CHAPTER 3 EUROPEAN CORN BORER: THE RELATIONSHIP BETWEEN STORED RESOURCES AND DIAPAUSE TIMING

3.1 Background

According to the National Oceanic and Atmospheric Administration, 2016 was the warmest year on record and temperature increases are expected to continue through the year 2100 [25, 26, 27]. As seasonal temperatures increase, the duration of warm summers will expand, cool winters will contract, and temperatures during the spring and fall will become less predictable [28, 29]. Animals monitor variation in seasonal factors like temperature and photoperiod (daylight hours) because these factors can affect the availability of nutrition, mates, and habitat. Seasonality predictably cycles between conditions that are favorable for insect activity and conditions that are stressful and unfavorable. Many temperate-dwelling insects protect themselves from seasonal stress by entering diapause before their environment becomes unfavorable [1].

Insects in diapause can survive for months in harsh conditions such as X, X, X and typically do so without access to nutrition by lowering their metabolic activity and suspending their development [30, 3]. Before the environment becomes unfavorable, insects prepare for diapause by and storing nutrients in the form of lipids, proteins, and carbohydrates in their X [1]. It has been shown that Colorado potato beetles (*L. decemlineata*) (Kort and Koopmanschap 1994) and southwestern corn borers (*D. grandiosella*) (Brown and Chippendale 1978) accumulate stored energy in the form of protein and pink bollworm (*P. gossypiella*) (Adkisson et al. 1963) and *Culex pipens* mosquitoes (Mitchell and Briegel 1989), store energy in the form of lipids. The stored energy is drawn upon to maintain insect metabolism during diapause, and after diapause the unused resources are utilized to perform post-diapause functions. Metabolic activity for many insects is directly related to temperature and insects preparing for diapause in warmer environments may struggle to both satisfy the energy demands of an increased metabolism and storage requirements for diapause

Insects entering diapause without adequate nutrition supplies may exit diapause early, die in an unfavorable environment. Models of *Calliphora vicina* (Robineau-Desvoidy) have provided valuable insight into the effects of nutrition on the duration of diapause. It was discovered that when diet was restricted, larvae entered diapause with less mass and remained in diapause for a shorter period than larvae given an unrestricted diet [44]. Insects that exit diapause early could be exposed to lower than optimal temperatures and may not have sufficient stored nutrients to meet the anabolic requirements for post-diapause development, metamorphosis, repair, and reproduction [3, 4].

Climate change could also decrease levels of stored nutrition in diapausing insects as warmer and more variable fall and winter temperatures increase insect metabolic activity [31, 32, 33, 4]. These researchers held diapausing *Diatrea grandiosella* Dyar moths in warm temperatures and compared lipid mass to moths diapausing in cool temperatures. The moths that were exposed to the warmer temperatures also demonstrated a significant decrease in lipid stores at the end of diapause compared to moths in cooler conditions [Thompson and Davis 1981].

Warmer temperatures during diapause preparation could increase metabolic rates and could redirect resources away from nutrient storage. Being unable to build up enough stored energy before the onset of diapause could limit an insect’s ability to enter diapause before the onset of winter. Similarly, warmer winter temperatures could also increase the metabolism of diapausing insects, causing them to deplete stored energy before environmental conditions become favorable for development the next spring, leading to mortality. Surviving diapause with reduced resources could also affect adults post-diapause and limit critical functions like dispersal, mating, and reproduction.

*Ostrinia nubilalis* (European corn borer) has served as an excellent model to describe how warm fall or winter temperatures influence nutrition storage before and during diapause. European corn borers consist of at least two genetically distinct and naturally segregating genotypes that coexist at the same latitude. Although they both experience winter at the same time, the long-diapause genotype enters diapause earlier and exits later than the short-diapause genotype (citation needed). . Research is lacking information on the European corn borer nutrition storage strategies between these two strains and a more thorough analysis could increase our understanding of how insects might adjust to warming winter temperatures as Earth’s climate changes.

Adjusting to climate change for some insect species may be difficult because warmer yearly temperatures could lead to reductions in population size or extinction. European corn borers with a short-diapause genotype could provide insight into how climate might negatively impact insect populations if warmer diapause temperatures drain nutrient stores prematurely and these larvae exit diapause before seasons change. However, the effects of climate change could also be positive for some insects. If the effects of warmer diapause temperatures can be mitigated by larger nutrient stores, then insects that utilize this strategy like long-diapause European corn borers could thrive.

Warmer fall temperatures experienced by the two strains of European corn would increase metabolic activity before diapause and concurrently decrease the amount of stored nutrition during diapause. .would Both types experience similar thermal environment during diapause, but may differ in their ability to effectively store nutrients. . I hypothesize that the long-diapause genotype will accumulate more nutrient stores prior to diapause than the short-diapause genotype and that genotypes will not differ in regards to larvae nutrient depletion rates.

Ho: All species of European corn borers accumulate similar nutrient quantities prior to diapause

Ha: Long-diapause genotypes of European corn borers will accumulate more nutrients than short-diapause genotypes

Ho: All species of European corn borer larvae will deplete nutrients at a similar rate

Ha: Different genotypes of European corn borer larvae will deplete nutrients at a different rate

Materials and Methods

To investigate the relationship between diapause length and nutrient storage, lipid stores at the start of diapause and during diapause were measured in each strain. This research showed that larvae with the long-diapause genotype accumulated more lipid mass at the onset of diapause compared to larvae with the short-diapause genotype. However whether the rate of lipid depletion between the two strains differed during diapause was inconclusive.

References (To be added)