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SOME PHYSIOLOGICAL CHARACTERISTICS OF MELON LADYBUGS IN THE PERIOD OF WINTER DORMANCY IN KASHKADARYA REGION

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ABSTRACT:

The paper describes that the departure of a melon ladybug for wintering is characterized by the cessation of active nutrition, a decrease of the water content in the body and the accumulation of fatty substances in the body of beetles. A decrease of the water content in the body of beetles during the winter period is correlatively associated with increasing of hypothermia of their body fluids. During the wintering of the melon ladybug, there is a gradual consumption of fat and fat-like substances. The most intensive consumption of fat in beetles is observed in the spring after wintering, during the period of active locomotor activity.

Also, the period of wintering of the melon ladybug is characterized by a decrease in oxygen consumption and inhibition of the entire tissue metabolism. During this period, beetles are in a state of deep dormancy, and are probably the most resistant to low temperatures in their habitat.

KEYWORDS: vegetation, area, metabolism, imago, experiment, hibernation, antifreeze, tolerance, glycerin, hemolymph, tissue metabolism, similar.

INTRODUCTION:

The seasonal periodicity of climatic conditions and vegetation of melons and gourds in different areas has left a deep imprint on the melon ladybug and its biology. The transition to the state of winter dormancy of the melon ladybug is usually preceded by the onset of certain rhythmically repeating environmental conditions unfavorable for active life. In addition, an important role in this process is played by the seasonal periodicity of the vegetation of forage plants, which inevitably affects the biology of the species. In different climatic zones of the growing season of pumpkin crops, the main fodder plant of the melon ladybug takes about 6 to 7 months a year. She spends the remaining 5-6 months in the adult stage under plant debris, surrounded by melons and gourds. Males and unfertilized females hibernate.

The high viability of the melon ladybug is largely associated with the state of winter dormancy, which contributes to the survival of the insect at an unfavorable season. The physiological characteristics of the winter dormancy of beetles, the timing of the beginning and end of wintering, the state of beetles during wintering cause both theoretical and practical interest.

There is reason to believe that the changes occurring in the body at the onset of winter dormancy or its termination concern primarily the energy of tissue metabolism and the intensity of respiration. Therefore, when studying the physiological essence of the winter dormancy of the melon ladybug, we focused on determining the dynamics of the accumulation and consumption of reserve substances (fats), due to which the life of the body is maintained during the resting period, in particular, water metabolism, respiration intensity, as an integral indicator of oxidative processes in body tissues. In the literature, there are data on an increase in the amount of fat, a decrease in water content and on changes in gas exchange before the transition of insects to wintering and during the wintering period of different species, such as colorado potato beetle, cotton worm and others (Larchenko, 1937; Ushatinskaya, 1957; 1966; Chernyshev , 1996; Romanenko 2013; Denisova 2014; Strelkova 2017; Tilavov 2018, etc.). However, such data are not available in the melon ladybug.

MATERIAL AND METHODS:

When studying the dynamics of the accumulation and consumption of reserve substances, due to which the body of the melon ladybug exists during long periods of rest, the percentage of water and the amount of fat in the body were taken into account. To characterize gas exchange and tissue metabolism, the intensity of oxygen absorption was studied.

The water content was determined by the gravimetric method. For this, 20 females and 20 males from each test batch were dried in triplicate at a temperature of 70-80 ° C to constant weight, i.e. all remaining water in the body was taken into account. The amount of fats was determined by extraction in small models of the Soklet apparatus with ethyl ether, pounded with a canopy of 20 beetles, dried to constant weight. The amount of fat was also determined separately for females and males in triplicate. The oxygen uptake rate was measured monometrically (on 30 females and 30 males, divided into batches of 5 individuals) in Warburg apparatus at a constant temperature of 26 ° C.

The biomaterial for analysis was kept in field cages in natural conditions, i.e. exposed to changes in climatic factors. The height and gas exchange were measured under laboratory conditions, where beetles taken from the cages were introduced 2-3 hours before the start of the study. In total, about 3000 beetles were used for the experiments.

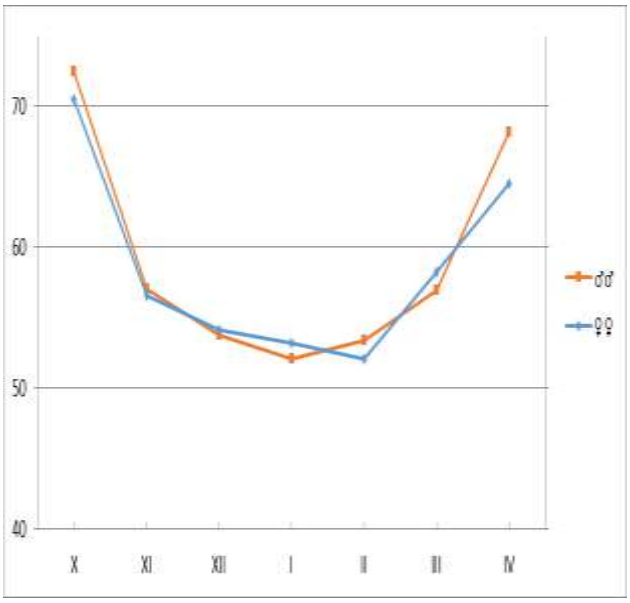
The water and fat content of the melon ladybug was determined at the Kashkadarya Regional Agrochemical Station, and the respiration rate was determined at the Department of Physiology of Karshi State University.

RESEARCH RESULTS:

As you know, water is an integral part of the constituent substances of the body, as their solvent and their carrier. With water, all substances enter the body, including those to be assimilated during nutrition, it flushes out the products of the breakdown and decomposition of these substances (Kuznetsov, 1953). The water necessary for life enters the body when drinking, is part of the food, is adsorbed by the integuments of the body and tracheal system, and is obtained as a product of metabolism.

The high physiological significance of reducing the amount of water in the body of insects before the transition to a state of dormancy and the restoration of its content to the norm, characteristic of active life after the end of dormancy is indicated in the work of R.S. Ushatinskaya (1957), E.M. Shagov (1967) and others.

The results of the determinations of the water content in the body of beetles at different periods of imaginal life are shown in Figure 1.



Pre-winter feeding 2017 wintering 2018 feeding beetles after wintering

Fig. 1 - Water content in the body of melon beetles at different stages of imaginal life

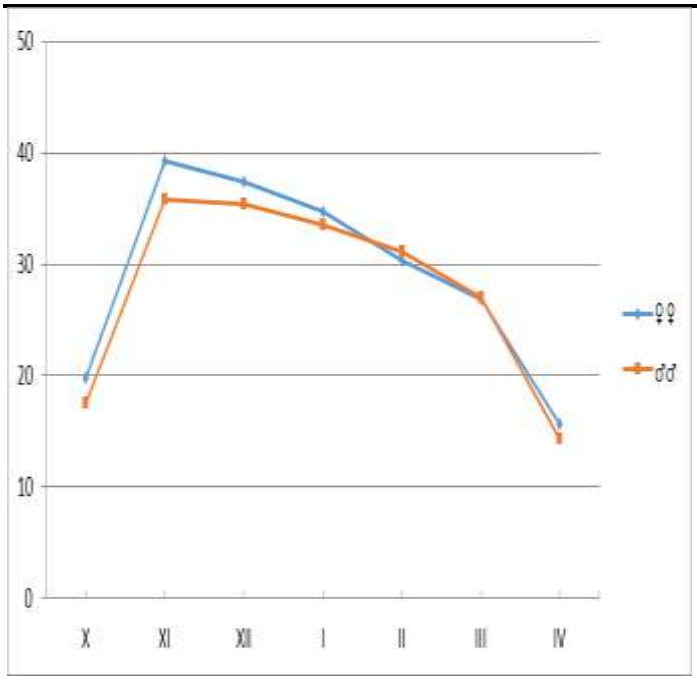
As can be seen from the above data, the water content in the body of the melon ladybug is not the same at different stages of imaginal life. The water content in the body of beetles during the pre-winter feeding period (October) is high, on average, 70.5% of the wet body weight in females and 72.4% in males. As the beetles left for wintering, the water in the body of beetles of both sexes became much less - 56.6% in females and 57.0% in males. This decrease of water content in preparation for wintering is due to the cessation of nutrition and the release of the intestines from excrement.

During the period of wintering, the water content in the body of the melon ladybug remains almost unchanged. In the winter months, the water content in the body of beetles ranges from 52.1% to 53.8% in females, 52.1% to 53.8% in males. The overwintered beetles during the active feeding period (April) have a high water content: in females - 64.5%, in males - 68.1%. Beetles feed actively during this period. Water in the body of beetles comes mainly from food.

Thus, a decrease of the water content in the body of beetles during the wintering is apparently correlatively associated with an increase of hypothermia of their body fluids. The higher water content in the body of beetles during the period of active feeding (October, April) is possibly due to their lower cold resistance.

Taking into account the duration of the state of winter dormancy of insects, it can be argued that a significant amount of energy is spent on maintaining their life during this period. A number of authors on different species of insects have shown that fats and carbohydrates are the main energy substrates that support life during the dormant period. The deposition of large amounts of fat in insects, mainly in the adipose body, before the transition to a state of winter dormancy was noted for many species (Kozhanchikov, 1936; Ushatinskaya, 1952, 1984; Anderson, 1981, etc.).

The fat content in the melon ladybug, the dynamics of their accumulation and consumption were taken by us as one of the physiological indicators of preparation for the transition to winter dormancy, the general picture of the change in the fat content at different stages of the imaginal life of the melon ladybug is presented in Figure 2.



Pre-winter feeding 2017 wintering 2018 feeding beetles after wintering

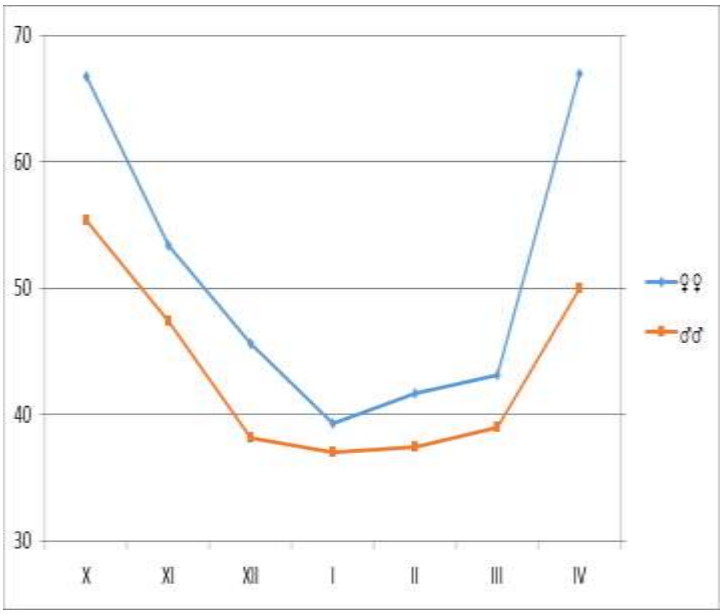
Fig. 2 - Fat content to dry matter weight at different stages of the imaginal life of a melon ladybug

As can be seen from the data presented, during the period of active life of beetles (October), the content of fat in the body of beetles is low, in females on average 19.8%, and in males 17.5% of the weight of dry matter. After pre-winter feeding, the beetles hibernate with a significant amount of fat. In November, females averaged about 39.3% body fat and males 35.8%.

During the wintering of the melon ladybug, a gradual consumption of fat reserves was observed. From the beginning of wintering to mid-January, the consumption of fat was small, although the temperature of the environment at that time was kept at about 10-14 °C, in January females had 34.8%, and males 33.9% fat from dry weight.

The most intensive consumption of fat in beetles was observed in the spring after wintering, during the period of active locomotor activity and until summer in search of food and at the beginning of feeding. During this period (April), the amount of fat in females was 15.6%, in males 14.3% of the dry weight.

It is obvious that at various stages of insect life, body weight does not remain constant. For example, according to Z.P. Cudare (1968), from the egg to the imago, the body weight of the Colorado potato beetle increases more than 200 times. The change in the average wet weight of the adult melon ladybird at different stages of the imaginal life is shown in Figure 3.



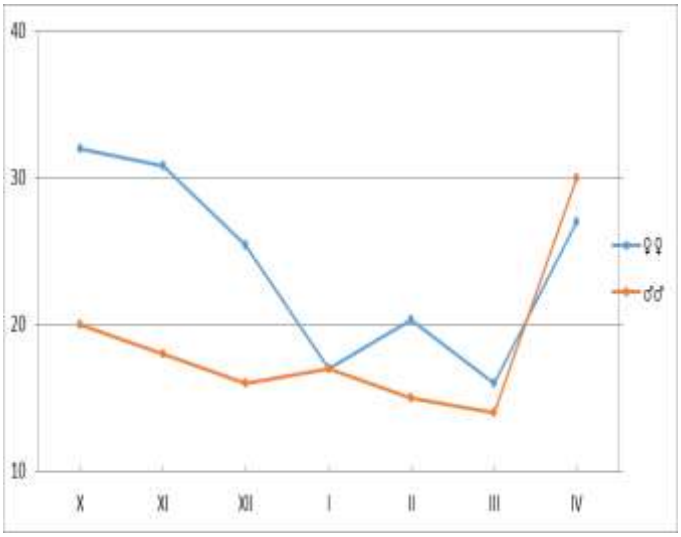
Pre-winter feeding 2017 wintering 2018 feeding beetles after wintering

Fig. 3 - Average wet weight of a melon ladybug at different stages of imaginal life

As can be seen from the above data, the maximum weight of beetles was recorded during the pre-winter feeding period, when the average weight of females reached 66.8 mg, and that of males, 55.3 mg. After the cessation of feeding, a decrease in the water content in the body of beetles is observed; when they go into hibernation, the body weight of the beetles decreases markedly. In December, females weighed 45.6 mg, males 38.1 mg. Wet body weight during early spring to the beginning of the recovery period remained almost constant. After the beetles leave wintering, during the period of active feeding (April), the wet weight

of their body noticeably increases. In females, body weight at this time averages 67.0 mg; in males, 50 mg. During the period of spring activity, the wet weight of the beetles increases slightly due to the increase in the amount of water in the body.

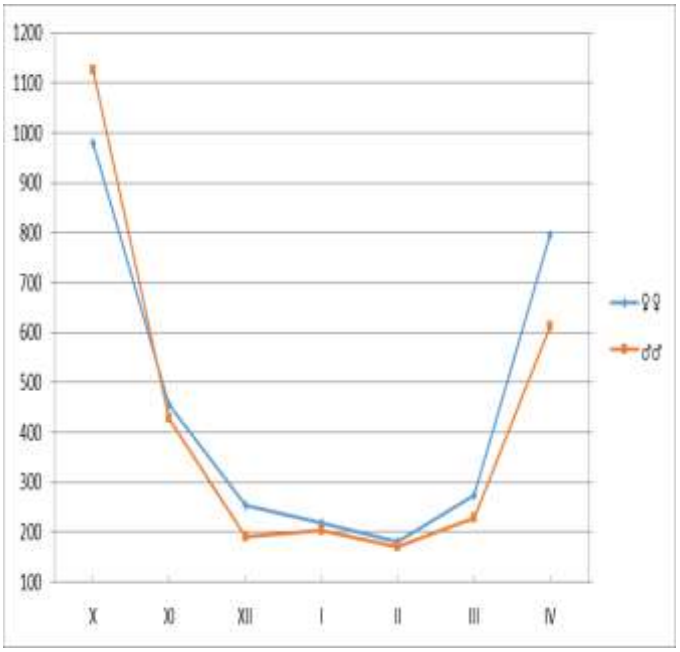
The dynamics of the average dry weight of beetles is similar, established for the same stages of imaginal life in Figure 4.



Pre-winter feeding 2017 wintering 2018 feeding beetles after wintering
Fig. 4 - Average dry body weight of a melon ladybug at different stages of imaginal life

The average dry weight of beetles after the maximum observed during the active feeding period before hibernation decreased, moreover, faster at the beginning of hibernation and slower in winter. A significant increase in dry weight in overwintered beetles is observed in both sexes during the period of active feeding. During this period, the dry weight of females averages 27 mg, and that of males 30 mg. This is due to the fact that in the spring, hungry beetles actively feed, reserve substances accumulate in the body and insects prepare for reproduction.

The study of changes in the respiration rate of the melon ladybug was carried out at the stage of imaginal life, at which measurements of other parameters were also carried out in order to identify the role and nature of gas exchange in different periods of the imaginal life of the beetle (Figure 5).



Pre-winter feeding 2017 wintering 2018 feeding beetles after wintering
Fig. 5 - The respiration rate of the melon ladybug at different stages of the imaginal life

As can be seen from the data presented, the intensity of oxygen consumption in the melon ladybug during the pre-winter feeding period is quite high. The average volume of absorbed oxygen at this time was 980 mm3 g / h in females and 1126 mm3 in males. But within 15-20 days after the beetles leave for wintering, the intensity of their respiration decreases almost twice. In November, the level of oxygen absorption in females is 456 mm3 g / h, and in males - 428 mm3. The minimum volume of oxygen absorbed by beetles is observed throughout the entire wintering period and averages 180-254 mm3 g / h in females, 170-204 mm3 in males.

Judging by the change in the intensity of gas exchange, the state of deep physiological inhibition of metabolism in the melon ladybug lastes from December to March. During this period, the beetles are in a state of deep dormancy, and are probably the most resistant to low temperatures. With the transition of

hibernating beetles to active life (April), the level of their respiratory metabolism increases significantly.

THE DISCUSSION OF THE RESULTS:

Our studies of the physiological characteristics of the winter dormancy of the melon ladybug, associated with the study of water exchange and reserve substances, due to which the life of the body is maintained during a long period of rest, their dynamics of accumulation and consumption, as well as identifying the features of gas exchange, allows us to make some generalizations.

A change in metabolism, as a result of which winter dormancy occurs, appears in the melon ladybug long before the beetles, having stopped feeding, go to winter. The accumulation of reserve substances begins from the first days of feeding of young beetles of the summer generation and reaches large values by the time of the manifestation of the reaction of negative phototropism, which marks the transition of the insect to dormancy. In this regard, the individual weight of beetles increases significantly, although the relative content of water in their body, as the stage of pre-winter feeding and the release of the intestines, decreases markedly.

When beetles leave for winter dormancy, the water content in their body decreases significantly. This, in turn, leads to a decrease in metabolic rate. Determination of the intensity of oxygen consumption in the melon ladybird showed that after 30 days of pre-winter feeding, the level of oxygen absorption dropped more than two times. This fact confirms the reduction in the general level of metabolism in the body of beetles. Reserve substances (fats) in winter are consumed very sparingly and therefore their amount decreases insignificantly during the winter is known that insects have two main wintering strategies. They survive the winter season either by being able to withstand the freeze or by avoiding it. In both cases, resistance to low temperatures is provided by a whole set of organic substances, the synthesis and accumulation of which is triggered and regulated by certain signaling factors of the environment. In species that avoid freezing, such substances include proteins - antifreeze, polyhydric alcohols and sugar.

The synthesis of proteins - antifreezes begins after the onset of a certain photoperiod. For example, the lowest temperature at which freeze-tolerant Pythodepressus beetles survive is a function of the glycerol concentration in the hemolymph prior to freezing. The lowest temperature in beetles without glycerol in the hemolymph was 7.5 ° C, and in beetles containing 1500 ml of glycerol in the hemolymph - 27 ° C (Zachariassen Karl, 1977). A number of authors showed in different insect species that the more severe the temperature conditions of wintering, the higher the glycerol content in the insect organism and the lower their hypothermia point (Dudash, 1980, 1984; Hansen and Viik, 1984; Baust, Rojas, 1985, etc.).

In cold-resistant insects, glycerin increases the ability to hypothermia, prevents tissue fluids from freezing and thereby allows insects to better endure the harsh winter period. It is possible that the melon ladybug has a similar resistance mechanism to low temperatures.

Judging by the intensity of oxygen consumption and a decrease in water content, the most profound state of inhibition of metabolism continues in the melon ladybug until mid-March. Further, the water in the body of the beetle gradually becomes more and the intensity of gas exchange begins to increase.

After the beetles leave wintering, the water balance is restored, the intensity of gas exchange and tissue metabolism increases to the limits typical for the period of active life. Spring warmth and abundance of food shortens the recovery period, and vice versa, cold slows it down and lengthens it.

CONCLUSIONS:

The results of the studies allow us to draw the following conclusions:

1. The departure of a melon ladybug for wintering is characterized by the termination of active nutrition, the release of the intestines from food debris, a decrease of the water content in the body and the accumulation of fatty substances in the body of beetles.
2. The water content in the body of beetles during the wintering period is almost unchanged; in overwintered beetles, i.e. during the period of active feeding, the water content in the body of beetles increases due to food.
3. During the wintering period of the melon ladybug, fat reserves are gradually consumed, and the most intensive fat consumption is observed after wintering, during the period of active locomotor activity.
4. The maximum weight of beetles of both sexes is reached during the pre-winter feeding period. As the beetles leave for winter, the body weight noticeably decreases during the spring, i.e. until the beginning of the recovery period, the weight of the beetles remains almost constant. After wintering, during the period of active feeding, the wet weight of the beetles increases slightly. The dynamics of the average dry weight in the winter and recovery periods is similar.
5. The intensity of oxygen consumption during the pre-winter feeding period is quite high. As the beetles leave for hibernation, the respiration rate decreases almost two times. During the wintering period, the oxygen consumption by beetles is observed at a minimum level. The wintering period of the melon ladybug is characterized by a decrease in the activity of gas exchange and inhibition of all tissue metabolism.

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