Influence of Host-Parasite Interactions on the Population Dynamics of Ticks

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Knowledge of the ecology of tick vectors of disease remains relatively unavailable. This is especially true of population dynamics, the importance of which has not been recognized by most specialists. Consequently, meaningful predictions concerning future trends in tick-borne disease are difficult or impossible. Control programs, with one or two notable exceptions, have not been effective.

To appreciate the value of exacting studies of population dynamics for understanding the ecology of zoonotic diseases, I propose that we evaluate their importance in several tick-disease associations of major importance. Host-parasite interactions represent one of the focal points in these dynamic associations, and it will be convenient to isolate that parameter for comparison between the different species. Individual interactions between a particular parasite and its host may be governed by 1) *parasite dependent phenomena,* and 2) *host dependent phenomena.* Parasite-dependent phenomena include *predilection, opportunism,* or some combination of the two. Predilection may in turn be subdivided into *behavioral predilection,* i.e., positive selection of a particular animal or rejection of all but a very restricted group of animals, and *environmental predilection,* i.e., acceptance of such hosts that enter the parasite's restricted environment. *Opportunism,* in its extreme form, is the opposite of predilection and is expressed by the more or less indiscriminate acceptance of all hosts that enter the parasite's expanded environment. *Host dependent phenomena* include such attributes of a particular vertebrate species as its abundance, activity range, activity rhythm, seasonal activity period, habitat utilization, body size, and any age- or sex-related differences in these parameters.

Detailed and simultaneous study of these many complex interactions pertaining to the ecology of a tick-borne disease constitutes a very great effort. Few workers have attempted to mount such a study. Further, much of the information available is fragmented. Realizing the limitations of examining past investigations with the hindsight of today's concepts, let us look at work done on 2 problems, with host-parasite relationships as the focal point. Specifically, I will consider work on 1) *Ixodes ricinus* in relation to tick borne encephalitis, and 2) *Dermacentor variabilis* in relation to Rocky Mountain spotted fever. Finally, we can look at a life table and tick model and consider the potential advantages of these tools for predicting the infectiousness of disease foci, and for a rational basis of vector population control.

IXODES RICINUS (L.) IN RELATION TO TICK-BORNE ENCEPHALITIS

In Austria, *I. ricinus* is an important vector of tick-borne encephalitis. Loew, Pretzmann, Radda and others (Loew, et al. 1964, Pretzmann, et al. 1963, 1964a, 1964b) undertook a multifaceted investigation integrating tick-host interactions with tick population dynamics, climatic conditions and vegetation. The hillside focus used for these studies comprised 3 vegetative cover types: mature evergreen forest with little understory, meadow forest margin with dense understory, and mixed young forest regeneration, also with dense understory. Ticks, including all active stages of *I. ricinus,* were collected directly by dragging at systematically positioned sampling points, each 16 m^2, distributed throughout each biotype in the disease focus, and representing approximately 0.5 to 1.0% of the total area of the focus. Ticks were also collected from live trapped animals. The mature forest was the least suitable, while the other 2 biotypes varied in their importance for the different life stages. Habitat utilization by the hosts of the immature stages conformed to the findings obtained by direct sampling of ticks. Most mice, *Apodemus* spp., were caught in Biotype 3, while most voles, *Clethrionomys,* were caught in Biotype 2. Table 1 summarizes the estimates of the total numbers of *I. ricinus* in a uniformly comparable sampling area and, extrapolating from that, in the entire study area. Considerable variation appears to have occurred in the density of larvae and adults, but not of nymphs, between years. Host-parasite relationships were analyzed for immature feeding on small mammals. The relationship was best described by predilection, though the type, whether host-oriented or environmental, could not be discerned from these studies. Small mammals supported virtually all of the larvae that fed, and probably represented the dominant hosts for the nymphs. Table 2 summarizes some of the findings on host-parasite relationships for these life stages, utilizing the data presented by Pretzmann, et al. (1964a). *Apodemus flavicolis* was the dominant murine host, was well as the most abundant of all small mammals, (47.8%); *Clethrionomys glareolus* was the most abundant of the microtine rodents. Reorganizing data by host species and sex, incorporating the data on host abundance, tick attachment indices, and turnover frequency, it becomes possible to identify the contributions of each form to the support of the tick population. *Apodemus flavicolis* is clearly the most important contributor. Males are more important as tick hosts than females, unless the latter become much more abundant. Consequently,