Aspectos Bioecológicos do Coró-das-hortaliças *Aegopsis bolboceridus* (Thomson) (Coleoptera: Melolonthidae) no Cerrado do Brasil Central

Resumo

Insetos vulgarmente conhecidos como corós são as formas jovens de besouros pertencentes à família Melolonthidae (Coleoptera). Essa família de insetos encerra um número expressivo de espécies que nas fases imatura e adulta desempenham diferentes papéis bioecológicos dentro dos ecossistemas. Ocupam quatro dos cinco níveis tróficos básicos, atuando como consumidores primários e secundários, produtores secundários e degradadores. No Brasil são registradas cerca de 1008 espécies de Melolonthidae cujas larvas se desenvolvem no solo. Algumas são consideradas pragas-de-solo importantes, pela alimentação da fase larval em raízes de plantas cultivadas, cujos sintomas são percebidos em reboleiras e se caracterizam por plantas de menor porte, amareladas, murchamento e redução drástica no estande da cultura. A ocorrência dessas pragas na região do Cerrado, independente do sistema de plantio, tem sido alvo de preocupação por parte dos agricultores pela severidade de seus danos, pela expansão das áreas atacadas, pela ocorrência sistemática em safras consecutivas e pela quase inexistência de medidas eficientes de controle. Recentemente, foram constatados danos severos causados por corós em hortaliças no Distrito Federal e em milho no Estado de Goiás. A espécie foi identificada como ***Aegopsis bolboceridus*** *(Thomson) (Coleoptera: Melolonthidae). Trata-se de uma espécie descrita de material coletado no Brasil, que até pouco tempo era considerada rara e sobre a qual pouco ou quase nada se sabe dos hábitos dos adultos ou das fases jovens. Objetivou-se com esse trabalho fornecer informações a cerca da bioecologia do coró-das-hortaliças,* ***A. bolboceridus****, que servirão de base para estudos de estratégias de manejo dessa nova praga.*

Termos para indexação: Pragas-de-solo, Coró-das-hortaliças, Ecologia.

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Bioecological Aspects of the White Grub of Vegetables *Aegopsis bolboceridus* (Thomson) (Coleoptera: Melolonthidae) in the "Cerrado" of Central Brazil

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The management strategies for white grubs necessarily involve knowledge of basic aspects of its ecology in which correct identification of species is the starting point. Studies focusing their bioecology are fundamental, because they let us learn about the white grub's behavior and its life cycle, allowing inferences regarding the most appropriate stages for the adoption of control measures. The imperative need for studies are currently focused on the development of effective tactics to keep pest populations at acceptable levels, since the attempts to contain or mitigate the damage caused by *A. bolboceridus*, by farmers, have been completely inefficient until now.

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In areas with high infestation of *A. bolboceridus*, the most critical periods are the months between December and March / April, when third instar larvae constitute the majority of population. In vegetable farms around Planaltina County (Núcleo Rural Taquara – Chácara 70), in the Federal District, all crops of bell peppers, eggplants, chili peppers, cabbage, cucumbers, cauliflower, beans, green beans and kale were lost, during 2004, 2005 and 2006. In the 2005/2006 and 2006/2007 corn harvest, *A. bolboceridus* was found causing serious losses in many farms in Água Fria de Goiás County, in the state of Goias, and Unaí County in the state of Minas Gerais.

Concluding Remarks

The absolute majority of the species of white grubs can be viewed as beneficial organisms, playing an important role in the environment as decomposers of vegetable or animal organic matter. These species, ultimately, accelerate the nutrients mineralization process, improve soil structure by incorporating organic materials to the soil, and are an important link in the complex web of relationships between different organisms. Those who eat roots, in areas not disturbed by human activity, naturally maintain their population balanced by natural enemies action. The observed damage by white grubs in areas of "Cerrado" is a recent fact, compared to earlier reports of damage caused by these insects in southern Brazil. This can be attributed to the fact that the intensive agricultural development of the "Cerrado" region occurred during the last 30 years. The advance of farming and ranching activities by uprooting the native vegetation in the "Cerrado" areas may have contributed to the environmental imbalance that ended up favoring, this or that species, which may have contributed to the emergence of insect pests never before described. White grubs were first reported attacking vegetables in the Federal District, and more recently, maize crops in Goiás and Minas Gerais States. However, due its polyphagous habit, it is possible that other crops, also of economic importance, may be affected.

The damages observed are due to root feeding by the larva (Figure 15), that leads to plant death, if they are attacked in the seedling stage. Older plants, already producing, show marked decrease in yield capacity. The most common symptoms are yellowing, wilting and finally plant death (Figure 16). Plants with these symptoms are easily pulled out of the soil; have an underdeveloped root system and present larvae of *A. bolboceridus* in the soil around their perimeter.

Figure 15. Damage caused by *Aegopsis bolboceridus* in: (A) bell pepper and (B) bean (left: plants without damage; center and right: plants with roots damaged).

Figure 16. Symptom of wilt in bell pepper caused by attack of *Aegopsis bolboceridus*.

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A. bolboceridus, its distribution is quite irregular, for example, in the same area and sampling date was found 130 larvae/m^2 in a sample and no individuals in other samples.

The vegetable with grub is native to the Brazilian "Cerrado", a fact that has been confirmed by capturing these insects with light traps in areas of native vegetation that are distant from cultivated fields. The hypothesis is that the advancement of farming and ranching activities by clearing the native vegetation in the "Cerrado" areas is one of the factors that has allowed this insect to adapt to the agricultural environment and become an important pest in some regions.

Hosts

The white grub of vegetables can be considered an extremely polyphagous species, i.e., it feeds on a wide range of plant species. In the field, it has been already observed feeding on roots of bell peppers (*Capsicum annuum* L.), eggplants (*Solanum melongena* L.), chili peppers (*Capsicum chinense* Jacq.), cabbage (*Brassica oleracea* var. *capitata* L.), cucumbers (*Cucumis sativus* L.), cauliflower (*Brassica oleracea* L. var. *botrytis*), beans (*Phaseolus vulgaris* L.), green beans (*P. vulgaris* L. var. Macarrão Brasília) and kale (*Brassica oleracea* L. var. acephala). Besides these cultures, larvae have been observed feeding on sugarcane (*Saccharum officinarum* L.), ornamental plants, tanner grass (*Brachiaria* sp.), on several weeds that grow in the vegetable fields and in native vegetation. Damage caused by *A. bolboceridus* has also been observed in greenhouse crops of bell peppers. In laboratory experiments, this species has been reared on soybean and corn.

Damage

The damages depend primarily on three factors: the larval instar of the insect, larvae population size, and plant age; the first two are the most important. Larvae of the first and second instars have smaller food capacity, or ability to consume roots, than those of the third instar. Until now, no adult beetles were observed feeding on crops.

Figure 14. Pupal chamber of *Aegopsis bolboceridus*. Pre-pupae within the pupal ch]amber (center).

During the month of May, the larvae inside the cocoons develop into pre-pupae and then into pupae. In July, they become adults and remain inactive until the first rains of October. The increase in soil moisture seems to be a sign for the insects to break the cocoons and start mating, starting a new cycle. However, the adults seem to be genetically programmed to leave the soil only during the months of September / October. In the laboratory, artificial increase of soil moisture during July and August did not make the adults become active.

The white grub of vegetables has a two-phase life cycle, each one with duration of approximately six months. The active phase occurs from September / October to March / April, represented by the adults becoming active, egg-laying by the females and larval development. The dormant phase comprises the larval diapause, pre-pupa, pupa and inactive adults, all stages occur inside the cocoons from March / April to September / October.

So far, no relationship was found between the occurrence of the white grub of vegetables and soil tillage systems, as is the case, for example, of *D. abderus*, which has preference for colonizing areas under no-tillage (GASSEN, 1993a, 1993b). Within the areas attacked by

Presentation

This publication is of great practical value. It represents the effort of the author to generate information about the bioecology of the white grub of vegetables that, under certain conditions, can become a pest, attacking many kinds of vegetables. It also shows the importance of better publicizing the research results conducted at Embrapa Cerrados on the control of different insect pests.

Most of the white grubs are beneficial; they help, for example, in the decomposition of organic matter. The damage caused by white grubs in the Brazilian “Cerrado” is a recent fact and, thus, the bioecological aspects of this pest need to be well understood to implement adequate control.

We hope that the survey results and the information contained in this publication shall be very useful and can contribute to the development of effective control tactics to keep the population of white grub of vegetables at acceptable levels and, thus, not causing economical damage.

Wenceslau J. Goedert
Director General Embrapa Cerrados

The first instar larvae appears in the field in October, and can be found until mid-December, the second instar between November and February, and the third instar larvae occurs between December and May. The distribution of larvae in the soil profile is quite variable; however, most can be collected up to 20 cm far from plant roots. Some, however, have been found more than 50 cm in depth, near or on decaying wood stakes. The larvae, in all instars, feed on roots of many plants. However, field observations have suggested that this species is able to survive long periods without food or feeding of decaying vegetable material.

The third instar larvae are the most voracious and capable of causing the most damage to cultivated plant species. At this instar, the larvae are active from December to March, feeding continuously on the roots in order to store energy. The larvae built small chambers within the root system for feeding purposes (Figure 13). In the end of March, they stop feeding, become less active, empty their digestive tract and decrease significantly in size. Using their own saliva, the grubs build elliptical shape clay cocoons with about 5 cm in diameter (Figure 14). Once inside, they enter into diapause, a state in which the insect does not feed and greatly reduces its metabolism. These cocoons are quite resilient. They have a smooth and compact internal coating and can be found at different depths in the soil profile.

Figura 13. Food chamber of *Aegopsis bolboceridus*.

Behavior

Aegopsis bolboceridus is a univoltine species, since it produces only one generation per year. The four stages (egg, larva, pupa and adult) of development of *A. bolboceridus* occur on pre-defined periods during the year and always within soil, except for the adult stage, that leaves the soil in swarms during mating season. White grub of vegetables has its life cycle synchronized with the environmental conditions in the "Cerrado". The immature stages (larvae), those that feed on roots, are active during the rainy season (October to March / April). In the dry season (April / May to September), they stop feeding, developing into pupae and, posteriorly, adults who come out of the soil to mate and start a new cycle at the beginning of the rainy season each year.

With the first rains in September/October, adults of *A. bolboceridus* leave the soil, usually in the evening, and through the release of sex pheromones, males and females mate. After mating, the females bury themselves to lay there fertilized eggs. Eggs can be found in the field during the months of October and November. They are placed into the soil very close to each other, within a small isolated chamber built by the female (Figure 12) in a depth that usually does not exceed 15 cm. The eggs are very resistant and remain viable even when the soil has low humidity.

Figure 12. Oviposition chamber of *Aegopsis bolboceridus*.

Sumary

Figure 9. Adult of *Aegopsis bolboceridus* (male).

Figura 10. Adult of *Aegopsis bolboceridus* (female).

Figure 11. Differences in size observed in *Aegopsis bolboceridus* (males).

Figure 8. Pupa of *Aegopsis bolboceridus* (female).

Adult

Adults of *A. bolboceridus* are beetles whose color varies from dark-brown to reddish. They present front fossorial legs (adapted for digging) with the presence of three external tibial spines and a thorn on the apex of the tibia. It is possible to observe in the hind legs the presence of several spines and reddish-brown hairs, which are also found throughout the insect's thorax and abdomen. There is sexual dimorphism in this species, with the presence of two extensions in the form of horns on the head and prothorax of the male (Figure 9), but not on the female (Figure 10). Adult females measure about 26.0 mm and the males can reach up to 36.0 mm (including the length of the thoracic and cephalic extensions). The adult size seems to be conditioned by the quantity and quality of the diet of the insect in the larval stage. So, larvae that had access to more nutritionally adequated food, and are capable of accumulating more reserve, will result in larger insects. Size variation of up to 80% in length in adults has been observed. In *A. bolboceridus*, the size difference between adults can be such (Figure 11) that some small individuals may be erroneously identified as belonging to another species.

Bioecological Aspects of the White Grub of Vegetables *Aegopsis bolboceridus* (Thomson) (Coleoptera: Melolonthidae) in the "Cerrado" of Central Brazil

Charles Martins de Oliveira

Introduction

The Brazilian Federal District, located between the coordinates 15°30' and 16°03'S and 47°19' and 48°12'W, despite its small area, is currently one of the greatest producers of vegetables in Brazil. This activity is responsible for 35% of the agricultural GDP (Gross Domestic Product) in this region. The production of vegetables is often carried out by smallholders, working with a narrow margin of profit, and totally dependent on market price fluctuation. For this reason, and because many of the cultivated plant species have a relatively short life cycle, producers carry out a strict phytosanitary control program, to avoid losses caused by insect pests and diseases. The vegetables produced in the field or in greenhouses have a wide range of pests that can damage leaves, stems, roots and tubers.

It has been observed, in recent years, severe damage caused by beetle larvae in various plant species in the Federal District vegetable producing areas (Núcleo Rural Taquara, Planaltina/DF, Brazil). These larvae completely destroy the root system of plants, causing their death. The damage has been observed in the rainy season, mainly between the months of December and March in both, field and greenhouse. Attempts to control this problem using chemical pesticides did not achieve any satisfactory result.

This new insect pest was identified by Dr. Miguel Angel Morón (Department of Biosystematics of Insects, Instituto de Ecologia, AC Apartado Postal 63, 91000, Xalapa, Veracruz, Mexico) as belonging to the species *Aegopsis bolboceridus* (Thomson) (Coleoptera: Melolonthidae) and will be referred to here on by the common name "white grub of vegetables". This is a beetle species which was described from material collected in Brazil, in which, until recently, it was considered rare. Little is known about the habits of adults or younger stages (eggs, larvae and pupae) of this species and even about other members of the tribe to which it belongs (Agaocephalini). Also, there are no reports of this species as an agricultural insect pest in the world. Besides the white grub of vegetables, other species of white grubs were reported in Brazil attacking various crops such as maize (*Zea mays* L.), soybean [*Glycine max* (L.) Merrill], wheat (*Triticum aestivum* L.) and sorghum [*Sorghum bicolor* (L.) Moench] (AVILA; RUMIATTO 1997; HABE et al., 2001) in the "Cerrado" (Savannah) region, mainly in the states of Mato Grosso do Sul (RUMIATTO; AVILA, 1997), Goiás, Mato Grosso, and the Federal District (SALVADORI; OLIVEIRA 2001).

The purpose of this work was to provide information about the bioecology of white grub of vegetables, *A. bolboceridus*.

The White Grubs

White grubs are beetle larvae (Coleoptera) belonging to the family Melolonthidae (ENDRÖDI, 1966; MORÓN, 1997, 2001; MORÓN et al, 1997); These insects are holometabolic (complete metamorphosis), presenting four stages: egg, larva, pupa and adult. The larval stage is the longest and consists of three sub-stages (instars), where the insect undergoes two successive molts, increasing considerably in size. The life cycle is usually quite long, with some species taking up to three years from egg to adult emergence.

In the adult form, the beetles usually have legs with thorns, five articulated tarsal segments and the characteristic lamellated club antennae formed by the last 3-7 segments of the antennae. Some species may have extensions in the form of horns on the prothorax and

Figure 6. Setae pattern on the tip of the larva abdomen (raster).

Pupa

The white grub of vegetables has an exarate pupa, i.e., the thoracic appendages, legs and wings are visible and easily detached from the body. The pupae have a caramel-brown coloration, and, in those that give rise to adult males, it is possible to verify the presence of two extensions in form of horns on the head and prothorax (Figure 7), which was not observed in female pupae (Figure 8). The female pupa has approximately 33.0 mm in length, and the male has 37.0 mm.

Figure 7. Pupa of *Aegopsis bolboceridus* (male).

Figure 3. First instar larvae of *Aegopsis bolboceridus*.

Figure 4. Second instar larva of *Aegopsis bolboceridus*.

Figure 5. Third instar larva of *Aegopsis bolboceridus*.

/ or head. As for size, there are species with less than 1 cm to some more than 15 cm in length, sometimes larger and heavier than small vertebrates (SALVADORI; OLIVEIRA, 2001). Their colors vary from dark and frosted to very metallic and bright. In relation to their feeding habit, the adults of this family can feed on leaves, flowers, fruits, pollen, nectar, plant exudations, humus, manure, carcasses of animals and fungi, and some species may be predatory to other insects (MORÓN, 1997). However, there are species in which the adults do not feed.

Worldwide, there are around 20,000 species of insects belonging to the family Melolonthidae (MORÓN, 2001) and the South America is probably the Neotropical region with less data about its described species within this family. However, there may still be a considerable number of undescribed species worldwide.

The larvae are scarabeiform. Present body of milky-white color, C-shaped, with three pairs of legs and a dark colored head. The larvae show negative phototropism, living in environments with no light, and most of them can be found in the soil. Some species live in rotting tree trunks or even associated with birds or rodents nests or colonies of social insects (termites, ants ...) (MORÓN, 1997). The white grubs that live in the soil can build permanent galleries from which they come out to look for food. Many species feed on organic matter (plant, animal, humus, rotting animal carcasses) and can be considered beneficial because of their important role in decomposition and incorporation of organic matter, mineralization of nutrients, aeration and improvement of soil structure, besides serving as food for many organisms such as predators, parasitoids and pathogens. Others are phytophagous, feeding on seeds, roots or young plants. When these species are established in cultivated areas, they can be considered serious pests, depending on the population level, its feeding capacity and economic value of the culture in question. The symptoms of white grub attack generally occur in patches characterized by smaller, chlorotic plants, and a drastic reduction in plant population (OLIVEIRA et al. 1997; OLIVEIRA, 2000) Most severe losses occur when plants are attacked in the early stages of their development (OLIVEIRA et al. 1997; OLIVEIRA, 2000).

In Brazil, some species of white grubs are considered important pests in several crops of high economic value, especially in the Southern region, for example *Diloboderus abderus* (Sturm) (GASSEN, 1989; SILVA 1995; SILVA et al., 1996), *Phyllophaga triticophaga* Morón & Salvadori (SALVADORI, 2000) and *P. cuyabana* (Moser) (OLIVEIRA et al., 1997), attacking crops such as corn, wheat and soybean.

White Grub of Vegetables: bioecological aspects

In scientific literature there are no reports about the species *A. bolboceridus* causing damage to cultivated plant species and there is no basic information about its life cycle and behavior.

Life cycle

Egg

The eggs of *A. bolboceridus* are initially elliptical. During the embryonic stage they become spherical, gradually increasing in volume. They have a white-opaque color and the chorion resistant and flexible. The eggs measure about 4.1 mm in diameter (Figure 1). The incubation period, under controlled laboratory conditions, ranges from 13 to 19 days.

Figure 1. Eggs of *Aegopsis bolboceridus*.

Larva

The larval period is the longest and lasts approximately 60% of the biological cycle of the white grub of vegetables. At this stage the insect passes through three larval instars, where the larva sheds its skin two times and increases in size (Figure 2). The larvae, after hatching, measures approximately 14.0 mm in length (Figure 3), reaching 21.8 mm at the end of the first instar. The second and third instars larvae retain the same morphological characteristics of the first, however they increase significantly in size, reaching, at the end of each phase, approximately 42.0 mm (Figure 4) and 86.0 mm (Figure 5) in length, respectively. The white grub has a C-shaped body, with milky-white color and three pairs of thoracic legs. The head is well sclerotised, brown colored and armed with a pair of powerful jaws. Especially in the second and third instars larvae, the terminal portion of the body is long and it is possible to observe, through the integument, the presence of soil in its interior, which is eaten together with the roots, giving this region a dark-brown color. The larvae also presents nine pairs of reddish elliptical spiracles (respiratory structures), each pair located on opposite sides along the body. Near the head, and above the first pair of spiracles, there are two irregularly shaped spots of orange-red color. The entire body of the larva is covered with setae. The ventral terminal region (raster) of the grub displays characteristic setae arrangements, which have taxonomic value (Figure 6).

Figure 2. *Aegopsis bolboceridus* larva soon after moult from second to third instar.