Medical ecology and epidemiology

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ECOLOGY HAS BEEN DEFINED as the study of relationships between organisms and their environment. The environment includes physical, chemical and biotic factors. Biotic factors include all other organisms in the environment including plant cover, food species, predators, parasites and pathogens. Thus, *medical ecology* can be defined as the study of those relationships between organisms and their environment that are of medical significance.

Audy (1965) considered the terms *medical ecology* and epidemiology as being essentially synonymous. In practice, however, epidemiological studies have been primarily concerned with disease epidemics in human populations. Vectors and host species have been an integral part of such studies, yet the focus has been on man's involvement. There are many zoonotic disease pathogens, however, that involve man as part of their life cycles only accidentally and very occasionally. To focus solely on man's contraction of such diseases in epidemiological studies may not be the most direct route to an overall understanding of such diseases. The transmission link to man may even be based on unusual environmental or temporal factors and secondary or abnormal vectors. Thus, in some cases at least, the traditional approach of epidemiological studies may not establish awareness of the principal events of the enzootic transmission cycles and thereby limit the predictability of man's overall risk of contraction of the disease.

Medical ecology appears to be a useful term to distinguish between studies that focus on zoonoses in general compared with epidemiological studies which often seem to concern themselves primarily with man's involvement in zoonoses. Medical ecology differs from epidemiology in dealing more with endemic disease transmission cycles in species other than man. In a way, medical ecology deals with pre-epidemics. Major epidemiological studies usually are not begun until after an epidemic begins in man or livestock. By that time, the factors that were important in leading up to the epidemic may no longer exist. For example, the enzootic vectors may no longer be abundant and epizootic vectors may not be known. Thus, it can be seen that studies of medical ecology are complementary to and necessary for epidemiological studies.

With the recent interest of the public and the press directed toward problems of environmental pollution, the term ecology has become popular, but restricted in its popular definition. Another side of the human ecological problem is his involvement with pathogens usually associated with life cycles of other species, the various types of zoonoses. Man sometimes contracts zoonotic pathogens, the transmission cycle of which he is neither a normal nor a necessary part. Thus, to understand the circumstances of man's involvement in zoonoses, the overall ecology of the disease transmission cycles must be known, including the ecology of natural hosts, vectors or intermediate hosts.

In Malaysia, over 70 per cent of the land is still covered by forests or scrub vegetation (Wyatt-Smith 1954). Diseases contracted by people active in these areas often fall into the category of fevers of unknown origin (FUO), resulting not only in deaths, but in economic losses in numerous man-hours lost and human suffering. Often when the origins of FUO's are investigated, the pathogens are found to be zoonotic agents that have accidentally found their way into man. There are many examples, notably leptospirosis, scrub typhus, tick-borne encephalitis and Japanese "B" encephalitis.

The lives of zoonotic pathogens, like those of other organisms, are governed by various ecological factors. Survival and dispersal depend on adaptations on the part of the organisms. In equatorial ecosystems, where the species diversity exceeds that of other regions in the world and where the ecological relationships are most complex, we understand these ecological factors the least.

The zoonotic diseases most frequently contracted by man appear to be common pathogens of man's closest relatives, the mammals. In an accidental host, infections sometimes take a bizarre form and morbidity and mortality may be much greater than in the normal host. This seems to be the case in leptospirosis, scrub typhus, tick-borne encephalitis and other zoonotic diseases in man. Because of the cryptic nature of these diseases in their normal hosts, it is important to determine the characteristics of the endemic life cycle of the pathogens with regard to vector and host biology in order to evaluate the potential for a given zoonosis becoming epidemic.

The various aspects of host biology that may be important in disease transmission include their specific distribution (including altitudinal, habitat, vertical and temporal), feeding habits, periodicity of reproduction, population dynamics and behavioral factors (Muul, 1970). Studies of these factors would enable the epidemiologist to ascertain the potential roles of the various species in zoonotic disease cycles.

As far as habitats are concerned, in Malaysia the Lowland Dipterocarp forests usually give way to Hill Dipterocarp forests at elevations above 1,000 feet (Wyatt-Smith, 1952). Above 2,500 feet, the forest is called Upper Dipterocarp, with species compositions of trees differing from those found at lower elevations. Montane Oak forests occur from 3,500 to 5,000 feet. Here many of the trees are related to those occuring in temperate regions. Many of the mammals occuring as isolated populations at elevations above 3,000 feet (Lim, 1970) also have continuous distributions of their nearest relatives (conspecifics) in more temperate regions in the north. Good examples of such are *Callosciurus flavimanus*, *Dremomys rufigenis*, *Rattus fulvescens*, and *Rattus edwardsi*.

These ecological communities above 3,000 feet can be thought of as "ecological islands" in a "sea of lowland forest". They are often isolated from other similar communities, such as in the case of Gunong Benom in Pahang. These communities appear to be remnants of a continuous distribution in this region during earlier times when climates were cooler, perhaps at times of maximal glaciation in the northern hemisphere during the Pleistocene. Apparently as the regional climates became warmer, these communities were replaced elsewhere by communities better adapted for the warmer climates. The hill top communities survived owing to the lower temperatures at high elevations.

There appear to be differences also between mammalian species in various habitats, such as primary and secondary forests. For example, associations of arboreal mammals appear to be represented by different species in the various size categories in the two habitats. Among ground mammals, such as rats, similar species associations tend to encompass both primary and secondary forests. Differences in prevalence in parasites in the various habitats are also becoming apparent. Most recently, for example, it has become evident that scrub typhus rickettsiae occur at a higher rate in forest rats than in those that occur in scrub habitats, the classical habitat of scrub typhus.

In West Malaysia, about 200 species of mammals are known. Each species occupies its peculiar ecological niche within the various ecosystems. The ecological niche of a species is its total way of life within the ecosystem. The infection of man by zoonotic disease organisms may be accidental, but the involvement of endemic hosts is not. The predisposition of various species to involvement in zoonotic disease cycles depends to a large extent on their ecological niches. Thus, on the basis of knowledge of the niches of the various species, an epidemiologist could assess their potential involvement in a given zoonosis, singling out certain species so that not all of the 200 species of mammals need to be of concern. But this type of detailed information takes a long time to accumulate.

There are preliminary data to illustrate differences in the distribution of pathogens in host species with differing ecological niches. For example, arboreal mammals seem to be much less involved in the transmission cycle of scrub typhus rickettsiae than are ground species. Arboreal species, on the other hand, seem to have much higher rates of infections with red blood cell protozoa, including *Plasmodium* (Dunn et al, 1968).

Thus far, surveys of prevalence to ascertain foci of activity of zoonotic diseases have been conducted mostly on the ground. According to Harrison (1957), about two-thirds of the species of mammalian hosts and potential hosts, except bats which are all arboreal or cave dwelling, occupy the canopy zone of the forests. Primary forests in the lowlands grow to over 200 feet high. Because some of the canopy species seldom descend to the ground or are not readily trapped, it is difficult to determine their densities and involvement in zoonoses. Some have been considered rare, but with varied collecting techniques they have been found to be as common as others (Muul and Lim, 1971). This means that if epidemiological studies depended solely on results of trapping on the ground, species that may be important in a zoonosis could be overlooked.

Very few studies of arboreal mammals have been attempted. Few investigators in the past have resorted to constructing ladders and platforms on trees or towers to study the ecology of canopy species, (McClure, 1966). Currently the staff of the IMR is using a transect walkway constructed in the canopy of a rain-forest at heights from 30 to over 120 feet from the ground. Over 1,200 feet long, this transect affords a large sampling area in the canopy, unlike the point sampling possible with the use of platforms (Muul and Lim, 1970). The trapping results, thus far, indicate that the biomass represented by small mammals is about the same in the canopy as on the ground. However, there are several arboreal species known to be present that do not enter traps. Most of the ground species can be trapped readily.

To further clarify the roles of various vertebrates in the tropical ecosystems and to relate their niches to their involvement in transmission cycles of various diseases, a great deal more information is required. Studies in medical ecology such as those discussed in this paper and elsewhere (Muul, 1970) should help to elucidate the various disease problems involving wild animals and perhaps provide clues for eventual limitation of man's contraction of those diseases. Such studies should go hand in hand with epidemiological studies of factors that predispose man's involvement in the various zoonotic disease transmission cycles. This sort of team effort by epidemiologists (including veterinarians), ecologists, mammalogists, entomologists, as well as scientists in other disciplines, should prove fruitful in dealing with various disease problems in equatorial areas.

Summary

The terms of epidemiology and medical ecology are clarified. Epidemiology has been defined as the study of disease epidemics in man. Medical ecology is concerned with the endemic disease transmission cycle and factors that may predispose epizootics. The two approaches have different emphases, but are complementary. Knowledge of ecological niches of various mammals enables an epidemiologist to single out certain species so that not all 200 species of mammals occuring in West Malaysia, for example, need to be of concern. Mammals are not distributed randomly but occur in associations with certain altitudes, types of habitats and vertical zones within forests. Their predisposition for involvement in zoonoses depends on their ecological niches.

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