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Summer Diapause of the Clover Leaf Weevil, *Hypera Punctata,* and Lesser Clover Leaf Weevil, *Hypera Nigrirostris,* in Wisconsin

James A. Latsinger
University of Wisconsin

James W. Apple
University of Wisconsin

SUMMER DIAPAUSE OF THE CLOVER LEAF WEEVIL, *HYPERA PUNCTATA*, AND LESSER CLOVER LEAF WEEVIL, *HYPERA NIGRIROSTRIS*, IN WISCONSIN[1]

James A. Litsinger[2] and James W. Apple[3]

ABSTRACT

Low respiration rates, immobility, lack of feeding, and undeveloped reproductive systems confirmed a summer diapause in the overwintered and current-year adults of the clover leaf weevil, *Hypera punctata*, and lesser clover leaf weevil, *Hypera nigrirostris*. The prolonged summer diapause and extended winters in Wisconsin set strict limitations on the available time for damaging populations to develop on red clover, *Trifolium pratense* thus assuring the status of these weevils as minor pests.

Summer diapause is a common mechanism among insects to escape periods when their host plants become nutritionally unsuitable (Masaki 1980). A primary function of summer diapause is to synchronize the insect's life cycle with that of its host rather than being an escape mechanism to avoid hot dry conditions.

The alfalfa weevil, *Hypera postica* (Gyllenhal) (Litsinger and Apple 1973), and Egyptian alfalfa weevil, *H. brunneipennis* (Boheman) (Madubunyi 1978), are two well-studied insects which undergo summer diapause. The former occurs in the Great Lakes region of the U.S. Two red clover-feeding weevils in the same genus, the clover leaf weevil (CLW), *H. punctata* (Fabricius), and the lesser clover leaf weevil (LCLW), *H. nigrirostris* (Fabricius), occur in the Great Lakes region and are likely candidates for summer diapause as they feed on developing leaves and buds of red clover during spring months. Studies to date have only alluded to summer diapause in these pest species.

Folsom (1909) in Illinois and Tower and Fenton (1920) in Indiana reported that the CLW reached adulthood in May and June and remained "semidormant" until oviposition began in September. These authors stated that all oviposition took place during the fall after adult activity resumed.

Oviposition by the LCLW occurs mainly during the spring in the U.S. and Europe. Markkula and Tinnila (1956) in Finland noted eggs most abundant from April–July. Summer dormancy was not mentioned even though a pre-ovipositional period up to nine months occurs. The few larvae found in the fall in New York (Detwiler 1923) and Ohio (Sechriest and Treece 1963) were evidence of a partial second generation derived from the maturation of a small proportion of new-generation adults.

In Coleoptera summer diapause occurs during the adult growth stage and its syndrome is characterized by accumulation of fat reserves, undeveloped gonads, low metabolism, and lack of feeding (Masaki 1980). Concurrent with studies in Wisconsin (Litsinger and Apple 1973) to determine the periodicity of the imaginal summer diapause of the alfalfa weevil, respiration measurements were taken and the reproductive status determined for CLW and LCLW.

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[1]Research supported by the College of Agricultural and Life Sciences, University of Wisconsin, Madison.

[2]Department of Entomology, University of Wisconsin, Madison. Present address: International Rice Research Institute, P.O. Box 933, Manila, Philippines.

[3]Department of Entomology, University of Wisconsin, Madison. Present address: 6534 Casabella Lane, Boca Raton, FL 33432.

MATERIALS AND METHODS

Weevil cultures were maintained in clear plastic shoe-box cages on red clover, *Trifolium pratense* L., in an open-air insectary at Arlington, WI (43°18'N Lat.). Overwintered adult CLW and LCLW were collected from nearby fields in May 1971. Current-year adults were reared from larvae field-collected in May. Oxygen uptake (μl/mg) by CLW (per 0.5 h) and LCLW (per 1 h) adults was measured biweekly from 25 June to 11 November, according to procedures outlined by Litsinger and Apple (1973).

On each date, 10 adults were randomly chosen from the cultures of overwintered and current-year weevils of each species. Beginning in August, small numbers of males and females were periodically dissected in vivo to determine sexual development.

RESULTS AND DISCUSSION

Clover leaf weevil, current-year adults. Average oxygen consumption of current-year CLW adults declined rapidly from 0.38 μl/(mg · 0.5 h) on 25 June to levels below 0.15 μl/(mg · 0.5 h) during July and early August (Fig. 1). No feeding occurred in the cultures during this period and the adults remained aggregated and motionless between the leaves of paper toweling at the bottom of the cages. This adult inactivity signified the entry into summer diapause. Supporting evidence comes from dissections. During August, weevils of both sexes possessed hypertrophied fat-bodies, typical of insects in diapause (Brazzel and Newsom 1959). Flagellated but immobile sperm were present in five males dissected 6 August. On 31 August five dissected males possessed mature spermatozoa, and sperm were present in spermathecae in four of seven dissected females

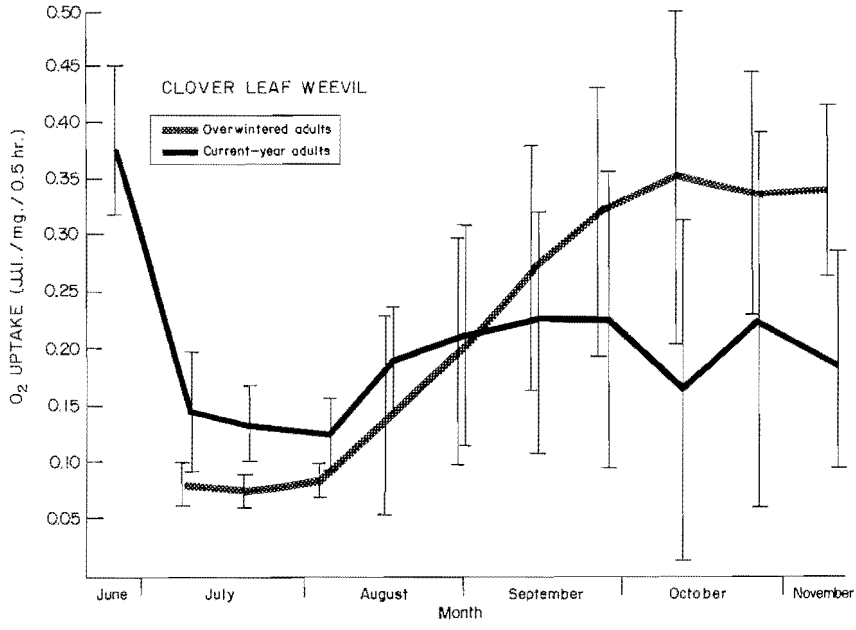

Fig. 1. Seasonal adult respiration rates of the clover leaf weevil. Vertical lines indicate standard errors for each mean value.

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indicating mating had occurred. The first fully-developed eggs were noted in two of seven females dissected on 14 September when oxygen uptake averaged 0.21 μl/(mg · 0.5 h). The large standard errors about the means of oxygen uptake in the fall months were due to a mixture in the CLW adult population of diapausing and post-diapausing individuals.

At the beginning of overwintering in November, 12 of 16 adults measured showed diapause levels of oxygen uptake (0.25 μl/(mg · 0.5 h)) and were sexually immature upon dissection. The results indicate that most current-year adults at Wisconsin latitudes overwinter in diapause and sexual maturation is delayed until spring. At the more southerly latitudes of Illinois (Folsom 1909) and Indiana (Tower and Fenton 1920) the onset of winter is delayed compared to Wisconsin to favor fall oviposition.

Overwintered adults. Overwintered adults ceased oviposition and feeding by late June and were respiring at low levels (0.08 μl/(mg · 0.5 h)) by the first sampling date 9 July (Fig. 1). Oxygen uptake rose sharply in the adults beginning mid-August. Oviposition resumed in late August in the culture and continued throughout the fall. The more rapid sexual maturation of the overwintered adults was a result of the prediapause existence of fully developed reproductive organs, requiring only the maturation of eggs in the fall. Hypertrophy of gonads upon summer diapause renewal by overwintered CLW was also found in the alfalfa weevil (Litsinger and Apple 1973).

Lesser clover leaf weevil. The majority of both the current-year and overwintered LCLW adults remained inactive and respired at low rates (0.6 μl/(mg · h)) from August through October (Fig. 2). After July no larvae were collected from the field and no eggs were recovered from caged host plants. Respiration rates of overwintered adults increased in November to 0.9 μl/(mg · h) but none of the six surviving current-year females dissected on 11 November at the termination of the experiment were sexually mature. The fact that their fat bodies were lean on this date indicated that diapause was ending at this time. Without an energy reserve the adults would have difficulty surviving over the four-month winter.

Our interpretation is that both the current-year and overwintered LCLW adults undergo a prolonged summer diapause, longer than either the alfalfa weevil or CLW. A diapause state from August through October is supported by adult immobility and aggregation in between the leaves of paper toweling, non-feeding, sexual immaturity, and low respiration. A prolonged summer diapause would explain the reports from Finland stressing

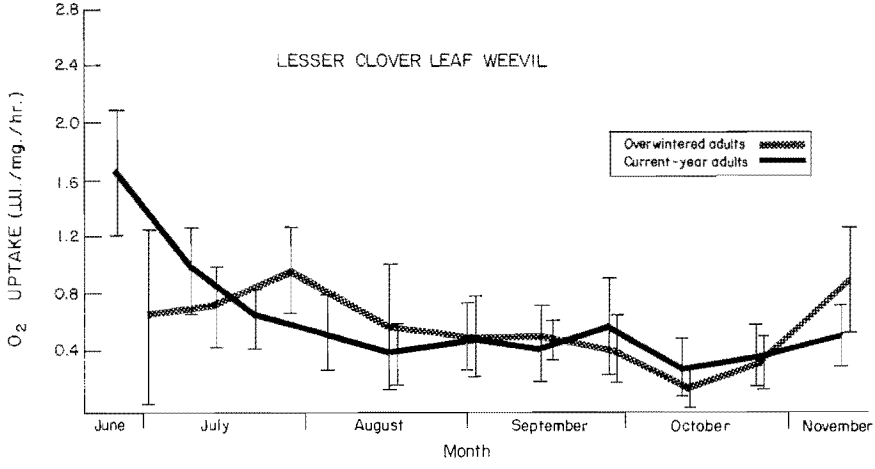

Fig. 2. Seasonal adult respiration rates of the lesser clover leaf weevil. Vertical lines indicate standard errors for each mean value.

spring oviposition as well as a prolonged nine-month pre-ovipositional period (Markkula and Tinnila 1956).

The extended periods of inactivity, diapause in the summer and immobility during the winter, in Wisconsin severely limit the available time for these pests to develop into damaging populations and no doubt explains their status as minor pests.

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