UDK 630*453+151 (*Stereonychus fraxini* De Geer)(001)

Izvorni znanstveni članci – Original scientific papers
Šumarski list, 7–8 (2014): 387–395

CONTRIBUTION TO THE STUDY OF BIOLOGY OF ASH WEEVIL (*Stereonychus fraxini* De Geer)

PRILOG POZNAVANJU BIOLOGIJE JASENOVE PIPE (*Stereonychus fraxini* De Geer)

Milan DREKIĆ[1], Leopold POLJAKOVIĆ PAJNIK[1], Verica VASIĆ[1], Predrag PAP[1], Andrej PILIPOVIĆ[1]

Abstract

One of the most harmful defoliating insects on ash species in Southeast Europe is the ash weevil (*Stereonychus fraxini* De Geer). Frequent occurrence of ash weevil outbreaks initiated research of the biology of this insect. The aim was to study the less known parts of insect biology, such as time of the insects development in natural conditions, fertility and fecundity of females, the duration of the embryonic, larval and pupal development, the amount of food consumed by larvae and adults. Research of insect development in nature conditions were carried out during 2008 and 2009 in the forests Branjevina near the town Odžaci in Serbia. This research was carried out by observation on 15 permanently labeled lower branches, every 6–9 days. Growing of insects in order to determine fertility and fecundity of females, the duration of developmental stages and the amount of food consumed by larvae and adults was carried out in a building with outdoor conditions.

Results are showing that overwintered adults become active from the beginning of the second decade of March until beginning of April. Female fertility was ranged from 30 to 104 eggs, and total fecundity from 58 to 109 eggs. Embryonic development was in range from 9 to 11 days. First larvae were found on leaves in the second decade of April, and the last are observed at the end of June. Ash weevil larvae undergo three larval stages. The entire larval stage development lasts 16–20 days. Larvae consumed average 3.3 cm^2 of narrow – leaved ash leaves. Pupal stage lasts from 6 to 8 days. Adults of new generation occur in the same year from the beginning of the second decade of May to the beginning of July, and immediately after eclosion starts with additional feeding for overwintering and each adult feeds on average 2.5 cm^2 of narrow leaved ash leaves.

KEY WORDS: *Stereonychus fraxini,* ash, biology

1. INTRODUCTION
Uvod

Among insects defoliators feeding on ash, the ash weevil (*Stereonychus fraxini* De Geer) is famous for its harmfulness and frequency of occurrence in South – East European countries (Mikloš 1954,1977, Marović 1963, Tsankov et al. 1990, Pojras 1993, Mihajlović and Ristić 1995, Ciesla and Moore 2007, Avramović et al. 2008, Glavendekić 2010). Ash weevil is common in Europe, North Africa and Asia Minor (Wingelmüller 1921). Ash weevil is oligophagus species feeding on: *Fraxinus excelsior* L., *Fraxinus angustifolia* Vahl., *Olea europea* L. and *Phyllirea media* L. (Mikloš 1954, Scherf 1964, Lemperiere and Malphettes 1983, Hrašovec and Harapin 1999, Blando and Mineo 2004). Ash weevil is harmful both as larva and adults. Overwintered adults in early spring

[1] Dr. sc. Milan Drekić, Dr. sc. Leopold Poljaković – Pajnik, Dr. sc. Verica Vasić, Dr. sc. Predrag Pap, Dr. sc. Andrej Pilipović, Institute of Lowland Forestry and Environment, University of Novi Sad, Antona Čehova 13 street, 21000 Novi Sad, Serbia, Corresponding author: mdrekic@uns.ac.rs

for additional feeding and oviposition damage the buds, shoots and leaves. In case of heavy attacks can cause a complete destruction of buds and consequently the absence of normal spring development of leafs. Larvae firstly skeletonize then completely eat the leaves, while the new generation of adults, because of additional feeding, make damage on the leaves. Lemperiere and Malphettes (1983) reports ash weevil damages on ash seedlings as a very considerable due to destruction of terminal buds. Outbreaks occur frequently and last 4–5 years, or longer (Mihajlović 2008). Frequent defoliations of ash trees cause loss of growth, physiological weakness and creation of favorable conditions for the attack of secondary insects. Vajda (1974) determined that dry vegetation periods, waterlogging of soil and attack of ash weevil play an important role in ash dieback by weakening trees and creating predisposition for the attack of bark beetles *Hylesinus fraxini* Panz. and *Hylesinus crenatus* Fab. Ash dieback in the lowland forests around the river Sava is mentioned by several authors (Vajda 1974, Janeš 2004, Medarević et al. 2009). A particular problem in the cultivation of ash in Europe is the occurrence of new pathogen *Hymenoscyphus pseudoalbidus* Roberge ex Desm. (anamorph *Chalara fraxinea* T. Kowalski) which causes ash dieback (Kowalski 2006, Queloz et al. 2010) and which is recorded in numerous European countries. This pathogen in Southeast Europe has been recorded and confirmed in Hungary (Szabó 2008), Slovenia (Ogris et al., 2009) and Croatia (Barić and Diminić 2010, Županić et al. 2012) and represents a threat for narrow - leaved and European ash. This imposes a need for research of the adverse factors that threaten the development of these ash species. Among them, ash weevil is one of the most important. There is a lack of results of ash weevil research and available data are generally older and that was the reason and encouragement for our research group to explore some parts of the insect biology which are insufficiently explored. Data on the biology of this insect are provided by many authors (Nüsslin 1913, Nüsslin and Rhumbler 1927, Mikloš 1954, Schwerdtfeger 1957, Scherff 1964, Lemperiere and Malphettes 1983, Tsankov et al. 1990, Pojras 1993, Blando and Mineo 2004), and they differ in the number of generations, and the time of the occurrence of various developmental stages. Data on fertility and female fecundity, number of larval stages, quantity of food consumed by larvae and adults of ash weevil are insufficient in the available literature data.

Research is undertaken aimed at studying those parts of insect biology that are unknown, or various data referring to those parts are found in the literature. Good knowledge of the insect biology is the basis for exploration and application of efficient protection measures.

2. MATERIAL AND METHODS
Materijal i metode

Biology of ash weevil was studied in the period 2007–2009 in the narrow – leaved ash stands in the Branjevina forest near Odžaci in Serbia (N 45° 27' 15", E 19° 12' 11") in the laboratory and in building with walls covered with mesh (outdoor conditions) in Novi Sad.

Overwintered adults activation time, their number, number of larvae, cocoons, and adults of new generation was observed and registered in Branjevina forest on 15 permanently marked lower branches on 15 trees, approx. 1 m in length. For every 6–9 days from February to July in 2008 and 2009 branches are thoroughly inspected and recorded present number of adults, adults in copulation, larvae and cocoons of ash weevil on branches.

By growing insects in the building with the outdoor conditions we studied fertility and fecundity, the duration of the embryonic, larval and pupal stage of development, the amount of food consumed by larvae and adults, as well as the number of generations.

In order to determine the time of laying eggs, fertility and fecundity of the ash weevil females, moss was collected in the forest Branjevina from twelve narrow – leaved ash trees in January 2008. The moss was inhabited by overwintering adults of ash weevil. The moss was placed in two cages lined with mesh size 50 × 50 × 70 cm, which were kept in the building with outdoor conditions. From the moss were extracted three females to review reproductive organs and determining the presence of eggs in the ovaries on 1st, 11th, 18th and 28th February and 10th March 2008. After activation of adults from moss on March 15th adults were put into a plastic box with a diameter of 15 cm and a height of 8 cm covered with mesh and fed by narrow – leaved ash buds and grown in outdoor conditions. The dissection of three females was carried out every three days until the end of March. Also, immediately after overwintered adults activation, from the moss in cages, based on morphological difference was allocated 20 pairs of males and females from March 15th to March 21st and they were separately grown in 20 plastic boxes with a diameter of 12 cm and a height of 6 cm covered by the net. Branches of narrow – leafed ash with 5–10 undamaged buds, and undamaged shoots were placed into the cages. Buds and shoots were taken from undamaged and for that purpose cultivated plants. Cages were cleaned periodically every 1–2 days, the new feed added, and eggs oviposited in all previously placed buds, shoots and stronger leaf stems were observed with examination under stereo microscope and counted. In this way the period of egg laying and female fertility was determined. After death, females were dissected in order to determine the number of eggs remained in the ovary and the total fecundity. Experiment was established under outdoor conditions.

The embryonic development duration was determined in the period from April 8th to April 21st, 2008 on the sample of 100 eggs. In the plastic box with ash weevil adults in the morning were placed shoots with undamaged buds. Meantime laid eggs, were collected under the stereo microscope in the early afternoon from the buds and placed onto the wet filter paper to prevent them from drying. The embryonic development duration was determined by daily observation and under uncontrolled outdoor conditions.

The larval development was determined by individual growing of 40 larvae in period from April 19th to May 15th, 2008. Larvae were grown in Petri dishes with a diameter of 9 cm and a height of 1.2 cm in uncontrolled outdoor conditions. The number of larval stages, duration of development of individual stages and the total duration of larval development were determined by daily observation. Larvae were fed with leaves of narrow – leaved ash. The quantity of food consumed by larvae was expressed as difference between leaf area of leaves before and after feeding measured by the meter of leaf area (ADC Bioscientific Ltd., AM300).

Duration of the pre-pupa and pupa stadiums was determined by growing 50 pre-pupas and pupas, which were cut out by scalpel from newly formed cocoons during the period from the 1st to 6th of May, 2008. After that insects were placed in Petri dishes on wet filter paper and by daily control was determined duration of pre-pupa and pupa stage. Experiment was established under outdoor conditions.

Duration of additional feeding for overwintering and the quantity of food consumed by adults before entering the diapauses were determined by separate growing of 25 adults of new generation from June 1st, 2009 in outdoor conditions. Adults were grown in plastic Petri dishes with a diameter of 9 cm and a height of 1.2 cm, where one undamaged leaf was placed in. Every two days the leave was changed by new undamaged one. Adults were fed on narrow – leaved ash leaves and the quantity of food consumed by larvae was expressed as difference between leaf area of leaves before and after feeding measured by the meter of leaf area (ADC Bioscientific Ltd., AM300).

In order to determine the number of generations at the end of May, 2007, 20 adults of new generation were grown on narrow – leaved ash plants planted in five pots and covered by the net. Adults were grown immediately after eclosion. Plants were observed on regular basis in order to register eventual development of new (second) generation of insects. Experiment was established under outdoor conditions.

3. Results
Rezultati

First ash weevil adults were observed on the branches in Branjevina forest at the beginning of the second decade of March in 2008, and a larger number of overwintered adults was found during April (Figure 1). In early May the number of adults declined suddenly and from the mid May with the occurrence of the new generation of adults their number increased again and reached a maximum at the end of May. Adults continued to occurred until the end of June.

In 2009, the first adults were confirmed in early April (Figure 2), and further presence of adults in the ash canopy greatly coincided with the number found in 2008.

After leaving their winter shelters, adults began with feeding by feeding on buds first, and later after flushing they fed on young shoots and leaves. First copulations in 2008 were observed at the end of March. Numerous copulations were

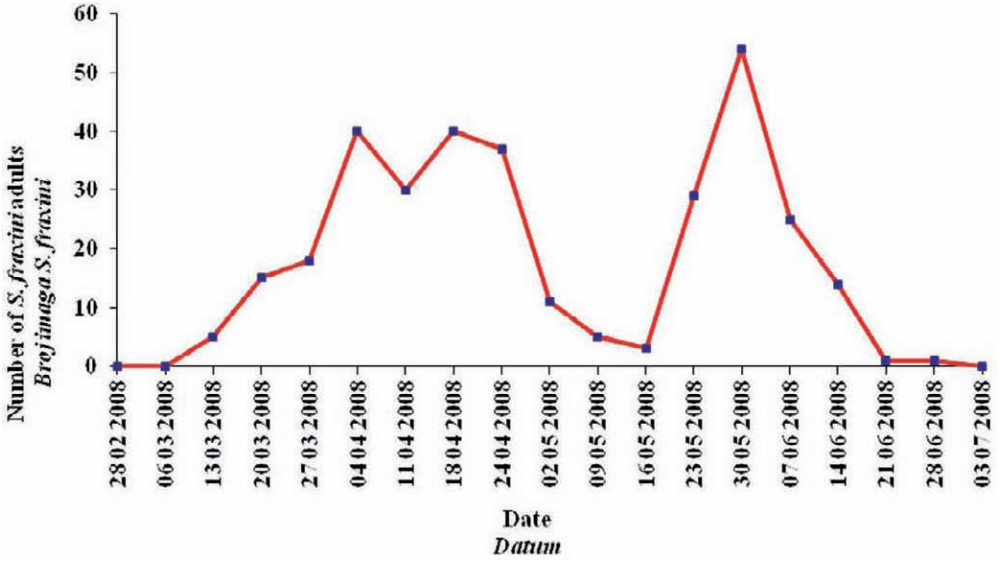

Figure 1. Number of *S. fraxini* adults found on 15 branches in Branjevina forest in 2008.
Slika 1. Broj imaga *S. fraxini* na 15 grana u šumi Branjevina u 2008. godini

observed during April, and in the first decade of May they ceased. The first copulation in 2009 were observed in early April, and the last in early May probably due to the late occurrence of overwintered adults. Termination of copulation in early May might be explained by the fact that most of the overwintered females die after laying eggs. Although the number of adults on ash branches in both years increased from mid-May due to the occurrence of the adults of new generation the copulations were not observed.

By dissection and observation of female reproductive organs during winter diapause revealed that the eggs were not formed in the ovaries. By growing ash weevil females after activation and by observation of reproductive organs of three females every three days, it was determined that the process of oogenesis started immediately after beginning of additional feeding. Fully developed eggs in females were noticed 12 days after female activation (Table 1).

Table 1: Results of inspection of S. fraxini females reproductive organs
Tablica 1: Rezultati pregleda reproduktivnih organa ženki S. fraxini

Date *Datum*	Number of females without formed eggs in reproductive organs *Broj ženki bez obrazovanih jaja u reproduktivnim organima*	Number of females with formed eggs in reproductive organs *Broj ženki sa obrazovanim jajima u reproduktivnim organima*
01 02 2008	3	0
11 02 2008	3	0
18 02 2008	3	0
28 02 2008	3	0
10 03 2008	3	0
18 03 2008	3	0
21 03 2008	3	0
24 03 2008	3	0
27 03 2008	1	2
30 03 2008	0	3

In females grown aimed at fertility and total fecundity determination, the beginning of egg laying was observed from 12 to 22 days after their activation. The oviposition period was quite long and in females grown in the trial for fertility determination it lasted up to 51 days. Over the course of one day the females layed from 1 to 14 eggs into one to four chambers previously made in buds, shoots and leaf petals. During egg laying the pauses ranging from 1 to 4 days were observed. From 1 to 8 eggs were oviposit into one chamber. From the total of 429 observed chambers one egg was oviposited in only 4.9%, two eggs in 19.6%, three in 35%, four in 22.1%, five in 12.1%, six in 3.5%, seven in 2.3%, and eight eggs were observed in only 0.5% of chambers. The mean number of eggs per chamber was 3.39. It was observed that females oviposit their eggs in the same bud for several times. Oviposition was confirmed in each of the 20 females grown in the trial. The number of the oviposited eggs depended on the female and ranged from 30 to 104, while the average number was approx. 67. Dissection of dead female revealed remaining eggs in the ovaries, and their number ranged from 2 to 28. Total fecundity of the females ranged between 58 and 109 eggs – on the average 76 eggs per female. It was confirmed that embryonic development ranged from 9 to 11 days (on average 9.6 days).

On 15 ash branches reviewed in 2008 the first larvae were observed on April 18th, and the last on June 13th (Figure 3).

The greatest number of larvae was observed at the end of the first decade of May. The occurrence of the first larvae in the following year was confirmed six days later in regard to 2008, and the last larvae at the end of June (Figure 4). In

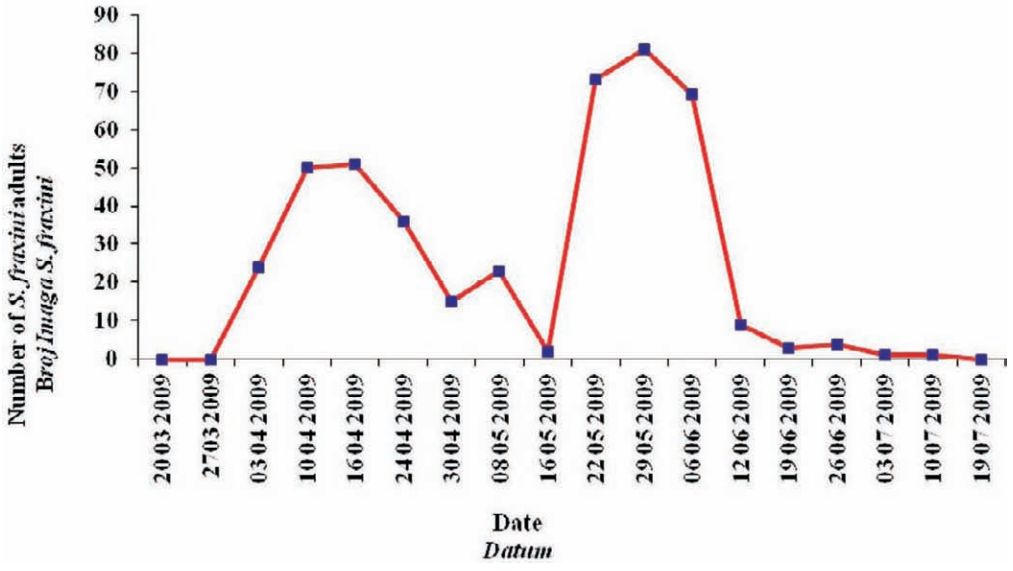

Figure 2. Number of *S. fraxini* adults found on 15 branches in Branjevina forest in 2009.
Slika 2. Broj imaga *S. fraxini* na 15 grana u šumi Branjevina u 2009. godini

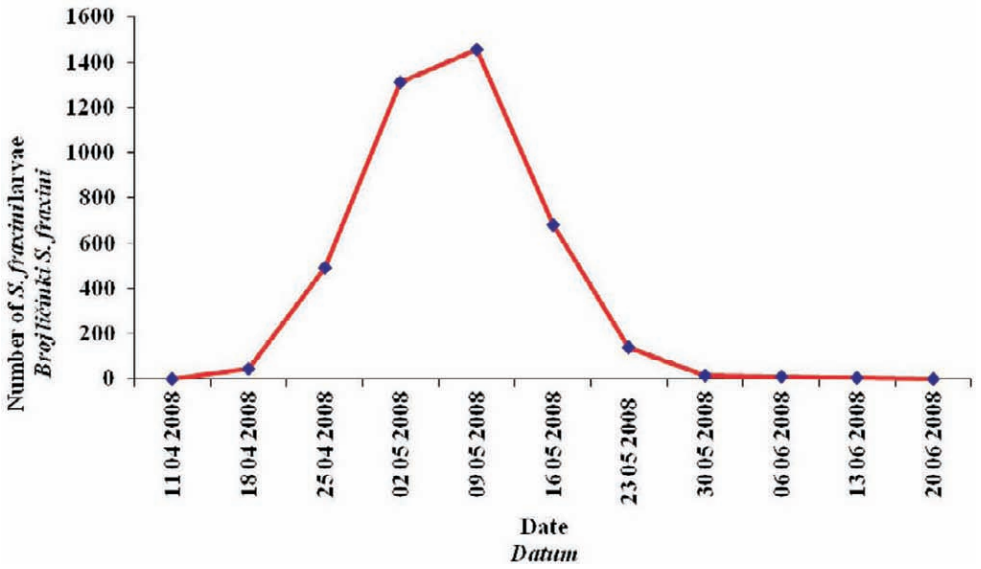

Figure 3. Number of *S. fraxini* larvae found in 2008 on 15 branches in Branjevina forest
Slika 3. Broj ličinki *S. fraxini* na 15 grana u šumi Branjevina u 2008. godini

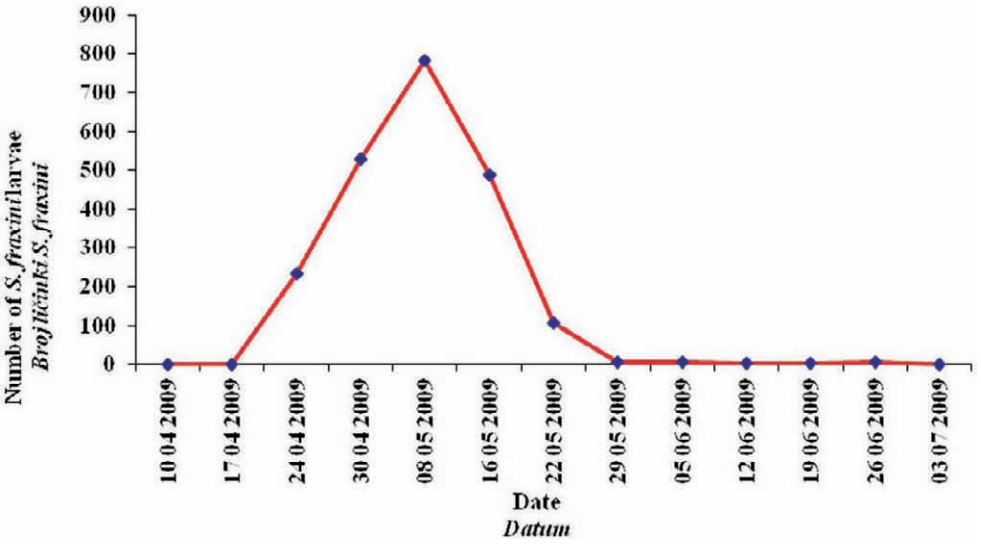

Figure 4. Number of *S. fraxini* larvae found in 2009 on 15 ash branches in Branjevina forest
Slika 4. Broj ličinki *S. fraxini* na 15 grana u šumi Branjevina u 2009. godini

both years the greatest number of larvae developed during the period from the beginning of the third decade of April till the end of the second decade of May, but outside this range a small number of larvae were present, hence the greatest damages caused by larvae occurred in this period.

Laboratory studies revealed that ash weevil larvae undergo three developmental stages. Average larval development of the first stage lasted for 6.4 days, while larvae of the second and the third stage had shorter developmental time (5.1 i.e. 5.8 days). It was determined that larval development lasted between 16 and 20 days (on average 17.3 days). Larvae of the first stage damaged leaf insignificantly, and on average consumed 0.24cm^2 of leaf area. Second stage larvae consumed on average 0.65cm^2, and that of third stage 2.41cm^2. The sexual ratio index of 40 grown larvae was 18/22 (female/male). Females larvae consumed larger leaf area compared to male larvae. On average male larvae consumed 3.02 cm^2, and females 3.63 cm^2 of narrow – leaved ash leaf. It was determined that both sexes consumed on average 3.3cm^2 of leaf area during larval development.

Upon completion of development larvae secrete slimy layer, which dries and hardens after several hours forming a cocoon. They first enter the pre-pupa stage without molting and then transform into the pupa. Pre-pupa stage last for two days. Pupa stage lasts between 6 and 8 days (on average 7 days)

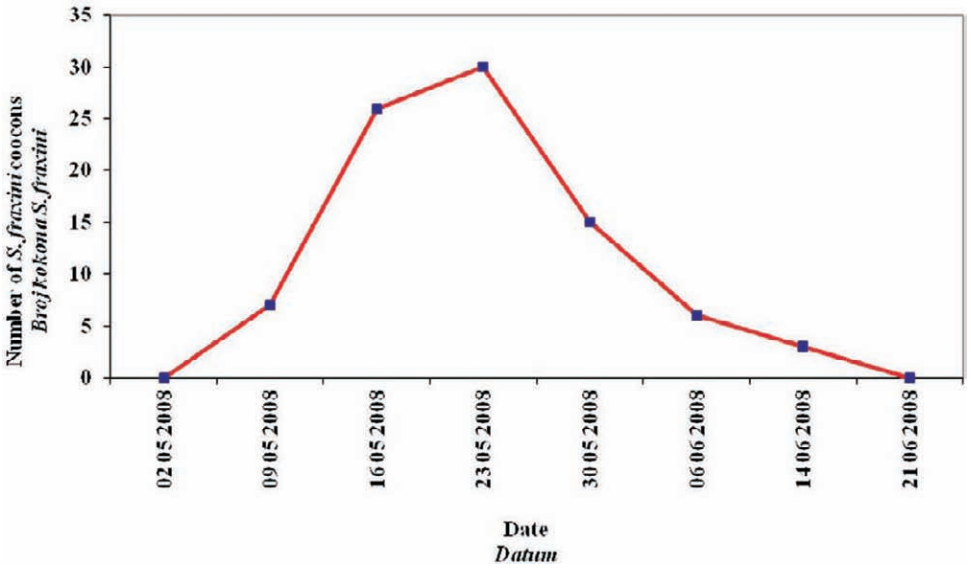

Figure 5. Number of *S. fraxini* cocoons found on 15 branches in Branjevina forest in 2008.
Slika 5. Broj kokona *S. fraxini* na 15 grana u šumi Branjevina u 2008. godini

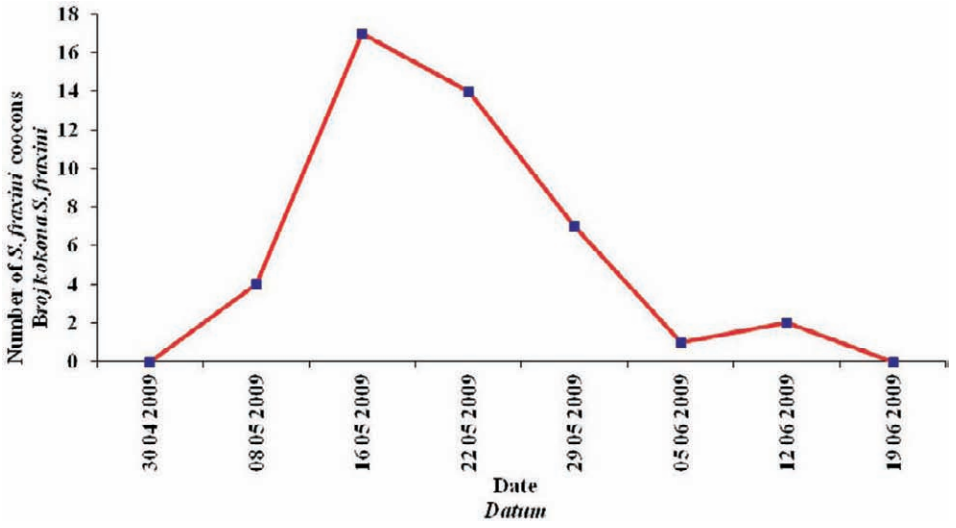

Figure 6. Number of *S. fraxini* cocoons found on 15 branches in Branjevina forest in 2009.
Slika 6. Broj kokona *S. fraxini* na 15 grana u šumi Branjevina u 2009. godini

The occurrence of the first cocoons on branches in Branjevina forest was observed on May 9th, while the last cocoons occurred in mid-June in 2008 (Figure 5).

The period of cocoon formation in 2009 was almost identical to that of 2008 (Figure 6).

Table 2: Insect development calendar for *S. fraxini*
Tablica 2: Kalendar razvića *S. fraxini*

Month / *Mjesec*											
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
+++	+++	+++	+++	+++							
			. . .	. . .	.						
			--	---	---						
				• • •	• • •	•					
				++	+++	+++	+++	+++	+++	+++	+++

\+ Adult / *Imago*; . Egg / *Jaje*; – Larva / *Ličinka*; • Pupa / *Kukuljica*

Studies conveyed in nature revealed that adults of new generation occurred on mass from the beginning of the second decade of May, hence causing the increased number of adults on ash branches (Figure 1 and 2). Insect development calendar for *S. fraxini* in Branjevina forest is shown in Table 2.

Immediately after the eclosion, the adults of new generation began with supplementary feeding for overwintering period. It was confirmed that the supplementary feeding lasted between 9 and 13 days. During supplementary feeding adults consumed on average 2.5 cm^2 of the ash leaf area. Adults which immediately after eclosion were placed on the ash plants in pots, and covered with the net fed on leaf of the nursery plants for a short time, and then entered the dormancy without copulation and oviposition, which revealed that the ash weevil had one generation per year.

4. DISCUSSION
Rasprava

Activation of adults from the winter shelters was observed at the beginning of the second decade of March, i.e. in early April, and the great difference in the time of adult activation in the two observed years may be explained by the temperature differences. Average temperature in March of 2009 was 0,9°C lower compared to 2008. By comparing the beginning of swarming with the average daily temperatures it was observed that activation of adults started after 2 – 4 days with average daily temperatures about 10°C (Drekić 2011).

Obtained results revealed that the temperature is one of the major environmental factors influencing the time of adults winter diapauses interruption. Differences in time of overwintered adult activation were also mentioned by other authors. Mikloš (1977) determined that overwintered adults occurred in late March or early April. Similarly, Lemperiere and Malphettes (1983) for France and Blando and Mineo (2004) in Sicily mentioned that adults occurred in late March. Tsankov et al. (1990) mentioned that in Bulgaria activation of adults occurred in early April, and according to Pojras (1993) in Moldavia the adults occurred in the second half of April. The difference between authors relating to the time of adult activation was probably the results of different ecological conditions and different mean daily and monthly temperatures prevailing in the years of investigation. This indicates necessity of monitoring of adults activation in order to apply the control measures in appropriate time.

Oviposition began 12 to 22 days after female activation in spring. Marović (1963) claimed that oviposition began after only two days, which was quiet short period of supplementary feeding compared to our studies. Differences in terms of oviposition, which under our conditions started in early April and extended till early June, and according to Schwerdtfeger (1957), which in biological formula mentioned oviposition in May, might be the consequence of late activation of overwintered adults under climatic conditions in Germany, resulting in late oviposition and larva development which according to Schwerdtfeger (1957) and Scherf (1964) took place in May and June.

Development of larvae in our country was observed from the second decade of April which was in accordance with Mikloš (1977), whose research was done under similar environmental conditions. In our studies the larvae occurred almost at the same time, although the occurrence of adults in 2008 was observed 20 days earlier, which revealed that oviposition coincided with flushing of the ash trees in order to supply feed for newly hatched larvae.

Upon death, unlaid eggs were found in ovaries of 85% of females. Eggs remaining in ovaries could be linked to growing conditions in experiment, which were certainly less favorable than those prevailing in nature. It could be assumed that the number of ovposited eggs under natural conditions is greater compared to those under growing conditions. Data on the number of eggs were mentioned by Tsankov et al. (1990), who used dissection and find aprox. 40 well developed eggs in female ovaries. Lesser number of eggs per female compared to our study could be explained by the fact that female oviposit eggs during prolonged period of time, which coincided with the process of oogenesis, and only number of formed eggs found in ovaries could be confirmed by dissection.

Miklos (1954) disregards significance of additional summer feeding of young adults for overwintering, stating that it is insignificant compared to larvae consumption. Comparison of determined average leaf area of 3.3 cm^2 consumed by larvae during their development with the average damaged area of 2.5 cm^2 caused by adults feeding for overwintering revealed that the larvae nutrition was only 32% higher, and that damage caused by supplementary nutrition of adults for overwintering could not be neglected. These damages were even more significant because they occurred later during vegetation, and that late defoliation of deciduous trees has more negative influence on tree vitality than that occurring in early spring (Androić et al. 1981).

By studying literature it was observed that there were big differences among authors in terms of the number of generation. Some authors (Mikloš 1954, 1977, Scherf 1964, Androić et al. 1981, Tsankov et al. 1990, Pojras 1993, Blando and Mineo 2004) stated that ash weevil had only one generation per year, which was also confirmed by our studies, but some others mentioned two, and even more generations per year (Nüsslin 1913, Nüsslin and Rhumbler 1927, Lemperiere and Malphettes 1983, Nageleisen 1992). Various quotations regarding the number of generations were probably not the consequence of various conditions under which the studies were carried out, for Blando and Mineo

(2004) mentioned that in Sicily, which is close to south border area of this insect, the ash weevil had only one generation per year. It was probably the matter of various interpretation of prolonged period of egg oviposition, which was sometimes in small number of overwintered females prolonged until June, which was interpreted as the occurrence of the new (second) generation. Prolonged oviposition period was also observed in our studies in the case of a strong attack, when all buds were destroyed, and females were waiting for the new leaves to lay their eggs in order to provide necessary food for their offspring.

5. CONCLUSIONS
Zaključci

Adults of ash weevil left winter shelters from the beginning of the second decade of March until the early April, depending on the air temperature. Copulation period started at the end of March or the beginning of April and lasted until the beginning of May. Oviposition began 12 to 22 days after female activation. Female fertility ranged from 30 to 104 eggs, and total fecundity from 58 to 109 eggs. Embryonic development ranged from 9 to 11 days. Ash weevil larvae were present on leaves from the second decade of April to the end of June. The greatest number of larvae fed on leaves from the beginning of the third decade of April until the end of the second decade of May. Larval development lasted from 16–20 days. During development larvae consumed average 3.3 cm^2 of narrow leaved ash leaves. Cocoons formed from the beginning of May until the end of June, and the pupal stage ranged from 6 to 8 days. Adults of new generation occurred during the same year, from the beginning of the second decade of May till the beginning of July. After ecclosion adults of new generation performed feeding before overwintering. Average leaf area consumed by ash weevil during additional feeding is 2.5 cm^2. Ash weevil had one generation per year.

ACKNOWLEDGMENTS
Zahvala

This paper was realized as a part of the project »Studying climate change and its influence on the environment: impacts, adaptation and mitigation« (43007) financed by the Ministry of Education and Science of the Republic of Serbia within the framework of integrated and interdisciplinary research for the period 2011–2014.

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Sažetak

Jasenova pipa (*Stereonychus fraxini* De Geer) je jedan od najznačajnijih defolijatora koji se javlja na jasenima u jugoistočnoj Europi. Biologija jasenove pipe istraživana je u razdoblju 2007–2009. godina u sastojini poljskog jasena u šumi Branjevina kod Odžaka u Srbiji, laboratoriju i uzgojem insekata u objektu sa zidovima pokrivenim mrežom s vanjskim uvjetima.

U šumi Branjevina je na 15 stalno obilježenih donjih grana različitih stabala poljskog jasena, dužine oko jedan metar, u 2008. i 2009. godini praćeno i zabilježeno vrijeme aktiviranja prezimjelih kornjaša (njihov broj i aktivnost), broj ličinki, kukuljica i kornjaša nove generacije. U cilju određivanja fertiliteta i fekunditeta ženki, odmah je po aktiviranju iz mahovine stavljeno u kutije na odvojen uzgoj 20 parova mužjaka i ženki. Tijekom uzgoja utvrđen je broj jaja koja su ženke odložile, a nakon uginuća ženki napravljena je njihova disekcija radi utvrđivanja broj jaja zaostalih u ovarijima. Trajanje embrionalnog razvoja utvrđeno je na uzorku od 100 jaja. Pojedinačnim uzgojem 40 ličinki utvrđen je broj stupnjeva, trajanje razvoja pojedinih stupnjeva i ukupno trajanje razvoja ličinki. Količina hrane koju ličinke konzumiraju, određena je kao razlika izmjerene površine neoštećenog i oštećenog lišća aparatom za mjerenje površine lišća. Uzgojem 50 predlutaka i lutaka utvrđeno je trajanje stadija predlutke i lutke. Uzgojem 25 imaga nove generacije utvrđeno je trajanje dopunske prehrane za prezimljavanje i površina oštećenja na lišću od kornjaša, koja je utvrđena kao razlika izmjerene površine ostećenog i neoštećenog lišća.

Istraživanjima je zaključeno da se prezimjeli kornjaši aktiviraju u razdoblju od početka druge dekade ožujka do početka travnja (Grafikoni 1 i 2). Period kopulacije trajao je od kraja ožujka ili početka travnja do prve dekade svibnja s kulminacijom sredinom travnja. Fertilitet ženki kretao se od 30 do 104 jaja (prosječno oko 67), a fekunditet od 58 do 109 jaja (prosječno oko 76). Embrionalni razvoj trajao je 9–11 dana. U prirodi su se prve ličinke javile u drugoj dekadi travnja, a posljednje ličinke zabilježene su na lišću krajem lipnja (Grafikoni 3 i 4). Najveći broj ličinki bio je na granama krajem travnja i početkom svibnja. Stadij ličinke traje 16–20 dana. U prosjeku jedna ličinka tijekom razvoja obrsti 3,3 cm^2 lista poljskog jasena. Po završenom razvoju ličinke prave kokone od početka svibnja do kraja lipnja (Grafikoni 5 i 6). U kokonima ličinke prelaze u stadij predkukuljice koji traje 2 dana, a zatim u stadij kukuljice koji je trajao 6–8 dana. Imaga nove generacije su se javljala od početka druge dekade svibnja do početka srpnja i odmah po ekloziji počinju s dopunskom prehranom za prezimljavanje koja traje 9–13 dana, a pritom imaga prosječno obrste 2,5 cm^2 lista poljskog jasena. Zaključeno je da jasenova pipa ima jednu generaciju godišnje. Na osnovi prikupljenih podataka sačinjen je kalendar razvoja Jasenovog surlaša (Tablica 2).

KLJUČNE RIJEČI: *Stereonychus fraxini,* jasen, biologija