

XI. Internationaler Kongreß für Entomologie

Wien, 17. bis 25. August 1960

VERHANDLUNGEN

Band III

(Symposien)

Wien 1962

Herausgeber: Organisationskomitee des XI. Internationalen Kongresses für
Entomologie, Wien 1960

Schriftleitung: Prof. Dr. Hans Strouhal und Prof. Dr. Max Beier, beide
Naturhistorisches Museum, Wien I, Burgring 7

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Fig. 1. Artificial gathering place for wintering of *Brumus octosignatus* Gebl.



Fig. 2. Artificial gathering place for wintering of *Semiadalia undecimnotata* Schneid.

in einer Reihe die S-SO-O-Winde (Geschwindigkeit hauptsächlich 2—6 m/sek.), die offenbar Kohlschabenimagines von dem Gebiete der Sowjetunion brachten (Kanervo 1960). Eine ähnliche Wanderung ist auch in vielen anderen Fällen (Ormerod 1892, Hardy 1938, Harcourt 1957, Williams 1958, festgestellt worden.

LITERATUR

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SEASONAL MIGRATIONS OF LADY-BIRDS *BRUMUS OCTOSIGNATUS* GEBL. AND *SEMIADALIA UNDECIMNOTATA* SCHNEID IN CENTRAL ASIA

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(See plate V)

The lady-birds *Brumus octosignatus* Gebl. and *Semiadalia undecimnotata* Schneid are widely distributed in Central Asia and have here regular seasonal migrations. They hibernate in colossal accumulations on peaks of low mountain ridges; the *Brumus* likewise hibernates in windward tops of hills. The *Brumus* hibernates at altitudes from 400 to 2,500 metres above Sea Level, the *Semiadalia* — at altitudes of 2,000 metres and higher. The *Brumus* gather at the base of shrubs and grassy growths, the *Semiadalia* — between stones and in the cracks of rocks. The discovery of abundant accumulations permitted us to carry out observations over scores of assembles of both species. On ridges at altitudes from 2,000 to 2,500 metres the *Brumus* begin to gather about the 20th of July, at altitudes 1,500 to 1,600 metres — during the first ten days of August and at altitudes from 400 to 600 metres — from the middle of August. The gathering of *Semiadalia* at altitudes characteristic for this species occurs approximately five days earlier than the *Brumus*. The gathering at once becomes of a mass character. Intensive gatherings continue on separate ridges for three days and then gradually slackens off and after two weeks only individual beetles flying in from the valleys are observed. (The gathering begins about eight o'clock in the morning and ends by six-seven o'clock in the evening.) The temperature and humidity does not influence directly the gathering of lady-birds in the winter gathering places. We observed the gathering at 19 to 94 per cent. relative humidity and at temperatures from 20 to 36°C.

The time of the gathering for wintering depends on the time the beetles hatch from the pupae of the last generation. On mountainous slopes at altitudes from 1,100 to 1,500 metres the *Brumus* develops in one generation during the summer but on the

plains of Northern Uzbekistan and South Kazakhstan — two generations. The critical lower barrier to the development of the *Brumus* is the temperature at 20°C., (the higher barrier for the development of this species is the temperature at approximately 36°C.). The lower barrier for the development of the *Semiadalia* is equal on the average to 13.6°C. Beetles gather for the winter without nourishment with ample quantities of fat in their bodies.

The beetles prefer to settle down in old gathering places, this permits us to map out the gathering places. In the old gathering place of many year's standing, the beetles are attracted not only by the convenient location of the place but also by the smell of the old bodies of lady-birds. However, the smell of beetles, killed by the fungus *Tarichium*, frightens them off. The amount of insects in separate gatherings of both species is extremely different: from a few score of specimens to several hundred thousand specimens in one place. The more ordinary places have several thousand and tens of thousand of specimens. Both species of lady-birds studied—sit during the cold periods—at temperatures lower than 13°C., in dense masses. On being disturbed, already at a temperature of 12°C., they begin to move their antennae, legs and even crawl, but, later they again crowd into dense masses. Places suitable for the lady-birds to hibernate are so specific that the author and his assistants could without climbing from the foot of the hills and mountains determine the presence of the beetles' winter gathering places on them. The conditions necessary for the gathering of the lady-birds for winter were checked by creating artificial gathering places and placing them on watersheds of not big mountain ranges, which may be seen from the photographs—for the *Semiadalia* heaps of stone, for the *Brumus*—well ventilated boxes with wormwood bushes and a handful of old bodies of beetles. A great amount of beetles accumulated in the artificial gathering places.

The dispersal flight of the beetles in spring from gathering places lying at lower levels occurs earlier than that from the more elevated locations. It has been proved by observations with the help of thermometers, thermographs and psychrometers as well as by the dissections of the beetle's sexual system, that temperature and humidity have no direct influence on the flying away. They influence only indirectly, determining the time of the development of the sexual products and the beetles with the initial stage of the development of ovaries and testes fly away but earlier than this stage they do not fly away. We believe, that here must be place for incretory action. While the gathering of beetles takes place promptly and extremely intensive in Autumn, the dispersal flight in Spring is very prolonged in time and prolixity, it is more considerable in the *Semiadalia* than in the *Brumus*. From the biological point of view, the dispersal flight is co-ordinated with the time of the appearance of aphides in the valleys. (The more common food [in spring] of both species of lady-birds in Central Asia is the aphid *Macrosiphum jaceae* L.) After the dispersal flight and up to the moment of egg-laying the *Brumus* requires food in the course of fifteen days on the average and the *Semiadalia*—eleven days. The dispersal flight from mountain ranges, thanks to the different altitudes of winter gathering places, go parallel with the amount of the aphides in the valleys. From the more lower gathering places the dispersal flight of the lady-birds ends in the middle and in the third decade of April. From the most elevated locations the beetles end their dispersal flight towards the end of May. In the warm early spring time some large accumulations of *Brumus octosignatus* may break-up into much smaller groups

The data received by us on the biology of the *Brumus octosignatus* and *Semiadalia undecimnotata* allows us in the following manner to interpret from the general biological point of view the reasons for their seasonal migrations. The active life of these lady-birds is closely connected with periods of propagation of the aphides in Central Asia, living on xerophilous vegetation. In the period of hatching from the pupae of the second

generation of lady-birds the plant vegetation ends in the steppes of Central Asia and South Kazakhstan and the amount of aphides reduces to a minimum. No reserves of food remain for the lady-birds, although the temperature is favourable for their active life. The instinct (evidence from extremely ancient times and in a long line of generations) in the lady-birds was worked out for flying away to cooler places where the beetles loose their activity. And the beetles which did not fly away had to perish from starvation by not leaving their offspring. When the larvae feeds abundantly, the beetles of the second generation hatching from the pupae possess such an amount of fat that they may endure a prolonged hibernation right up to the time of the mass appearance of the aphides in spring. Similar accumulation of fat occurs with mammals hibernating in not an active state. The more cooler locations are the peaks of mountains which are open to the winds. The smell of beetles which died in the last wintering in the gathering places indicates to the lady-birds a more convenient place for sleeping and settling in masses, provides a better chance for survival at very low temperatures. That is why the gathering at much higher summits occurs earlier and at much lower summits later. It is possible to assume that the earlier the beetles of the second generation hatch from the pupae they migrate to greater heights.

Sufficiently high temperatures for the activity of the beetles in the mountains where occur winter accumulations of lady-birds come much later than in the valleys. Up to the time of the beetle's flight to the valley there is already active parallel propagation of aphides on rapidly vegetating plants. The beginning of the maturity of the sex glands, evidently, create in the lady-birds a stimulus to the increase of the instinct of flying away. At sufficiently high temperatures in the wintering places the beetles begin to develop sexual products. Yellowness appears in the testes of the males, there is a formation of the lower egg cell in the ovarian tubes of the females and before the dispersal flight there even occurs coupling. The complete development of the egg requires feeding, but at this time there is not enough food available for the beetles in the mountains. The unequal warming up of the lady-birds in various layers of the accumulations conditions non-simultaneous initial stages of the development of the sexual products. Here, the dispersal flight occurs even in the gathering place, located on identical altitudes above Sea Level, gradually, parallel with the growing amount of aphides in the valleys.

From this it becomes clear in the need for the *Semiadalia* to winter at much higher places than that which is possible for the *Brumus*. The thing is that the development of the sexual products in the ovaries, the embryonic and postembryonic development in the *Semiadalia* occurs considerable quicker than in the *Brumus*, regarding this we have quite detailed data, which were received at different conditions of temperatures and humidity. Under similar early dispersal flights of the *Semiadalia*, as this takes place from the lower gathering places of the *Brumus*, the *Semiadalia* would have laid eggs so early that her larvae would not have been provided with food.

The stimulus for the transmigration of the lady-bird species studied as well as the time and place for the transmigration and connected with these accumulations of specific quantities of fat masses in the beetles' bodies of the second generation, which we likewise studied, were created, thanks to the insufficiency of food for the lady-birds, beginning with the second half of the summer right up to the spring of the following year.