FOLIA PARASITOLOGICA 37: 340—342, 1990.

STABILITY OF DERMACENTOR VARIABILIS POPULATIONS (ACARI: IXODIDAE)

Lewontin (1966, Syst. Zool. 15: 141—142) proposed the use of the standard deviation of the $\log_{10}$ of a series of measurements as an index of variability. Because of the use of logs, this index is sensitive to low outlier values. This index, s, was used by Connell and Sousa (1983, Am. Nat. 121: 789—824) as a measure of the stability of the census numbers of populations with nonoverlapping generations. After an extensive review of population data, they set up seven classes from s = 0.0 to s = 1.2 of decreasing stability. They pointed out that short term studies can only indicate apparent population stability. Southurst (1983, J. Aust. ent. Soc. 22: 1—5) postulated that, in a frost free marginal habitat, temperature was of overriding importance as a determinant of tick population size between years.

This s measure was applied to the infestation level of *Dermacentor variabilis* at Hatchville on Cape Cod Massachusetts for the period from 1969 to 1988. The maximum standard drag sample of captured adults during the spring was taken as an index of infestation. During the period of 1969 to 1974 this s value was in the lowest class of variability and during the period of 1975 to 1988 the s value was in the second class of variability. This s value for the entire period however was in the highest class of variability. The first period was characterized by a continuous low level of infestation and the second period by high infestation (McEnroe, 1979, Rec. adv. Acarol. 2: 145—153, 1986, J. Appl. Ent. 102: 370—379, unpublished observations). Hatchville is a transition zone of climatic regulation between that of the offshore islands and the interior. Here in this marginal area the shift to optimum conditions requires primarily a winter diapause period with a below average period of frozen bare ground and secondarily above average humidity during the adult activity season.

At Hatchville the usual amount of adult activity has the reproductive potential to produce a large adult population immediately after a season with a small population when preceded by a winter with limited frozen bare ground. As shown in Fig. 1A, the population size following a winter with limited frozen bare ground (McEnroe, 1987, J. Appl. Ent. 104: 531—532, unpublished) is sensitive to its parental breeding season only at the lowest level.

When the parental breeding season is extremely depressed its reproductive potential becomes too low for an immediate recovery the following generation. This trend is illustrated by the lowest values in Fig. 1A. During the period of 1978—1980 at Bolton, in interior Massachusetts (McEnroe, 1984, J. Appl. Zool. 102: 370—379), the population crashed after the snowfree winter of 1979—80 with three months of frozen bare ground and recovery of the population required two years although the preceding winters had limited frozen bare ground (Fig. 1B).

Extreme depression of parental breeding activity follows both low winter survival combined with high water stress during the breeding season which results in such extreme depression of reproductive activity that immediate recovery cannot occur under relaxed regulation. In the absence of such regulation the population has an inherent stability around the carrying capacity of the ecosystem regulated by the density dependent regulation of larval host attachment (McEnroe, 1987, Folia parasitol. 34: 309). The spring adult cohort is derived from the previous years spring larval cohort (McEnroe, 1974, Acarology 16: 651—663). In the marginal area this spring larval cohort is large enough to immediately provide a large spring adult cohort following a survival winter. In this area the spring adult cohort can recover the following year from a previous depression. In the boundary area the spring larval cohort remains so depressed that two years of relaxed regulation are required for first an increase of the spring larval population to be followed by an increase of the spring adult cohort. That is two years are required for an increase of adults.

A proposed model of climatic regulation is shown in Fig. 2. Under continuous boundary conditions the population will remain rare with a limited reproductive potential. Relaxed regulation will only result in a small increase of the population. In effect the population will be insensitive to year to year climatic regulation. In a second season of relaxed regulation, because of the previous increase, a large increase of population size can be expected. Under marginal conditions the population will remain depressed but with a reproductive potential sufficient to produce a large increase following relaxed regulation. Such a population will be extremely sensitive to outbreaks under relaxed regulation. Under continuous relaxed regulation the population will approach the carrying capacity of the system and year to year variation of climatic conditions can result in a crash.

The climatic threshold, at Hatchville, for the marginal population of *Dermacentor variabilis*, between marginal and optimum conditions is 1) a reduction of the period of frozen

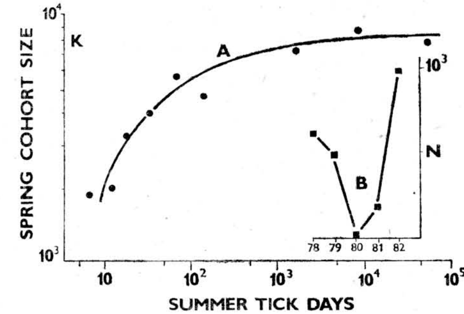

Fig. 1.
A. Population size of the spring adult cohort versus tick days, the sizeof the parental summer breeding season, following survival winters with limited frozen bare ground as a result of means above 0 °C and/or snowcover during cold periods. The summer tick days were determined from the average capture of adults during the summer. This summer activity was from the summer adult cohort plus, if any, the surviving spring adults. The apparent carrying capacity of the system (K) was ca 8 000 adults.
B. Spring population size, 1978—1980, at Bolton in interior Massachusetts. Following the winter of 1979—80 with continuous frozen bare ground, the population crashed and was too low to measure by mark and recapture.

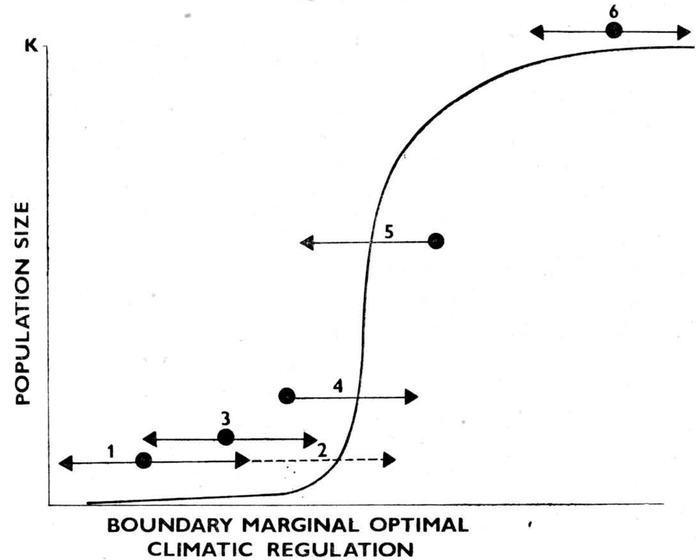

Fig. 2. Proposed relationship between population size versus climatic regulation. Optimum area, minimum density independent climatic regulation, biotic density dependent regulation; population approaches carrying capacity of the system. Boundary area, maximum climatic regulation at the limit for population survival. Marginal area, transition zone with alternate density dependent and density independent regulation with year to year climatic variation. Response to climatic variation as indicated; line 1, extinction; line 2, outbreak from boundary population following second season of relaxed regulation; line 3, stability; line 4, outbreak; line 5, crash; line 6, stability. The population will appear to be stable either under marginal or optimum conditions and chaotic in the area variable between optimum and marginal conditions. Secular trends of changed climatic regulation in the boundary area can lead to expansion or contraction of the species range.

bare ground by ca 3 weeks by either a rise in the January February means of ca 1.0 °C or snow-cover during cold periods, and 2) a decrease of several degrees between ambient and dew point temperatures during the adult season; for the boundary population of *Ixodes dammini*, the requirements are two consecutive years with 1) November and December mean temperatures ca 1 °C above normal, and 2) two winters with limited frozen bare ground period ca 3 weeks below average (McEnroe, Acarology, in press).

It also should be noted that long term secular trends in the degree of climatic regulation will expand and contract the species range.

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