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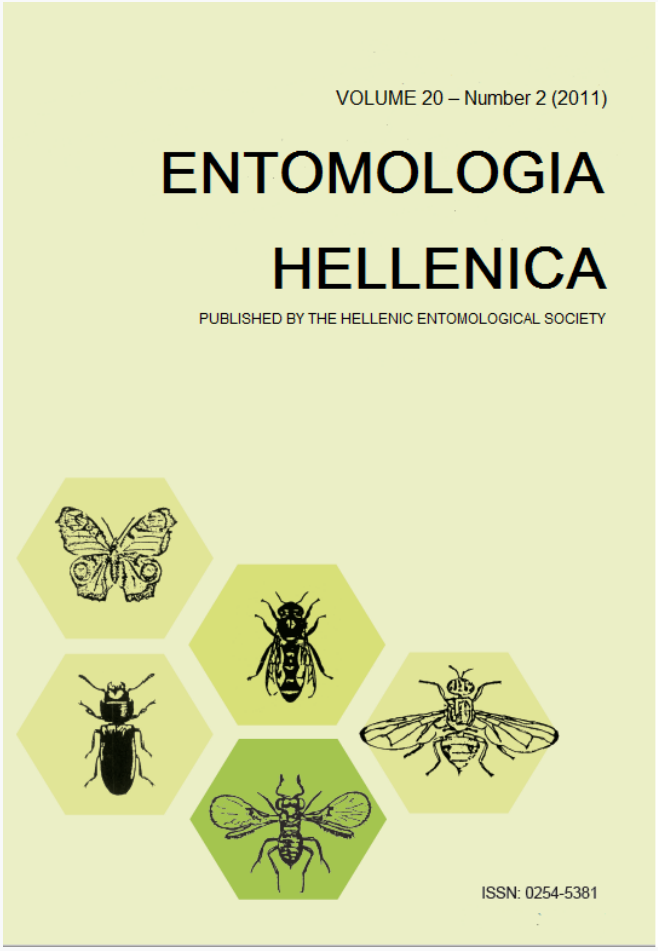

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Bio-Ecological Research of Lily Leaf Beetle *Lilioceris lilii* Scopoli (Coleoptera: Chrysomelidae) in Bosnia and Herzegovina

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ABSTRACT

In the present study some bio-ecological characteristics of *Lilioceris lilii* in Bosnia and Herzegovina are presented. The insect's presence was confirmed in the majority of the researched locations in Bosnia and Herzegovina. The average body length of *L. lilii* was 7.64 mm (7.025 mm for the males while 8.106 mm for the females) and the average body width 3.75 mm. The average length of a fully developed larva was 6.36 mm, and the average width was 2.69 mm. In terms of the cocoon, the average length was 8.83 mm and its width was 5.82 mm. Duration of embryonic development under field conditions was 8.5 days in average. The average duration of larval development (4 instars) was 16 days and the pupal stage lasted approximately 18 days. *Lilioceris lilii* retreated into winter quiescence at the beginning of autumn, thereof completes one generation per year. In the area of Sarajevo in field conditions the number of the laid eggs per female was 130 in average. The insect undergoes its entire development at the Asian and Oriental species of lily, on all the above-ground parts of the plants. *Lilium candidum* lily species that was present in all home gardens in the observed areas was the major host of the *L. lilii.* Experimentation with *Aloae vera* proved that this species was not a host of *L. lilii*.

KEY WORDS: Lily beetle*, Lilioceris lilii,* Liliacae.

Introduction

The *Liliaceae* family contains almost 4000 species and more than 280 genera propagating mostly via bulbs, rhizomes and tubers. It is prevalent throughout the Earth, except for the Arctic zone, and present for the most part in subtropical and temperate areas. They are perennial (rarely annual) herbaceous or woody plants. Many of them grow wild and they are edible, present at meadows and pastures, but are also cultivated for their decorative and bright-coloured flowers.

Representatives of the *Liliaceae* family are divided into several groups based on the structure of underground stems and fruits, as well as the structure of flowers. Decorative flowers are the main reason why numerous plants from this family are present in parks, gardens or areas of city greenery. Those are tulips, lilies, daffodils, amaryllises, etc. They can be cultivated in closed or open areas, in a vicinity of shrub-like plants, as well as in grass areas. Some species are suitable even for rocky grounds. Majority of lilies are esteemed as cut flowers. Numerous species of this family have intensive scent used as an extract in a perfume industry and therapeutic oils (representatives of *Aloae* genus), and they are applied in pharmacy and cosmetics industry. Prevalent and valued agricultural vegetable cultures belong to the *Allium* genus. There are eight types of lilies: Asian Hybrids, Oriental Hybrids, Martagon Hybrids, Candidum Hybrids, American

Hybrids, Longiflorum Hybrids, Trumpet Hybrids and wild species. In Bosnia and Herzegovina, there is a well-known wild species of lily named *Lilium bosniacum* (Beck) Beck ex Fritsch prevalent in mountain meadows and pastures (Fig. 1).

FIG. 1. *Lilium bosniacum* (photo: Cigankovic D.)

Upon the initial information on the existence of the pests, of the genus *Lilioceris* in Bosnia and Herzegovina, the goal of the research was to establish the insect's distribution in Bosnia and Herzegovina as well as an overview of its characteristics of morphology, biology and ecology.

In addition, because of the hypothesis that *Aloae,* with its specific characteristics valued as a medicinal plant, might show inhibitory characteristics towards the *Lilioceris lilii* Scopoli (Coleoptera: Chrysomelidae) pest, was also examined the possibility of the development of the insect on the *Aloae* plants (Fig. 2).

FIG.2. *Aloae vera.*

Materials and Methods

In the late 2006 and early 2007, intensive collection on information material on the insects began. Most of the data were collected in cooperation with available foreign authors and via the internet.

The determined method implied a follow up of the pests' life cycle with the pairs of *L. lilii* placed onto feeding lily plants. This method ensured a sufficient number of specimens (eggs, larvae, pupae and adults) for laboratory examination and statistical analysis, as well as determining population estimation. The plants were preliminary planted in 30 x 30 x 30 cm size flowerpots and protected by tulle nets, with 0.5 to 1.0 mm mesh, on a construction made of wooden bars (Fig. 3).

FIG. 3. Flowerpots with the planted lily plants.

The experiment for the research of the *L. lilii* was set up in two locations in Sarajevo, in Višnjik and Šip. Adults were collected in natural conditions at the beginning of the experiment. After their placing onto the experimental plants, a complete life cycle was monitored in a two-year research.

The flowerpots in which the development cycle of the researched pest was followed were placed in accordance with a prepared experiment plan at the 1.2x4.5 m and 1.2x5 m terraces. Each flowerpot was numerated

and marked on the outer surface. For the purpose of precise air temperature monitoring, thermometers were placed.

The first planting of the feeding plants, lily hybrids imported from Holland, was carried out on 16th March, 2007. The lily plants were planted in groups, two to four plants per flowerpot. The planting was carried out in properly determined gaps, and the plants had favourable conditions for their complete development, which enabled monitoring development stages of *L. lilii*. In order to determine the insect's presence and collect samples for the beginning of the research, the locations presented in Table 1 were chosen. In a total of 37 locations, comprising a single wide area, an average of 5 households was examined. The research was conducted during 2007 – 2010. Locations outside of Sarajevo and the mentioned city settlements were selected in accordance with geographical position in the southern, eastern, northern and western part of Bosnia and Herzegovina. The locations in the Sarajevo Canton were monitored several times a year during this research (at least three visits per year). The city settlements were visited more often, every 15 – 20 days during one year, except in winter when no on-site location research was carried out.

The adults after their collection copulated. Each pair was carefully set aside into separate containers and 1 – 2 days later they were isolated onto developed plants in flowerpots underneath net cages. The research was completely monitored in such natural controlled conditions.

At the end of the summer in 2007, seedling of plants were collected and prepared for the second year of research (2008). The same bulbs were used that were not taken out from the flowerpots during winter, and a number of plants were supplemented by a purchase and transfer of new bulbs from home gardens in the researched locations in 2007. During the winter-time period in 2007 and 2008 five (5) flowerpots were singled out from the experiment of the previous year, as well as the flowerpots with newly planted bulbs. They were kept in a protected area. As a protected area, a 1.5x3 m glassed-in terrace was used, where the experimental flowerpots were taken in the early winter of 2007, when temperatures were around 0°C. For the protection against freezing at the open terraces during the winter, ten (10) experimental flowerpots with sprouted lilies were planted in the late summer 2007 in greenhouse. A number of flowerpots remained in open terraces during the winter without protection from freezing, host plants are well known as cultures cultivated in open areas (nursery gardens, home gardens), and the researched pests were known as the pests on those cultures. For the purpose of the experiment in spring and summer 2008, already developed plants from the nursery garden were used. A total of 50 lily plants of various colours (red, white, yellow, orange and pink) were used in this experiment. For the set hypothesis on a possibly new feeding plant, i.e. its zoocidal effect, in the second year of the research (2008), five (5) *Aloae* seedlings were included into the experiment. The *Aloae* plants were transplanted from the mother plant from the home collection in the Visnjik location.

Eggs from the lily plants were placed onto the *Aloae* leaf, initially laid onto those plants by the female adults of the researched insects. Likewise, larvae already hatched or larvae, which fed on lily plants for a while, were placed onto the *Aloae* plants.

During the two-year research, eggs, larvae and adults were used for further rearing, and a part was kept in 70% alcohol as a material for laboratory analysis (measurements, recordings), carried out in the laboratory of the Faculty of Forestry in Sarajevo in 2008.

During the collection of the specimens from the experiment, the larvae that were the most developed were left on the plants in order to obtain a new generation. The same was done with a certain number of adults, upon obtaining a new generation. A lesser number of adults were left on the plants in

order to detect the moment of retreat into winter quiescence during winter. By the observation of the on-site appearance of insects, a life cycle of the researched insects was monitored in natural conditions, primarily for the purpose of their verifying and comparison to the rearing in controlled natural conditions.

During the collection of the eggs from the experiment, ten (10) eggs were singled out to separately planted lily plants in five (5) separate flowerpots for the examination of the development of the larval instars.

The number of the larval instars was determined by placing one, two or three at most, eggs per plant on the leaves of every separately planted lily in different flowerpots. Egg specimens from the same egg litter were placed onto every plant. By a daily observation of the plants, and later the larvae during their development and feeding on a leaf, through measurement and classification of the larvae by their size into several groups, number of development instars was determined.

The first attempt to reach the pupal stage was carried out in 2007 by placing the most developed larva, together with plant leaves (1 – 2 leaves) and soil from the flowerpots where they initially developed and fed into glass test tubes in favourable conditions.

A specimen of the pupal stage was obtained in 2008 by rearing on separate plants. From every placed couple, 5 to 10 most developed larvae were singled out, for which it was assessed, in accordance to their dimensions and a time period of their development, that they should soon reach the pupal stage. For this part of the experiment, it was necessary to look for new plants in adequate development stages. Through the observation of larvae in the flowerpots and on the plants, the time when they went underground to cocoon was recorded. After 7 – 15 days, digging of the flowerpots was carried out where pupae were formed, and the material for laboratory analysis was collected that way. The cocoons were being taken out periodically, after 7 days the earliest, and 15 days after placing the larvae, at the latest. From every couple separately, the cocoons were singled out into glass test tubes. The sample for further analysis, measurement and recording contained a total of 114 cocoons with the *L. lilii* pupae. Every flowerpot with the separate plants and larvae singled out for the stage of forming pupae was carefully searched. The plants were taken out from the flowerpots and formed cocoons with pupae were found in the root system zone. Adults emerged from these cocoons were singled out and included into the total. By rearing the adults, a large amount of specimen for the analysis was formed, and in two years of the research a new generation was obtained.

The surface on which the measurements were carried out was a millimetre paper covered by a transparent glass panel. The eggs were collected in the experiment during 2008 periodically, and a measurement preparation was provided from the newly collected eggs. The eggs were measured on the same day or 24 – 36 hours later. The specimens of larvae, pupae and adults collected during the experiment and conserved in the test tubes filled with 70% alcohol, were used for providing microscope slides. The material was collected periodically, since the extended oviposition period enabled all later development stages during the entire year. The content of all the specimens from the individual test tubes was measured separately. The specimen preparation procedure implied emptying a test tube into a Petri dish, separating units from the samples onto the subject glass placed onto the millimetre paper and measured under the microscopic magnification. The specimens of individual organs were prepared the same way, but they were separated with the use of pincers. During the measurement and adequate observation (0.8x), recordings of a part of the specimens of eggs, larvae, pupae and adults were carried out. For the entire

laboratory analysis, microscopes and binocular stereomicroscopes of different types and possibilities for magnifying objects were used ("Leica-BF 200", "Leica MZ-12", "Wild", "Leitz", "Forty- American Optical", "Dongwon").

Results

Dispersal

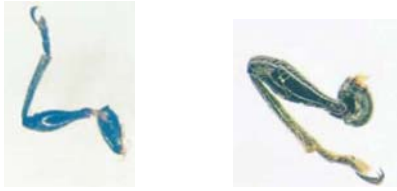
According to the data presented in the Table 1 form the locations researched, it can be concluded that the *L. lilii* is present in the entire territory of Bosnia and Herzegovina (Fig. 4). In terms of the horizontal distribution of the pest in Bosnia and Herzegovina, this species was noticed in the area from Visegrad and Gorazde in the east to Bosanski Petrovac in the west; in the north from Brod to Grude and Siroki Brijeg in the south of the country.

In terms of the vertical distribution, the highest point is the Trebevic-Miljevici location, 676 meters above the sea level, and the lowest is Grude-Mamici, 325 meters above the sea level.

FIG. 4. Locations in which the presence of the *Lilioceris lilii* was determined.

Morphological Characteristics

Adult: The *L. lilii* species (lily leaf pest) has a red chitinous covering. It is easily spotted in its natural environment, which was important for the identification of the insect during the on-site specimen collection. Its legs are black and covered in hair (Fig. 5). Since the adults copulated immediately during their collection in hunting containers, in cases that they were not collected in an on-site copulation process, a difference in size between males and females was observed, which was later confirmed in the laboratory measurements. The position of the head is orthogonal, with a pair of antennae (tentacles) positioned in front of the eyes. The antennae are composed of 11 joints and they are black. On a sample of a total of 246 adults of the *L. lilii* species, the measured average length of the body was 7.64 mm. The average width of the body for the *L. lilii* species was 3.75 mm (Fig. 6).



(a) (b)

FIG. 5. Front leg (a) and hind leg (b).

(a) (b)

FIG. 6. *Lilioceris lilii* adult – dorsal view (a) and ventral view (b).

TABLE 1. Locations and numbers of the collected specimens during the study (2007 – 2010).

Location	Number of collected specimens		
	Adults	**Larvae**	**Eggs**
Tarčin	0	0	0
Hadžići	0	0	0
Vogošća - Hotonj	10	10	10
Bare-Šip	10	30	20
Sarajevo – Koševsko brdo	12	20	0
Sarajevo - Betanija	0	0	0
Sarajevo -Nahorevo	0	0	0
Sarajevo - Višnjik	2	1	0
Sarajeyo (ul. Tepebašina)	4	12	0
Trebević - Miljevići	0	0	0
Mišević - Rakovica	2	2	0
Podlugovi	2	3	7
Srednje	2	0	0
Doboj - Derventa	0	0	0
Brod	3	3	0
Prijedor (ul. Đ. Đakovića)	0	5	0
Banja Luka - Mejdan	5	19	0
Kakanj	10	20	20
Kraljeva Sutjeska	3	0	0
Vitez - Grbavica	0	9	0
Donji Vakul (Hadžića Hise)	1	2	4
Jajce (Varoš)	0	8	0
Ključ	1	12	0
Bosanski Petrovac (ul. Jukića)	2	30	20
Bosanski Petrovac (Central)	0	39	0
Sanski Most (ul.Tomina)	1	23	12
Višegrad	0	0	0
Goražde	1	2	0
Puračić (kod Lukavca)	2	5	0
Konjic - Prkanj	1	3	0
Jablanica (ul. P. Bilića)	4	25	4
Mostar	2	0	0
Mostar - Vrapčići	0	10	0
Capljina - Ševaš Njive	0	30	16
Široki Brijeg	1	5	0
Grude-Mamići	5	2	0
Grude-Ledinac	4	5	8

Egg (ovum): Oviposition on the lily seedlings was carried out during three months. The eggs were positioned in groups of 16 eggs in average (2 to 30 eggs), laid in a regular row or cluster. The eggs are elongated oval in shape, orange in colour and interconnected by a mucous substance (Fig. 7). Prior to larval hatching, the eggs are dark brown. The eggs' morphological characteristics were observed and measurements of the specimen of a total of 473 eggs were carried out. Length and width of eggs were measured. In the first year of the research, the eggs were photographed on site, collected together with leaves and transferred onto the plants in the experiment to be used for further development of the insects. However, out of the eggs transferred that way onto the plants in the experiment, larvae did not develop, and the eggs dried out. The extended oviposition period (March-April-June-July) later ensured the presence of three development stages of the insects on the plants within the same period. The larvae that intensively fed on the leaves presented a limiting factor for a development of a certain number of eggs. Egg laying is not always typical, in a single row, as it is described in literature (Salisbury 2008). In the research described in this paper, it was observed that the eggs were not always laid in a regular single row, but often in a shape of small piles. Through the observation in the experiment and on-site, it was observed that eggs, which were laid on leaves on which the larvae were previously already hatched, were also drying out because the larvae fed on that same leaf. They chewed on the leaf above the egg litter and cut a part of the leaf containing the eggs. From the pile of the laid eggs, the larvae hatched simultaneously, and in the first stage they stayed and fed in a group. It was observed that only the length of the egg was variable, and that the width was repeated, it was constant (0.5 mm), therefore this parameter was not statistically analysed. The data on the constant egg width was confirmed in the available literature (Müller and Rosenberger 2006). On the specimen containing 473 eggs of *L. lilii,* the egg lengths were measured. The average length after the statistical analysis was 1.57 mm. The duration of the embryonic development, due to a varying air temperature during two years of the research, lasted 8.5 days in average (5 – 12 days). According to the data in a doctoral dissertation (Salisbury 2008), there is different information on the time periods of the embryonic development, hence the hatching of the larvae from eggs occurs within the period of 4 to 10 days (Balachowsky and Mensil 1936, Haye and Kenis 2004). However, duration of the embryonic development within the period of three weeks was also recorded (Cox 2001).

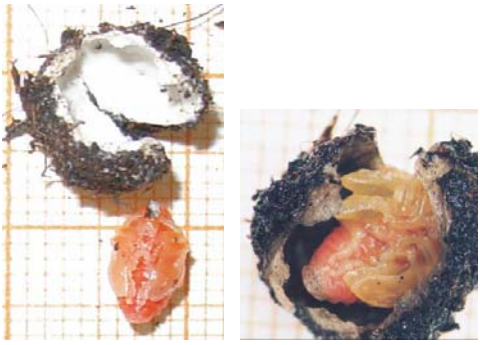
FIG. 7. *Lilioceris lilii* egg.

Larva: The *L. lilii* larva is orange with black chitinous head and three pairs of chest legs. During the analysis and laboratory measurements of larvae specimens, out of a total of 391 larvae, an average length of a larva was determined to be 6.36 mm and its length was 2.69 mm. Several claims of other authors on the appearance of larvae were confirmed during the research and laboratory analysis. According to the claims, at the dorsal side of its body the larva has got a pair of bristles and during its development it is covered in mucous secretion (Balachowsky and Mensil 1936, Emmel 1936, Livingston 1996). Through the experimental growth of the larvae in the second year of the research (2008), from the individually placed eggs on the separately isolated plants, a certain number of

development stages were determined. Through observation and recording of the number of moltings and classification of the larvae during their measurements of length into four groups, it was concluded that the larvae undergo 4 development stages. It was observed that during hatching and the first stage, the larvae stayed and moved in groups. They fed on the back side of a leaf, leaving the leaf's upper epidermis undamaged. They were classified into the first group, and during the measurements, dimensions of 1.2 mm after the hatching were registered. Through the observation it was determined that the larvae underwent the first developmental instar in a period of three (3) days. Before the second instar, the larvae reached the length of 2.50 mm. From the second on, they fed on the entire leaf surface and they were not in groups. Individually they moved on all the parts of the plant feeding on all the above-ground parts. The collected larvae were classified into the second group in accordance with the measured lengths of 2.50 mm to 6.00 mm. On the experimental plants for the observation of the larval instars, a time period of the second and third instar was monitored, and its duration was ten (10) days in average. At the end of the fourth instar they reached the length of even more than 1 cm, when they moved into the soil for the purpose of cocooning. According to Cox (1996), who determined the number of the larval instars by measuring the head capsule, the number of the instars is 4.

Pupa: At depth of around 10 cm in the soil, near the plant root system, the larvae transform into pupae. The pupa is of a free type (*pupa libera*). Upon taking the pupa from the cocoon, a light orange colour was observed (Fig. 8). A total specimen of cocoons with pupae was 114. The measured average length of the cocoons was 8.83 mm and the width was 5.82 mm. The cocoons were whitish in colour. During their growth, it was concluded that a total time period of the pupa stage was 18 days in average (15 – 21 days).

Information from literature was used as initial information on the appearance of the pupa. According to the information by some authors, the pupa is found in a silk-like cocoon in soil close to the host plants (Nolte 1939). The detailed description was given by Cox (1996), according to which the larva is cocooned in the soil, and the whitish cocoon is made from a fluid secretion excreted from its mouth. The pupa is pale red in colour with distinct abdominal segments.



(a) (b)

FIG. 8. Pupa out of the cocoon (a) and pupa in the cocoon (b).

Relations to Feeding Plants

The insect undergoes its entire development on the Asian and Oriental species of lilies, feeding on all the above-ground parts of the plant. Adults can also feed on species of *Fritillaria, Polygonatum, Solanum, Smilax* and *Nicotiana*, but the entire development cycle is not completed on these species (Livingston 1996, Casagrande and Tewksbury 2007a). The two year research carried out in natural conditions as well as in the controlled natural conditions within the set experiment, showed that the *L. lilii* species was not found only on the *Hemerocallis fulva* (L.) L., a horticultural species often present in city parks and home gardens. It is a species of lily with long, narrow leaves developed from the base of the plant, creating a large shrub-like rosette,

out of which orange flowers on long stems grow (Fig. 9).

FIG 9. *Hemerocallis fulva.*

The research for this paper established that the *Aloae* plants are not hosts to the examined insect. Larvae managed to hatch from the eggs, but they died already at the first development stage. The larvae transferred from the mother feeding plants (lilies) onto the *Aloae* plants, managed to survive for a while on the *Aloae* plant, but died soon after.

Life Cycle and Ecology

During the two-years observation of the life cycle of the *L. lilii*, on the basis of the observation of all the development stages of the specimens on the experimental plants, the duration of their development was determined. Through daily recordings of all the changes in the experimental plants during the research and observation of a development stage of an observed insect, as well as through analysing data, the length of each development stage and their number were determined, and number of generations was monitored as well. Data on the number of generations and the length of the development stages were uniform. Information in recent research on the number of generations was also confirmed by the results of this research. *Lilioceris lilii* species is univoltine and overwintered as adult. Frequent oscillations in the air temperature had an impact on the insect's behaviour during the development cycle, which was being compared during the two years of the research.

The average number of the eggs laid by the female upon the end of the winter quiescence for the following 30 – 40 days is 80 – 180 eggs. These data significantly differ from the data in the available literature, where it is stated that up to 300 eggs is laid during a year (Salisbury 2008).

It was determined that the duration of the embryonic development, depending on the air temperature, is around 8.5 days (5 – 12 days). Monitoring the life cycle of the larval stage, from the time of hatching out of eggs until its departure into the soil for cocooning, determined that this time period lasts approximately 16 days (12 – 20 days) and that the larva undergoes 4 instars. The rearing of pupae during this research and monitoring the appearance of new generations of the insects, determined that the time period of the pupa stage is 21 to 25 days.

Upon the winter quiescence in 2007, the first adult in the experimental pot appeared on 3rd February, 2008. The temperature of 14°C (according to the available information from the Federal Hydrometeorological Institute) was recorded. *Lilioceris lilii* starts its life activities already at 7°C. In the second year of the research (2008), during the collection of specimens for the follow up of the research and a visit to the location of Kakanj and Catici, it was determined that in the previous time period, in relation to the previous year (2007) larvae were present in a higher development stage on the same plants. This observation leads to a conclusion that in that year the insect appeared much earlier that the year before. Temperatures were higher during the winter quiescence period of the examined insects (from September 2007 to February 2008), when there were only few days with temperatures below 0°C, but above 5°C. With the earlier start of the period with air temperatures above 8°C, a very early appearance of the *L. lilii* in 2008 was

enabled. In the second year of the research, the development cycles of all the stages were faster, and the adults went into the soil for a winter quiescence quite late, at the end of the summer or beginning of autumn (Fig. 10).

Since the experiment was not interrupted in 2008 and the flowerpots containing adults in a winter quiescence were not removed, the appearance of the adults was observed in February 2009.

An oviposition was observed. Those were the females that copulated the year before (end of 2008), entered to winter quiescence and only the next year (2009) had the oviposition. These observations proved the statements in the works of some authors (Haye and Kenis 2004).

Discussion

In the present study some bio-ecological characteristics of *L. lilii* in Bosnia and Herzegovina are presented.

The insect's presence was confirmed in the majority of the researched locations in Bosnia and Herzegovina. Most of the locations were investigated in the Sarajevo Canton and neighbouring areas: Lukavica (Istocno Sarajevo), Pavlovac (Istocno Sarajevo), Pale, Trebevic mountain area (Miljevici), settlements Misevici - Rakovica, Podlugovi, Srednje, and the Sarajevo settlements Kosevsko Brdo, Bare, Sip, Kobilja Glava, Vogosca, Hotonj, Nahorevo, Betanija, Visnjik, Ciglane, Gorica, Marijin Dvor, Grbavica, Vraca. Apart from the Sarajevo Canton, monitoring and insects specimens collection was carried out in the areas of Doboj, Derventa, Brod, Prijedor, Banja Luka, Bihac, Kakanj, Kraljeva Sutjeska, Vitez, Donji Vakuf, Jajce, Kljuc, Bosanski Petrovac, Sanski Most, Catici near Kakanj, Rogatica, Visegrad, Gorazde, Lukavac, Konjic, Jablanica, Mostar, Capljina, Siroki Brijeg and Grude. In terms of the vertical distribution, the highest point is the location of Trebevic-Miljevici 676 m ASL and the lowest is Grude-Mamici, 325 m ASL.

Analysis and measurements of the specimens carried out at the Faculty of Forestry in Sarajevo, out of a total of 246 adults of *L. lilii*, determined that the average body length was 7.64 mm (6.0 – 9.0 mm). The average *L. lilii* body width was 3.75 mm (3.00 – 4.50 mm). A difference between males and females was prominent. An average length of a male was 7.025 mm (6.0 – 7.5 mm), and 8.106 mm (7.5 – 9.0 mm) of a female. An average length of a *L. Lilli* egg was 1.57 mm (1.25 – 1.64 mm).

In the area of Sarajevo the number of the laid eggs was 130 in average (80 – 180 eggs).

Duration of embryonic development in our field conditions was 8.5 days in average (5 – 12 days). Larvae continued their development cycle from the end of March until the end of August, during the entire vegetation period. An average duration of larval development is 16 days (12 – 20 days). Larva underwent 4 development instars. The pupal stage lasted approximately 18 days (15 –21 days).

Out of a specimen of 391 larvae, it was determined that an average length of a larva was 6.36 mm (2.22 – 7.81 mm), and an average width of a larva was 2.69 mm (0.85 – 3.20 mm).

An average cocoon length was 8.83 mm (7.92 – 9.75 mm) and its width was 5.82 mm (5.27 – 6.38 mm). Cocoons were whitish. During their growth, it was determined that a total time period of the pupal stage was 18 days (15 – 21 days).

Depending on the air temperature, they retreated into winter quiescence at the beginning of autumn. *Lilioceris lilii* completes one generation per year.

The insect undergoes its entire development at the Asian and Oriental species of lily, on all the above-ground parts of the plants. *Lilium candidum* lily species was present in all home gardens and was the major host of the *L. lilii*.

The *Aloae* plants were not hosts to the researched insect. In addition in home gardens or city parks, where the *Hemerocalis fulva* lily species was planted, the researched pest *L. lilii* was not noticed during the two year research.

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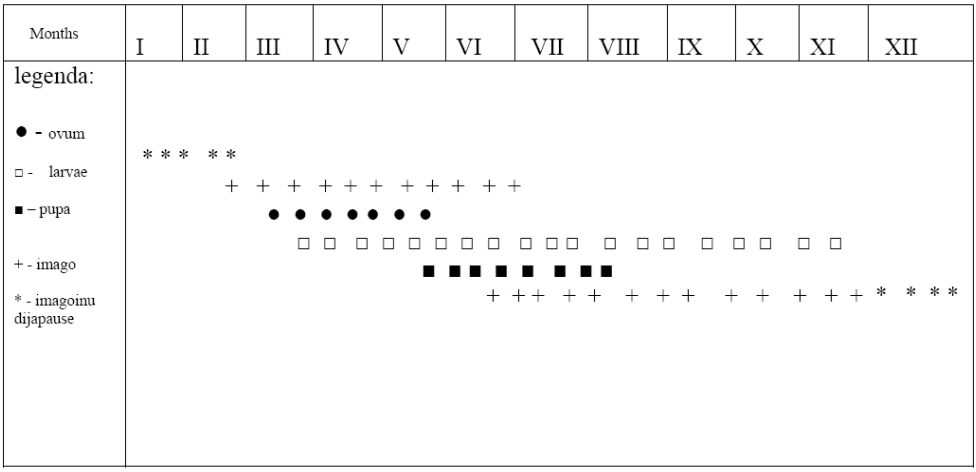

FIG. 10. Calendar of development

Μελέτη βιο-οικολογικών χαρακτηριστικών του *Lilioceris lilii* Scopoli (Coleoptera: Chrysomelidae) στη Βοσνία-Ερζεγοβίνη

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ΠΕΡΙΛΗΨΗ

Στην παρούσα εργασία μελετήθηκαν ορισμένα βιο-οικολογικά χαρακτηριστικά του εντόμου *Lilioceris lilii* Scopoli (Coleoptera: Chrysomelidae) στη Βοσνία-Ερζεγοβίνη. Η παρουσία του εντόμου επιβεβαιώθηκε στις περισσότερες περιοχές που ερευνήθηκαν. Το μέσο μήκος σώματος του *L. lilii* βρέθηκε 7,64 mm (7,025mm για τα άρρενα άτομα και 8,106 mm για τα θήλεα) και το μέσο πλάτος σώματος 3,75 mm. Το μέσο μήκος μιας πλήρους ανεπτυγμένης προνύμφης ήταν 6,36 mm και το μέσο πλάτος 2,69 mm. Το μέσο μήκος της νυμφικής θήκης ήταν 8,83 mm και το μέσο πλάτος 5,82 mm. Η διάρκεια της εμβρυακής ανάπτυξης σε συνθήκες αγρού ήταν κατά μέσο όρο 8,5 ημέρες. Η μέση διάρκεια ανάπτυξης των προνυμφικών σταδίων (4 προνυμφικές ηλικίες) ήταν 16 ημέρες ενώ η νύμφωση διήρκησε 18 ημέρες. Κατά την έναρξη του φθινοπώρου το έντομο εισέρχεται σε χειμερινό εφησυχασμό. Ως εκ τούτων συμπληρώνει μία γενεά ανά έτος. Η αναπαραγωγική ικανότητα του *L. lilii* στην περιοχή του Σαράγιεβο, υπό συνθήκες αγρού, υπολογίστηκε κατά μέσο όρο σε 130 ωά ανά θήλυ. Το έντομο ολοκληρώνει το βιολογικό του κύκλο σε Ασιατικά και Ανατολικά είδη κρίνου, σε όλα τα υπέργεια μέρη των φυτών. Το είδος *Lilium candidum* το οποίο βρέθηκε σε όλους τους οικιακούς κήπους (αστικές περιοχές) στις παρατηρούμενες περιοχές, ήταν ο κύριος ξενιστής του *L. lilii*. Πειραματισμός με το φυτό *Aloae vera* απέδειξε ότι αυτό το είδος δεν αποτελεί ξενιστή του *L. lilii*.