The induction of diapause protects insects from unfavorable environmental changes and for many insects metabolic activity during diapause is fueled by stored nutrition. The European corn borer has at least two different diapause genotypes, each with differences in regulating the response to the environmental cues used to trigger diapause, the physiological changes associated with induction of diapause, and most notably the duration of diapause. Our research leverages between-strain genetic variation in diapause duration for *O. nubilalis* to test the hypothesis that diapause length is indirectly associated with nutrition stores. Climate change is expected to cause summer temperatures to expand and fall and winter temperatures to rise. Warmer fall temperatures could increase metabolic activity and possibly reduce lipid stores during diapause preparations and/or drain lipid stores during diapause before the onset of winter. Prior to our ongoing study, diapause programming among European corn borers collected from maize fields in October has been correlated with increased lipid accumulation (Vukašinović et al., 2013). Measurements of lipid stores from the fat body and hemolymph showed larvae preparing for diapause accumulated more lipids compared to non-diapause larvae (Vukašinović et al., 2013). These results show an association between nutrition accumulation ahead of diapause however, they do not addressthe relationship between diapause length and lipid accumulation. We found that when long-diapause genotype larvae are programmed for diapause lipid storage increases store more lipids than short-diapause genotype larvae and non-diapause larvae.

Similar results were recorded for the Burnet moth (*Zygaena trifolii* (Esper)) diapause by Wipking et al. (1995). These researchers reared larvae in diapause programming conditions and non-diapause conditions at four different temperatures and measured lipid stores. Larvae programmed for diapause had a 2.5-fold increase in lipid stores as compared to larvae not programmed for diapause (Wipking et al., 1995). Nutrition storage prior to the onset of diapause is a pivotal step in diapause preparation for multiple taxa (Adkisson et al., 1963; Mitchell and Briegel, 1989). As fall temperatures increase, the degree to which these stores are accumulated in preparation for diapause may be reduced by a higher metabolic rate. Similarly, warmer temperatures during diapause in winter could prematurely drain stored energy causing insects to die during diapause or come out of diapause the next spring without sufficient reserves to restart their lifecycle activities including dispersing, mating, and reproducing.

Warmer and more variable temperatures at the beginning of diapause have both been found to reduce nutrition stores by increasing metabolic activity and reducing stored energy before the onset of winter. For example, a study by Williams et al. (2012) that focused on the effect of temperatures on stored nutrition suggested that diapausing insects experiencing temperature variations with increased temperature at the beginning of diapause store fewer resources and deplete those resources faster than insects in thermally stable environments before the onset of winter. To investigate the relationship between fluctuating warm temperatures and nutrition storage, these researchers reared *Erynnis propertius* (Scudder and Burgess) caterpillars that originated from environments that differed in thermal stability in a reciprocal common garden experiment with stable and fluctuating thermal treatments (Williams et al., 2012). Larvae reared in stable conditions stored significantly more lipids and entered dormancy 3-4 weeks later compared to their counterparts reared in thermally variable environments (Williams et al., 2012). In addition to lipid depletion at the start of diapause, higher winter temperatures have been associated with increased depletion of stored lipids during diapause. Thompson and Davis (1981) demonstrated that increased temperatures at the end of diapause can significantly deplete lipid stores in *Diatrea grandiosella* Dyar. Caterpillars were first reared at 21◦oC to program diapause. Once diapause was programmed, caterpillars were transferred into four temperaturetreatments ranging from 4◦C and 21◦C. After being held at these different temperatures for 60 days, the diapausing larvae were transferred to 27◦C and lipid stores were measured for 60 additional days (Thompson and Davis, 1981). Researchers noted the lipid stored of larvae from the 4◦C temperature treatment remained unchanged while larvae from the 21◦C temperature treatment lost 1.73 calories/insect per day of fatty acid during the same period (Thompson and Davis, 1981). European corn borers that experience combination of warmer fall temperatures at the start of diapause and warmer winter temperatures during diapause could experience a similar decline in nutrition stores. European corn borers that do not accumulate enough energy ahead of diapause could fail to enter diapause, terminate diapause prematurely, or suboptimal nutrition could lead to reductions in post-diapause adult functions.

Suboptimal nutrition storage has been previously implicated in restricting entry into diapause and reducing the amount of time spent in diapause. For example, a study using *Calliphora vicina* (Robineau-Desvoidy) investigated the effect of reduced nutrition on entry into diapause. Diapause in the *C. vicina* fly offspring begins maternally where adult female flies exposed to short photoperiod days alter how they provision the eggs of the offspring they lay, programming her offspring for diapause. After diapause-programmed larvae hatch, they begin feeding and storing nutrition in preparation for a larval diapause. Based on the research of Saunders (1997), diapause in these fly maggots appears to be regulated by photoperiod, temperature, and nutrition. Reducing the amount of nutrition diapause-programmed fly larvae could accumulate significantly reduced entry into diapause and the duration of diapause. Researchers found that when access to nutrition was restricted five days after hatching, 40.5% of larvae avoided diapause, but by restricting nutrition eight days after hatching produced bigger and fatter larvae where 95% of the larvae entered diapause (Saunders, 1997). Saunders (1997) also compared the time spent in diapause between small larvae weighing less than 40 mg and large larvae weighing over 60 mg. Small larval mass was associated with a shorter diapause and pupated approximately 20 days after hatching, however large larval mass was associated with a longer diapause and pupated approximately 50 days after hatching (Saunders, 1997).

REFERENCES:

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