

**Seasonal Variation in the Vagility of Populations
of the Red Milkweed Beetle, *Tetraopes tetraophthalmus***

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ABSTRACT

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Five populations of the red milkweed beetle, *Tetraopes tetraophthalmus* (Forster) (Coleoptera: Cerambycidae), in central Vermont and New Hampshire were sampled throughout the season and individual beetles were flight tested. The vagility of the populations (mean flight duration per sample) varied significantly during the season, with peak vagility coinciding with the flowering peak of its host plant during the 1st 3 wks of July. The findings show that it is possible to predict seasonal variation in vagility using basic life history information — lifespan, emergence times, and age-related patterns of vagility. Implications for pest management are suggested.

Vagility is the capacity of an organism to disperse over a wide area. It is a measureable attribute and one that is more informative than dispersal tendency, which is simply the likelihood of emigration. In flying insects, vagility consists of 3 components — the tendency to initiate flight, the tendency to exhibit sustained flight, and the tendency to move away from the point of departure. Since flight duration of insects is known to vary significantly with age (Dingle 1965, Rygg 1966, Rose 1972), and the age structure of most insect populations changes dramatically during a season, the vagility of a population must also change with time. The only such data available, however, are for polymorphic species in which the proportion of long and short winged forms have been measured (Denno 1978, Vepsäläinen 1978, Lamb and MacKay 1979), or for species with nondiapausing sedentary summer generations and a diapausing vagile winter generation (Iheagwam 1977).

This paper describes the seasonal variation in one aspect of vagility, flight duration, of populations of a univoltine monomorphic macropterous species, the red milkweed beetle, *Tetraopes tetraophthalmus* (Forster) (Cerambycidae).

Methods and Materials

Tetraopes is host specific to common milkweed, *Asclepias syriaca*, is univoltine, and is macropterous throughout its range in the north central and eastern United States (Chemsak 1963). In New England, the 1st beetles emerge in late June and populations persist until the middle of Aug.

Using available information on the age structure of *Tetraopes* populations during a season (Hartman 1977, Edgren and Calhoun 1958, Chemsak 1963) and the influence of age on the flight ability of individual beetles (Davis 1980), I projected the

seasonal variation in vagility for a population. To test the projection, I sampled 5 *Tetraopes* populations in the Connecticut River Valley in Vermont and New Hampshire throughout summer 1979. On each occasion, I collected 18 beetles at random from the population and kept them in individual containers in a temperature controlled chamber (28°C) for 2- 3 h before flight testing them.

The beetles were flight tested using a still air tethering technique (Dingle 1965). Individual beetles were suspended from an applicator stick with a small bit of adhesive for a period of 30 min. Loss of tarsal contact was sufficient to provoke flight and total cumulative flight time (usually encompassing from 1 – 5 flights) was recorded during the 30-min test period. Over 300 beetles were flight tested in this study.

Results

Projection of Seasonal Flight Variation

Flight duration of *Tetraopes* is known to vary with age (Fig. 1). Using the age related flight data (Fig. 1 dashed line), I obtained a mean flight duration value for each day of a beetle's life. For example, the flight value for day 14 is 7.85 min, for day 23, 3.95 min, and for day 51, 0.80 min. However, the lifespans of the beetles used to obtain the age related flight durations (Fig. 1) were significantly extended (up to 9 wks) in the favorable laboratory environment. Field estimates of the lifespans of *Tetraopes* is 4 wks. (Edgren and Calhoun 1958, Chemsak 1963). Moreover, *Tetraopes* has a teneral period of ca. 6 days, during which the beetles remain in or near the soil at the base of their host plant. Thus only the data for days 7 – 35 were used to project flight data.

Tetraopes populations build up steadily in size

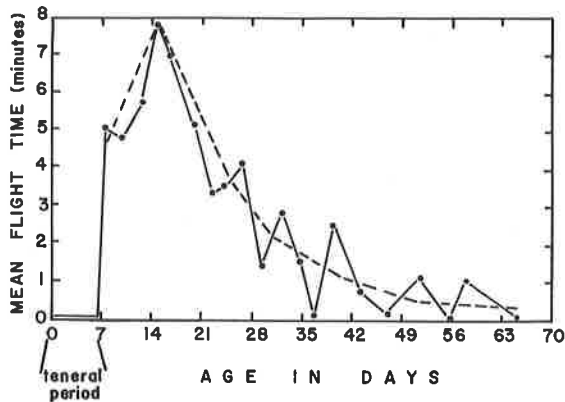


FIG. 1. —Variation in mean flight duration with age for *Tetraopes tetraophthalmus* (from Davis 1980). The dashed line, drawn by eye, was used to obtain flight duration values for beetles of different ages. See text.

To project seasonal variation in vagility, I assumed an equal number of beetles emerged on each of the 1st 28 days of the season and that all beetles lived for ca. 4 wks. The mean population vagility (MPV) for any one of the 1st 28 days is equal to the sum of the flight duration values for each age class present, divided by the number of age classes, i.e.,

$$MPV (i \leq 28) = \frac{\sum_{i=1}^d F_i}{d}$$

where F_i is the flight duration value for an individual i days old, and d is the age of population (1–28). The mean population vagility for any one of the last 28 days (29–56) is calculated in the same way, except there are progressively fewer age classes as d increases.

$$\text{Thus } MPV (i > 28) = \frac{\sum_{i=d-28}^{28} F_i}{57-d}$$

Measured Seasonal Flight Duration

Fig. 2A shows that the actual measured seasonal flight variation for a single population in West Lebanon, NH is quite close to the projected variation. The combined seasonal flight variation for all 5 populations sampled follows the same trajectory (Fig. 2B).

The proportion of long fliers, arbitrarily determined to be those individuals that flew longer than 6 min, also varies during the season (Fig. 3A.) However, the proportion of long fliers peaks after 2 wks, well before the population reaches its max-

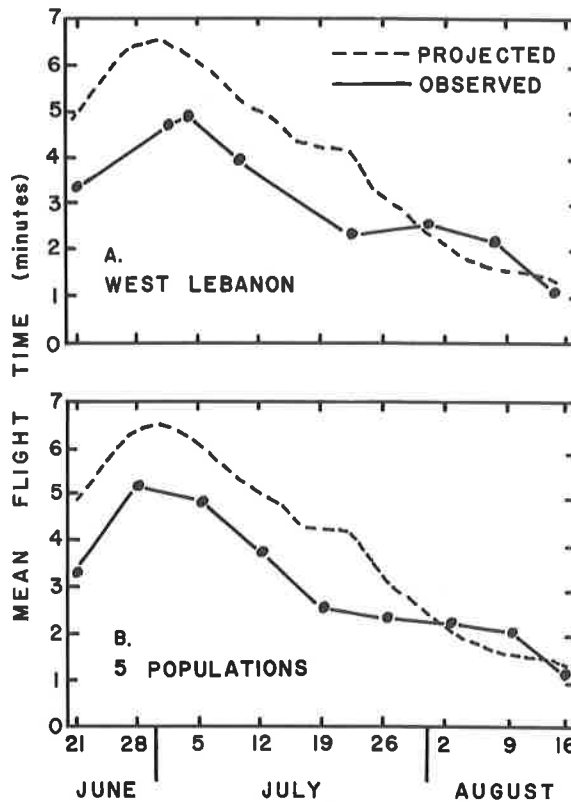


FIG. 2A. —Seasonal variation in mean flight duration for a single population (West Lebanon); B. for 5 populations combined. In A, each dot represents a single sampling effort (18 beetles). In B, each dot represents the sampling efforts from 1–3 populations (18–54 beetles).

imum size, usually after ca. 4 wks. Thus, the absolute number of long fliers in the population actually is maintained at a high level (Fig. 3B). Whereas the mean vagility (mean flight duration) drops by more than 50% from July 5 to 22, the absolute vagility (number of long fliers) decreases by only 20% during this time (Fig. 2A, 3B).

Discussion

The findings from all 5 populations indicate that in the Connecticut River Valley in Vermont and New Hampshire, *Tetraopes* populations are most vagile during the 1st 3 wks of July. It is significant that the seasonal variation in vagility corresponds so closely to the phenology of the beetle's host plant. In central Vermont and New Hampshire, I have found *Asclepias* plants in flower from the 3rd week in June to the 3rd week in Aug. The number of plants flowering early and late is very low, however, and peak flowering occurs during July.

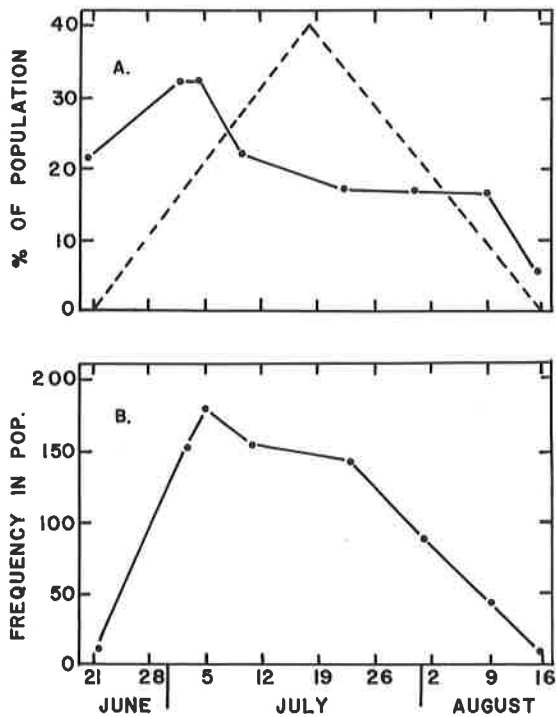


FIG. 3A. — Seasonal variation in the proportion of long fliers (individuals that flew for more than 6 min during the test period) in the West Lebanon population. The dashed line represents the idealized population growth curve of a *Tetraopes* population (based on Hartman 1977). B. Seasonal variation in the number of long fliers in the West Lebanon *Tetraopes* population. Data calculated by multiplying the proportion of long fliers by the population size (assuming the idealized growth curve) for each of the 8 time periods. For illustrative purposes, a population maximum of 1,000 was assumed. The shape of the curve is the important point, however, and this is not dependent on the maximum population size.

Hartman (1977) found that *Tetraopes* individuals that ate only leaves produced fewer offspring than those that ate flowers as well as leaves. Hartman argued that the coincident peaks of flowering and beetle population size in mid-July was due to selection against beetles that emerged at times when flowers are scarce. If flowers are very important to the fitness of *Tetraopes*, then it may be adaptive for beetles to disperse during a period when the quality of milkweed patches (flower availability) can be assessed. The vagility data from this study are consistent with this hypothesis.

It must be noted that not only age, but the reproductive state of an individual may be expected to influence vagility. It is believed that dispersal in many insect species is accomplished primarily by prereproductive adults (Johnson 1969). Rearing experiments with *Tetraopes* females previously collected from the field and flight tested have shown that at least some of the long flying females are gravid, indicating that new *Tetraopes* populations

could be established by one individual (Davis, unpublished data).

While vagility can be a population attribute, it is still the product of certain life history factors of the individuals, i.e., lifespan, emergence times, and variation in vagility with age. The most important finding of this study is not the elucidation of the seasonal variation in the vagility of a *Tetraopes* population, but that this seasonal variation can be predicted quite accurately from these life history parameters. This means that the seasonal variation in vagility for any insect species should be predictable, given the essential life history information. In insects that are multivoltine, the calculations will be more complex, but the seasonal variation in vagility can be projected as long as the age structure of the population is known throughout the season.

Of course flight duration is only one component of vagility. The tendency to initiate flight may also be important in influencing the tendency to disperse widely, and it is possible that this attribute also varies seasonally. Preliminary data for *Tetraopes* indicate that the seasonal variation in this attribute is much less than the seasonal variation in flight duration (Davis, unpublished data).

A projection of the seasonal variation in vagility might be helpful for pest management programs. The effectiveness of certain control measures often depends upon when the measure is applied. By identifying peak dispersal periods, pest managers can apply appropriate control measure before large scale dispersal occurs. One way to identify peak dispersal times is to conduct large scale trapping programs in the field throughout the season. This paper shows that this same information might be obtained with a more limited and less time consuming field effort supplemented by vagility projections from life history data that might already be available.

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Footnotes

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REFERENCES CITED

- Chemsak, J. A. 1963. Taxonomy and Bionomics of the Genus *Tetraopes*. University of California Press, Berkeley.

- Davis, M.A. 1980.** Variation in flight duration among individual *Tetraopes* beetles: implications for studies of insect flight. *J. Insect Physiol.* (In press).
- Denno, R. F. 1978.** The optimum population strategy for planthoppers (Homoptera: Delphacidae) in stable marsh habitats. *Can. Entomol.* 110: 135-42.
- Dingle, H. 1965.** The relation between age and flight activity in the milkweed bug, *Oncopeltus*. *J. Exp. Biol.* 42: 269-83.
- Edgren, R. A., and D. W. Calhoun. 1958.** Studies on a mixed population of milkweed beetles: phenological observations during 1956 and 1957. *Bull. Ecol. Soc. Am.* 39: 91-2.
- Hartman, F. 1977.** The ecology and coevolution of common milkweed, *Asclepias syriaca*, and milkweed beetles, *Tetraopes tetraophthalmus*. unpubl. PhD dis. Univ. of Michigan.
- Iheagwam, E. U. 1977.** Comparative flight performance of the seasonal morphs of the cabbage white fly, *Aleyrodes brassicae* (Wlk.) in the laboratory. *Ecol. Entomol.* 2: 267-71.
- Johnson, C. G. 1969.** Migration and Dispersal of Insects by Flight. Methuen. London. 763 pp.
- Lamb, R. J., and P. A. MacKay. 1979.** Variability in migratory tendency within and among natural populations of the pea aphid. *Oecologia* 39: 289-99.
- Rose, D. J. W. 1972.** Dispersal and quality in populations of *Cicadulina* species (Cicadellidae). *J. Anim. Ecol.* 41: 589-609.
- Rygg, T. D. 1966.** Flight of *Oscinella frit* L. (Diptera, Chloropidae) females in relation to age and ovary development. *Entomol. Exp. Appl.* 9: 74-84.
- Vepsäläinen, K. 1978.** Wing dimorphism and diapause in *Gerris*: determination and adaptive significance. In *Evolution of insect migration and diapause*. Hugh Dingle, (ed.) Springer-Verlag. New York. 284 pp.
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