which is responsible for transmitting a disease agent. For example, in a strict sense, a rat transmitting Streptobacillus moniliformis by an infective bite is clearly acting as a vector.

However, questions still remain. Is a cow a vector if it has voided urine which contains leptospires on a pasture upstream from a pond where people swim? is a head louse causing pediculosis not a vector because it is an etiologic agent, or is it a vector because

it actively seeks a host rather than being carried? How might these animals be regarded as reservoirs? Is a red wing blackbird which develops the very short-term viremia of western encephalitis a reservoir or vector? The student is then led into another portion of the lecture which brings out concepts defining reservoir.

Many definitions are given. The objective is neither to tie the student down with overprecise meanings nor to release him from precision needed in observation, reporting information, and in conveying ideas. Rather, it is taught that we should accept definitions with a good deal of tolerance and then proceed toward an understanding of the concepts which they express and work toward understanding both the whole environment and particular facets supporting disease agents.

This brief discussion has touched lightly and with few examples on two of the lectures in the course. One deals with concepts and scope of ecology as it is related to public health and the inevitable overlap of domains of study and their categorization. The other deals with nomenclature and definitions. Unmentioned yet are population dynamics, methods of estimating populations, concepts of nidal centers of disease, and cycles involved in nature. The bulk of the course consists of examples of diseases in nature and how each may affect man, as well as their usual hosts and vectors.

One of these, tularemia, is especially useful for the purposes of this course in that it occurs in many different nidal centers throughout the world, each having substantially different hosts, vectors, and cycles in nature. Modes of transmission to man are also different in each nidus. A few examples are excerpted from course content. In the Ozarks of Arkansas and Missouri, ticks are believed to be the principal vector from which man contracts tularemia. This area constitutes the epicenter of the vast nidal center of the eastern United States. In other parts of the nidal center (southern Illinois or Georgia) contact between hunters and infected rabbits is the usual mode of transmission to humans. Ticks are still involved as far as humans are concerned, however. Effective control measures consist of postponing the rabbit hunting season until adult rabbit ticks (the principal transmitters and reservoirs) have disappeared for the winter. Rabbits are highly susceptible so that they die quickly and do not maintain the infection in the population for long. In other nidal centers the patterns of transmission are different; in northcentral Utah, deer flies (Chrysops sp.) are the most frequent vector; in the Pacific northwest as far east as Montana, infected drinking water is of greatest concern; in Sweden and possibly Finland and other parts of eastern Europe, a mosquito (Aedes cinereus) is a vector bringing the infection to man. The organism is extremely hardy and persists in mud, water, and dry dust. It is regularly isolated from such vectors as fleas and lice, but these have not yet been incriminated as significant vectors in nature. The several remaining nidal centers and the many factors, well known and poorly understood which support the infection, are discussed.

The course is interspersed with and concludes with classroom discussions involving questions, commentary, and applied ecology dealing with control measures.

Concepts involving interrelations between ecology and public health are just beginning to evolve. One objective of this course and the planned literature is to contribute to this development in a positive manner. It is also intended that the student will leave with an open mind to these fields and will be inspired to seek information beyond that provided during the 5-day course.

LITERATURE CITED

ODUM, E. P. 1959. Fundamentals of Ecology. 2nd ed. Philadelphia: Saunders, Chapter 1.