ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LIX 31 Number 5, 2011

OCCURRENCE, BIONOMICS AND HARMFULNESS OF *CREPIDODERA AURATA* (MARSH.) (COLEOPTERA, ALTICIDAE)

J. Urban

Received: June 4, 2011

Abstract

URBAN, J.: *Occurrence, bionomics and harmfulness of Crepidodera aurata (Marsh.) (Coleoptera, Alticidae).* Acta univ. agric. et silvic. Mendel. Brun., 2011, LIX, No. 5, pp. 263–278

Flea-beetle *Crepidodera aurata* (Marsh.) is a forestry-important species of the family Alticidae. Its occurrence, bionomics and harmfulness were studied at Forest District Bílovice nad Svitavou (Training Forest Enterprise Masaryk Forest Křtiny near Brno) in the period 2007 to 2010. *Salix caprea* L. was the main host and *Populus tremula* L. an additional host. Last year's beetles occurred on woody species from the beginning of May to mid-October (most abundantly in June). In the laboratory, they lived 2 to 2.5 months and damaged on average 19.1 cm^2 leaves *S. caprea*. Females laid on average 246.5 eggs, namely in 15.4 clutches at 16 eggs. Beetles of the new generation mostly overwintered (70%) in pupal chambers. About 30% this year's beetles left pupal chambers. These occurred on trees from the second decade of July to the beginning of November (most abundantly in September). The smaller part of them ran over from *S. caprea* to newly grown young *P. tremula* in September and October. Males damaged on average 6.1 (females 7.0) cm^2 leaves of *P. tremula* during 3 to 4-week feeding. Beetles do not mate before hibernation and eggs develop in ovaries of females only after wintering. The development is obligatorily univoltine. With respect to the low consumption of food it is not usually necessary to control the pest. [1]

Alticidae, *Crepidodera aurata*, hibernation, occurrence, host species, fertility, food consumption, harmfulness

Willow flea beetle [*Crepidodera /= Chalcoides/ aurata* (Marsh.)] belongs to the most abundant representatives of the species-rich and development-interesting family of Alticidae in Europe. The centre of occurrence of the family is in tropics and subtropics where about 6000 species occur (Mohr, 1960). In the fauna of the CR, 187 species is noted (Strejček, 1993). Most of them are oligophagous. Beetles live freely and skeletonize or perforate leaves of herbs (rarely woody species). Larvae are rhizophagous, phytoparasitic or phylophagous. Due to often hidden preimaginal development in the earth or in various plant organs, their biology and damage are mostly nearly not known. They do mainly damage to agriculture and horticulture. In forestry, they are less harmful, namely mainly some species of genera *Crepidodera* Chevr. and *Altica* Geoffr.

Flea beetle *C. aurata* is the most important species of the genus in forestry. In Europe, genus *Crepidodera* includes eight species. All species are arboricolous. Beetles are phylophagous and larvae rhizophagous. As well as the majority of other species of flea beetles, it has thickened femurs of rear legs and excellent skipping abilities. The ability to skip is given by the occurrence of a "spring organ". By this specialized

1 The paper was prepared at the Faculty of Forestry and Wood Technology, Mendel University in Brno within the MSM 62156648902 research plan

sklerotized particle inside the distal part of rear leg femurs Alticidae differ from Chrysomelidae. They are characterized by a minute mostly lustrous body and relatively long filamentary antennae (slightly extensible at ends), which are converged at their base (connected to forehead). For *C. aurata* and some other species of the genus *Crepidodera*, metal-brilliant and variable colouring is characteristic. Splendid colouring of flea beetles signalizes that it refers to insect, which is considerably thermophilic and light-demanding.

In recent decades, high abundance of *C. aurata* was noted at many places in the CR. This species together with *C. aurea* (Geoffr.) occurred abundantly in the vicinity of the city of Brno at Forest District Bílovice nad Svitavou (TFE Masaryk Forest in Křtiny). A separate paper has been the result of field and laboratory studies concerning the occurrence, bionomics and harmfulness of *C. aurea* on *Populus tremula* L. and *Salix caprea* L. (Urban, 2011). Findings were also obtained on *C. aurata*, which occurred in the examined area mainly on *S. caprea*.

Distribution

Willow flea beetle (*C. aurata*) is a widely distributed eurytopic species. It occurs in the best part of Palaearctic zoogeographic region and mainly in its most extensive Euro-Siberian subregion. Therefore, e.g. Maican & Serafim (2001, 2004), Rozner (2003) and Rozner & Rozner (2008) consider the species as a Palaearctic species and D'alessandro & Biondi (2008) a Euro-Asian species. The centre of occurrence of the flea beetle is in Europe (Reitter, 1912; Schaufuss, 1916; Scheerpelz & Winkler, 1930; Heikertinger, 1954; Mohr, 1966; Maisner, 1974 etc.). Its natural range includes also the large part of a Mediterranean subregion including the northern most areas of Africa. In the north of Europe, the species is not abundant. In Denmark, Sweden and Finland, it is considered to be rare (Hellén *et al.*, 1939). According to Heikertinger (1948), in Scandinavia it occurs only in the south and only in Finland and Karelia, it occurs north. In addition to Europe, the author notes its occurrence also in Caucasus, Asia Minor, Siberia and China. In principle, Schimitschek (1944) notes the same distribution. General occurrence is concisely characterized by Bukejs (2009). According to him, the natural occurrence of the species was noted in Europe, northern Africa (Morocco), Caucasus, Asia Minor, Iran, Kazakhstan, Siberia, Mongolia, China and Korea. Aslan *et al.* (1999) and Gruev (2004, 2006) mention the species beside Europe including the European and Asian part of Turkey also in Morocco and Asia (except Japan).

Gruev (2005) mentions the concrete occurrence of *C. aurata* in Balkan countries (i.e. in Italy, Slovenia, Croatia, Monte Negro, Bosnia and Herzegovina, Macedonia, Albania, Greece, Bulgaria, Rumania and the European part of Turkey). On the area of the former Soviet Union, in addition to Russia the species was found in Latvia, Lithuania, Estonia, Byelorussia, the Ukraine, Georgia, Armenia, Azerbaijan and Kazakhstan (Nadein, 2010).

The flea beetle *C. aurata* is considerably tolerant to the external ecological environment. It occurs at various biotopes from lowlands up to mountains. It colonizes fast both unstable close-to-nature sites (e.g. river alluvia) and sites of anthropogenic origin (clear-cut areas, ruderal areas, former agrocoenoses etc.) (Januš, 2004). It is abundant e.g. in the inundation zone of the Danube (Muránsky, 1999; Bail, 2007). In Turkey, it rises up to an altitude of 2100 m (Aslan *et al.*, 1999), in the historical area of Macedonia up to 1500 m (Rozner & Rozner, 2008).

Generally, it is possible to state that *C. aurata* shows a little larger range of occurrence as compared to *C. aurea*. *C. aurea* has not been noted in Sweden, Finland, and northern Africa and in a number of Balkan and Asian countries yet (e.g. Monte Negro, Albania, Macedonia, Azerbaijan, Mongolia, Korea etc.).

On the area of the former Czechoslovakia, *C. aurata* ranks among generally very abundant species (Fleischer, 1927–1931; Roubal, 1937–1941; Javorek, 1947 etc.). It is abundant, e.g. in floodplain forests in Central Moravia in the Odra river area (Poodří) (Novotný *et al.*, 2006). In the High Tatras, it rises up to an altitude of 900 m (Roubal, 1937–1941). With respect to its mostly mesophilous character it prefers moist valley biotopes around rivers, lakes, reservoirs to steppe biotopes.

Host plants

Flea beetle *C. aurata* is an oligophagous species living on numerous woody species from the family Salicaceae (Kuhnt, 1913; Schaufuss, 1916; Schimitschek, 1944; Heikertinger, 1948; Pfeffer *et al.*, 1954; Vig, 1997; Rozner, 2003; Rozner & Rozner, 2008; Bukejs, 2009 etc.). According to Roubal (1937–1941), it colonizes mainly wild-growing and cultivated narrow-leaved species of the genus *Salix* (growing often even rather far from water) and rarely the genus *Populus*. Reitter (1912) mentions its very abundant occurrence on narrow-leaved *Salix* spp. and rare occurrence on *Populus* spp. along watercourses, nearby roads, in forests etc. Also according to Heikertinger (1954), main hosts of *C. aurata* are species from the genus *Salix*, less frequently *Populus*. Topp *et al.* (2002) mention the concrete spectrum of host species. According to these authors, the species occurs on *Salix alba* L., *S. caprea* L., *S. fragilis* L., *S. purpurea* L., *S. pentandra* L., *S. triandra* L. and *Populus* spp.

Numerous literary data show evidence of the marked trophic affinity of *C. aurata* to willows. For example, Medvedev & Šapiro (1965) note that in the European part of the former USSR, the flea beetle occurs on willows, sometimes namely even on a mass scale. In Bulgaria (Netolitzky, 1912; Warchalowski, 1974), it ranks among abundant to very abundant species on willows. In British Isles, it commonly occurs on *Salix* spp. and occasionally on other species where willows grow (Hubble,

2010). In Spain, it is considered as one of the most abundant phytophagous insect species on willows (Petitpierre, 1999). According to Vasiljev *et al.* (1974), beetles damage leaves of willows, namely *S. aurita* L., *S. cinerea* L., *S. caprea* L., *S. purpurea* L., *S. viminalis* and *S. fragilis* L. Throughout the CR, *C. aurata* is very abundant mainly on narrow-leaved *Salix* spp. along watercourses and reservoirs and very often also in secondary ruderal communities on *S. caprea* L. (Januš, 2004). In central and southern Europe, it ranks mostly among dominant species of Coleoptera in willow plantations, i.e. in planted and intensively cultivated stands of willows intended for the production of willow assortments for basketry (wicker-work) or energy purposes. The trophic preference of species of the genus *Salix* spp. reflected in the species name of *C. aurata* in many national languages, e.g. in Czech (dřepčík vrbový), English (willow flea beetle), German (goldhalsiger Weiden-Flohkäfer), Polish (złatka łozówka), Hungarian (ékes füzbolha), Spain (pulguilla de la mimbrera) etc.

It is known that the behaviour of insect herbivores changes depending on the quality and availability of food substrate. Not otherwise it is at *C. aurata*, which is particularly recently mentioned also as a pest on *Populus* spp. (Timčenko & Treml, 1963; Mrkva, 1963; Maisner, 1974; Vasiljev *et al.*, 1975; Georgiev, 2000 etc.). According to this host species, it is indicated in Russian as "zolotistaja topolevaja bljuška". In Germany, *C. aurata* was rarely found on *Alnus glutinosa* (L.) Gaertn. and *A. incana* (L.) Moench (Gharadjedaghi, 1977) and in England even on *Humulus lupulus* L. (Southey in Heikertinger, 1954).

Development and harmfulness

Flea beetle *C. aurata* is one of the most abundant dendrophagous insects on species of the family Salicaceae in the bulk of the Palaearctic region. Numberless publications devoted to its occurrence, host species or harmfulness mention the species. Considering the hidden development of larvae on roots of trees, its biology and population dynamics are, however, known only minimally. Until the 70s of the 20th century, it was declared that larvae of *C. aurata* and of other species of the genus *Crepidodera* live freely on woody species and skeletonize their leaves. Various methods of beetle and reputedly also larvae control were proposed.

At flea betle *C. aurata*, beetles overwinter (Reitter, 1912; Heikertinger, 1948; Maisner, 1974; Steinhausen, 2005 etc.). According to Reitter (1912), beetles occur on trees from spring to autumn, according to Heikertinger (1948), Mohr (1966) and Petitpierre (1999) from May to October and according to Kinelski & Szujecki (1972) from May to August (culmination at the beginning of June), according to Maisner (1974) from the beginning of May to the end of September and according to Urban (1981) from the beginning of May to the beginning of November. Numerous faunistic data are noted by Bukejs (2009) from Latvia. According to the author, the species occurs from 12 April to 6 September, most abundantly at the beginning of June. In mountain locations of Turkey (altitudes 1 300 to 2 200 m), it was found from 21 May to 31 August (mostly about 25 June) (Aslan *et al.*, 1999), i.e. about three weeks later than in Latvia. In the lowland region of Hungary, Steinhausen (1998) found the species from mid-April to the end of September and Rozner (2003) from 20 April to 5 October. From northern Hungary it is mentioned from 18 May to 11 October (Vig, 1997), from central Hungary from mid-April to the end of September (Steinhausen, 1998) and from northern Rumania from 14 June to 21 August (Maican & Serafim, 2001, 2004).

A paper of Steinhausen (2005) is evidently sporadic. It deals with the occurrence and generation conditions of Central-European species of the family Alticidae. The author ranks *C. aurata* among the first developmental type (in total five types). At this most common developmental type, beetles overwinter and lay eggs in early spring. Larvae develop during summer. Grown up larvae pupate in the second half of summer and subsequently, beetles of a new generation hatch from the pupae. The first numerical maximum (belonging to last year's beetles) occurs in the last decade of June. The second numerical maximum (belonging to this year's beetles) occurs in the first decade of September. According to these two numerical maxima, Steinhausen (2005) mistakenly supposes that the developmental cycle of *C. aurata* and other three abundant or very abundant Central-European species of the genus *Crepidodera* is bivoltine.

Studies on the kinematics of jumps of *C. aurata* and some other beetles from the family Alticidae (Brackenburg & Wang, 1995; Schmitt, 2004) are of interest. An ability to skip and akinesis are in principle a specific defensive behaviour, which is very important (together with good flying capabilities) for the successful colonization of suitable host species on various sites.

The flea beetle *C. aurata* is highly vagile expansive pest with marked trends to frequent gradations. It finds optimum living conditions in willow plantations where large amounts of trophicly attractive plant material is accumulated on a relatively small area owing to short rotation (usually one-year), additional fertilization and soil preparation. Therefore, some researchers consider the species to be a pest of osier plantations (Javorek, 1947; Wagner & Ortmann, 1959; Kadłubowski & Czalej, 1962; Kinelski & Szujecki, 1972; Maisner, 1974; Urban, 1981, 1982, 1983, 1993; Czerniakowski, 2002; Sadej *et al.*, 2006; Walerys & Sadej, 2008 etc.). Occasionally, it can damage also windbreaks, poplar nurseries (Maisner, 1974), park plantings of willows and poplars (Vasiljev *et al.*, 1975), willow plantations in arboreta (Urban, 1981) etc. However, damage caused by *C. aurata* does not exceed "threshold of economic harmfulness" and, therefore, it is not usually necessary to control it. In many publications on insect pests of forest trees the species is not even mentioned at all (Pfeffer *et al.*, 1961; Brauns, 1964;

Schwerdfeger, 1970; Schnaider, 1972; Koehler & Schnaider, 1972; Forst *et al.*, 1985; Švestka *et al.*, 1996 etc.).

MATERIAL AND METHODS

The main examination was carried out at Forest District Bílovice n. Svitavou (TFE Masaryk Forest in Křtiny) in 2010. The studied locality was situated at "Hádecké planinka", stand 374 E. The locality altitude reaches there 400 m, mean annual temperature 7.7 °C (in April to September 14.1 °C), mean annual precipitation 620 mm (in April to September 399 mm) and mean growing season 160 days. The stand consisted mainly of self-seeded broadleaved species of the 1st and 2nd age classes. In a species-rich composition *S. caprea* was dominant. Other examinations were carried out in stands 380 A, 380 B, 381 B and 373 D at 3 to 15-year *P. tremula*. The first three stands are situated in the vicinity of stand 374 E. The fourth stand occurs on a nearby southern slope at an altitude of about 340 m. Together with *C. aurata* the occurrence of *C. aurea* was simultaneously monitored. The occurrence, development and harmfulness of *C. aurea* are described in a separate paper.

Field inspections were carried out mostly in week intervals, namely from the beginning of May to mid-November. In total, 28 checks were carried out. The method of sweeping was used to monitor the beetle occurrence. In crowns of *S. caprea* and *P. tremula*, 100 unilateral sweepings were carried out in each check terms between 11:00 and 13:00. In addition to these systematic samplings, beetles were also caught for the purpose of subsequent examinations using simple collection or by particular sweepings. Through direct observation, the behaviour of beetles was determined in the course of their occurrence on woody species. Where necessary, samples of leaves of host species were taken from damaged trees for the microscopic examination of damage or quantification of the leaf area damage.

At caught beetles, their size, sex, and the number of eggs in ovaries of females were determined in the laboratory. At not-laid eggs, their dimensions were measured microscopically, namely length and width. Individually caught beetles were placed into individual or collective laboratory rearings on *S. caprea* or *P. tremula*. The main objective of these rearings was to determine the total area of damaged leaves and the total number of laid eggs. Findings were obtained on defecation, i.e. the number, dimensions and volume of produced frass pellets. On the basis of the mean volume of frass pellets from 1 cm^2 damaged leaf area the effectiveness was compared of using the food substrate, i.e. leaves of *S. caprea* and *P. tremula*.

To rear flea beetles, glass Drigalski plates of a diameter 10 (or 20) cm and height 5 (or 10) cm proved good. In smaller rearing vessels, freshly sampled leaves were used as food. To limit precocious wilting, leave petioles were wrapped by slightly moistened cotton wool. Into bigger rearing vessels, 10 to 15 cm long subterminal sections of foliaged shoots of host species were placed. Bases of these sections were placed into small vessels with water and throats of the vessels were then sealed by cotton wool. Checks (including food exchange for freshly taken food) were usually carried out in week intervals.

Considerable effort was made to study the embryonic and postembryonic development of *C. aurata*. Freshly laid eggs or larvae of the 1st instar were placed on fresh roots of host species. To maintain the vitality of roots the bottom of dark plates was covered by moist garden earth. For rearing, also young goat willows and aspens grown in flower-pots were used. Species in flower-pots were placed into lockable bags of light monofilament fabrics or into glass cylinders (diameter and height 50 cm) covered with fabrics from above. In this closed space, beetles ingested, copulated and females laid eggs into the earth. Unfortunately, rearings of larvae were not successful.

RESULTS AND DISCUSSION

Host species

At the majority of species of the family Alticidae, marked trends appear towards oligophagy to monophagy. Through relatively narrow food specialization Alticidae considerably differ from Chrysomelidae (Pernersdofer, 1941). Flea beetle *C. aurata* is a typical oligophagous species on representatives of the family Salicaceae. The species spectrum of host species is, however, very wide. Present findings show, that the beetle has high trophic affinity to many shrubby and arborescent species of willows and to some species of poplars. On the other hand, our second most common arboricolous flea beetle *C. aurea* damages mainly poplars and less often willows. Compared to *C. aurea*, the specious spectrum of hosts of *C. aurata* is wider.

Food preferences of *C. aurata* were studied in detail in 1969 to 1976 in six osier plantations in Moravia and in 1976 also in a willow plantation of the Mendel University Arboretum in Brno (Urban, 1981). In addition to the main species *S. viminalis* L. grown in osier plantations there were several other willow species (or hybrids). Its hybrids *S. × smithiana* Willd. (= *S. viminalis* × *S. caprea*), *S. × rubra* Huds. (= *S. viminalis* × *S. purpurea*) and *S. × mollissima* Elvert (= *S. viminalis* × *S. triandra*) occurred as interspersed individuals. Species (or hybrids) of willows (ordered according to the decreasing intensity of damage by the flea beetle) created following succession: *S. viminalis* L. (including hybrids), *S. purpurea* L., *S. amygdalina* L., *S. fragilis* L., *S. triandra* L. ssp. *concolor*, *S. × rubens* Schrank (= *S. alba* L. × *S. fragilis*.) and *S. × basfordiana* Schl. (= *S. alba* v. *vitellina* × *S. fragilis*). In the willow plantation of the University Arboretum about 350 willow species and hybrids were cultivated. Also there, beetles of *C. aurata* damaged willows

differently and nearly no of the species was quite resistant. *S. daphnoides* Vill., *S. hastata* L., *S. acutifolia* Willd. × *S. daphnoides* Vill., *S. viminalis* L., *S. acutifolia* Willd. and *S. foetida* Schl. × *S. nigricans* Sm. were damaged most. For example, *S.* × *basfordiana* Schl., *S. alba* L. v. *vitellina* f. *pendula*, *S. alba* L., *S. aurita* L. × *S. cinerea* L., *S. dasyclados* Winn., *S.* cv. *Americana*, *S. caspica* Pall. and *S. purpurea* L. f. *pyramidalis* ranked among the least damaged. Out of 41 in detail-evaluated species and hybrids of willows, *C. aurata* did not damage only *S. gilgiana* Seem. (Urban, 1981).

Salix caprea L. belongs to the most favourite host species of *C. aurata*. In 2010, this species was the main host of this flea beetle at all five examined localities at Forest District Bílovice nad Svitavou. On the other hand, *C. aurea*, which is common to harmful on *P. tremula*, occurred on *S. caprea* less abundantly. At all inspections, 1 950 (98.2%) imagoes *C. aurata* and only 36 (1.8%) imagoes *C. aurea* were found on *S. caprea* during the growing season 2010. On *P. tremula*, 261 (4.1%) imagoes *C. aurata* and 6 161 (95.9%) imagoes *C. aurea* were found. The proportion of *C. aurata* beetles on *P. tremula* gradually increased from 0.3 to 17.7% during May to October. This increase in the abundance of *C. aurata* on *P. tremula* occurred evidently in consequence of immigration of beetles of a new generation from *S. caprea*. At the end of the growing season, leaves on rather grown up shrubs of *S. caprea* were very tough and hardly trophicly utilizable for rather subtile beetles of *C. aurata*. Therefore, many *C. aurata* beetles probably flew over on young intensely growing self-seeding aspens at the end of August and mainly September. According to our findings, *P. tremula* is only an additional (secondary) host species for *C. aurata*. Massively reproducing and intensively growing aspens created even at the end of the growing season large, fine and sappy leaves, which were more suitable for the nutrition of young beetles of *C. aurata* than leaves of full-grown shrubby *S. caprea*.

Wintering the beetles

Leaf beetle *C. aurata* (and evidently also other representatives of the genus *Crepidodera*) overwinters in the stage of imagoes. There are only very little notes on actual wintering grounds in available literature. According to Roubal (1937–1941), beetles survive winter nearby willows in leaf litter and in slots of bark of stems and branches. They can also winter in holes in the earth, sand and (reputedly) abundantly also in nests of common mole (*Talpa europaea* L.). At examined localities at Forest District Bílovice n. Svitavou in 2010, young beetles wintered mostly (about 70%) in the place of their hatching, i.e. in earth pupal chambers. The smaller part of the *C. aurata* population (about 30%) left their pupal chambers and wintered at other places, namely probably mainly in the earth. At *C. aurea*, about 85% beetles wintered there in pupal chambers and about 15% beetles wintered at other hidden places.

The proportion of beetles wintering in pupal chambers and at other protected places depends mainly on climate and on the actual course of weather. E.g., in 1969 at Skalička near Hranice na Moravě (former district of Přerov) about 20% beetles left their pupal chambers while in 1972, all beetles wintered in pupal chambers there. In climatically substantially warmer Arboretum of Mendel University in Brno, young beetles left places of their development before hibernation and during August to October, they carried out maturation feeding on host species. Similar phenology showed *C. aurata* also in a south-Moravian osier plantation in Pouzdřany (former district of Břeclav) (Urban, 1981). Steinhausen (2005) mentions implicitly wintering the whole population of *Crepidodera* beetles out of pupal chambers. According to Lopatin (1960), beetles of the genus *Crepidodera* are markedly mesophilous and prefer places with higher moisture to dry steppe localities. However, long-term floods make successive wintering in the earth impossible and, thus, the abundance of insect herbivores is generally decreased in flooded areas and their species composition is simplified.

The occurrence of last year's beetles on woody species

Beetles *C. aurata* leave wintering grounds in the period of flushing host species. The beginning and course of leaving wintering places depend mainly on temperature and precipitation. In climatic conditions of Central Europe, beetles begin to occur on woody species usually at the beginning of May, under favourable conditions often already at the end of April. For example, at Skalička near Hranice in Moravia in 1969, last years year's beetles occurred in the open from the end of April to the beginning of July and sporadically until the beginning of August (most abundantly at the end of May and at the beginning of June). In 1972, beetles occurred from the beginning of May to the beginning of August and sporadically until the beginning of November (most abundantly in mid-June) (Urban, 1981). In Řícmanice (former district of Brno-country) in 1999, beetles were very abundantly found already 25 April. According to Kinelski & Szujecki (1972), the numerical occurrence of beetles on woody species culminates at the beginning of June, according to Walerys & Sadej (2008) already in the third decade of May.

At Forest District Bílovice n. Svitavou in 2010, last year's beetles *C. aurata* occurred on woody species from the beginning of May until 20 October (Tab. I). The number of beetles on woody species fast increased during May and reached maximum in June. From July, the number of caught last year's beetles irregularly decreased until October. Similar occurrence was determined at a relative species *C. aurea* on *P. tremula* in 2010. According to Tab. I, it is evident that in May and June, males were much more abundant than females (sex ratio 1.5 to 1.6:1). The numerical predominance of males over females is probably related to the frequent departure of females into the earth for laying eggs. In July and

I: *The number of last year's and this year's beetles of Crepidodera aurata caught on S. caprea in stand 374E. Bílovice n. Svitavou, 2010.*

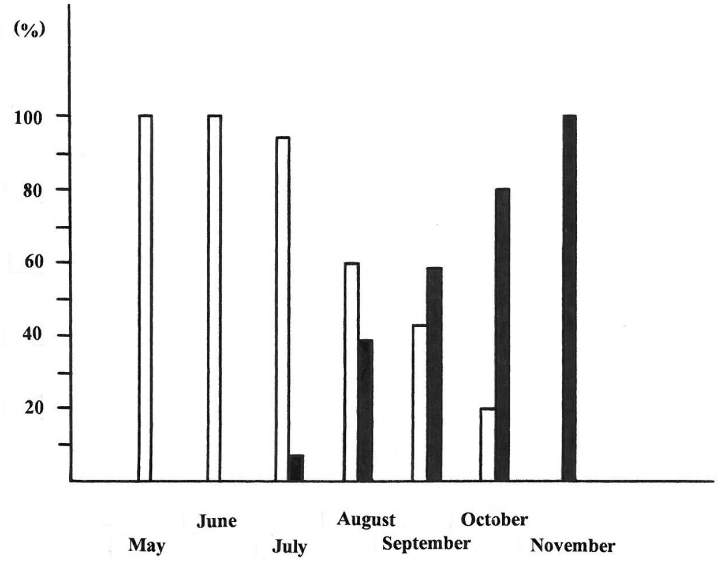
Date	Number of last year's beetles		Sex ratio (♂♂:♀♀)	Number of this year's beetles		Sex ratio (♂♂:♀♀)
	♂♂/♀♀	Total		♂♂/♀♀	Total	
6. 5.	24/16	40	1.5:1	-	-	-
20. 5.	55/36	91		-	-	
3. 6.	79/47	126	1.6:1	-	-	-
10. 6.	79/46	125		-	-	
16. 6.	24/20	44		-	-	
24. 6.	86/51	137		-	-	
1. 7.	33/41	74	0.8:1	-	-	1.5:1
8. 7.	67/67	134		-	-	
14. 7.	4/24	28		-	-	
21. 7.	24/35	59		2/1	3	
28. 7.	24/18	42		10/7	17	
4. 8.	10/15	25	0.8:1	6/9	15	0.8:1
11. 8.	13/14	27		6/12	18	
18. 8.	10/24	34		18/11	29	
25. 8.	34/30	64		14/21	35	
1. 9.	13/18	31	1.1:1	15/14	29	0.7:1
8. 9.	17/22	39		19/28	47	
15. 9.	33/18	51		29/35	64	
22. 9.	25/25	50		35/47	82	
29. 9.	10/6	16		11/29	40	
6. 10.	5/8	13	1.4:1	13/14	27	0.9:1
13. 10.	15/6	21		30/42	72	
20. 10.	2/2	4		22/22	44	
27. 10.	-	-		10/8	18	
3. 11.	-	-	-	9/10	19	0.9:1
10. 11.	-	-		1/1	2	
Total	686/589	1 275	1.2:1	250/311	561	0.8:1
(%)	53.8/46.2	100.0	-	44.6/55.4	100.0	-

August, females slightly predominated over males (sex ratio 0.8:1). In September and October, the numerical proportion of males in a population increased again (sex ratio 1.1 to 1.4:1). The same changes in the sex ratio of last year's beetles were in 2010 noted at *C. aurea* on *P. tremula*. However, more detailed causes of this phenomenon are not known for the present.

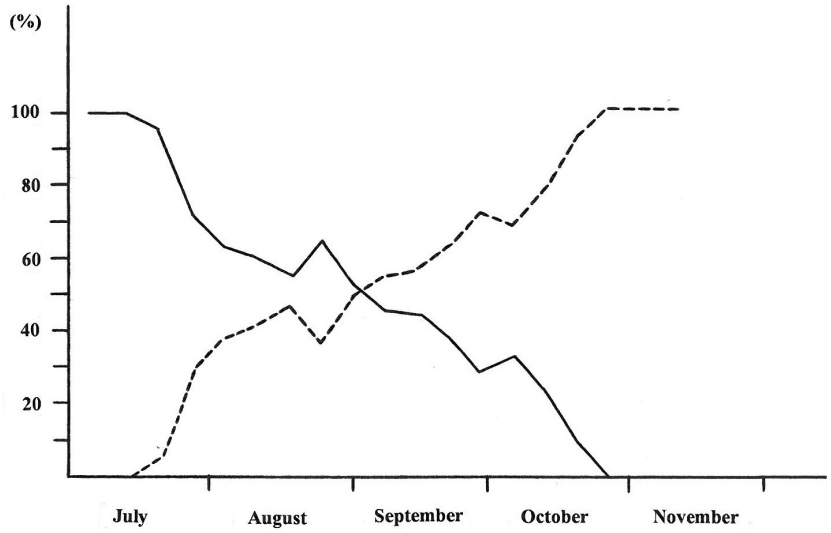
The occurrence of this year's beetles on woody species

This year's beetles of *C. aurata* begin to occur on host species in the period of top summer. In a willow plantation at Skalička near Hranice in Moravia, this year's beetles occurred in the open from the end of August to the beginning of October in 1969. However, only about 20% this year's beetles left their pupal chambers. It is of interest that about one third of them were parasitized by entomopathogenic nematodes from the family Mermithidae gen. sp. In 1972, however, this year's beetles did not occur on trees before hibernation at all and the whole population of *C. aurata* survived until spring of the next year in the earth. On the other hand, in the Arboretum willow plantation of Mendel University, very abundant occurrence was noted of this year's beetles before their departure to wintering grounds in 1976. Young beetles of a new generation occurred on trees from mid-August until the beginning of October (most abundantly in September). In the course of day, beetles were hidden in huge numbers in galls of mites *Eriophyes triradiatus* Nal. on *S. babylonica* L. (Urban, 1981).

At Forest District Bílovice n. Svitavou in 2010, the first this year's beetles of a new generation occurred already 21 July. Their abundance increased during the last decade of July and during August and in September it reached maximum. In the course of October, the numbers of this year's beetles on trees decreased and last beetles were noted on 10 November. At the very beginning of the period of colonization of woody species by this year's beetles (i.e. at the end of July), males predominated numerically (sex ratio 1.5:1). From August



1: *The percentage proportion of last year's imagoes (light) and this year's imagoes (dark) of C. aurata on S. caprea (in particular months). Bílovice n. Svitavou, 2010.*



2: *The percentage proportion of last year's imagoes (fully) and this year's imagoes (dashed line) of C. aurata on S. caprea (in particular checks). Bílovice n. Svitavou, 2010.*

until November, sex ratio was rather balanced (about 0.8:1) (Tab. I). The percentage proportion of last year's and this year's beetles in particular months and particular checks show Figs. 1 and 2.

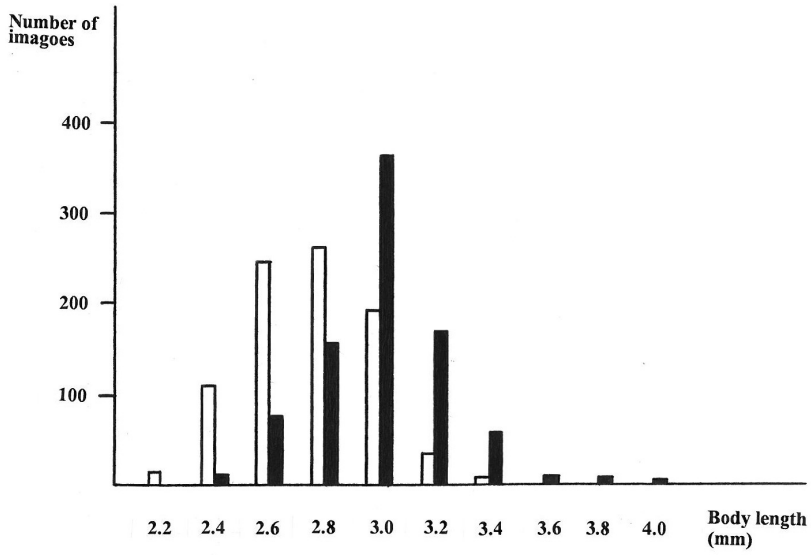
Size of beetles

In literature, there are numerous (but rather inaccurate) data on the size of beetles *C. aurata*. According to Kuhnt (1913), Schaufuss (1916), Heikertinger (1948), Mohr (1966), Maisner (1974), Schmitt (2004) etc. beetles are 2.5 to 3.5 mm long. For example Reitter (1912), Scheerpelz & Winkler (1930), Javorek (1947), Medvedev & Šapiro (1965) and Hubble (2010) mention similar length (2.5 to 3.3 mm). Nevertheless, the actual size of males and females has not been probably determined so far.

In 2010, extensive measurements were carried out of the body length of last year's and this year's males and females caught on *S. caprea* (Tab. II, Fig. 3). The body length of examined beetles ranged from 2.2 to 4.0 mm mean length being 2.9 mm. Males were 2.2 to 3.6 (on average 2.7) mm long and females 2.2 to 4.0 (on average 3.0) mm. Thus, females *C. aurata* were on average 0.3 mm longer than males. Almost no differences were found in the size of last year's and this year's beetles. Compared to *C. aurea* on *P. tremula* males and females of *C. aurata* were on average 0.3 mm shorter (Urban, 2011). Thus, on the basis of this investigation, it is necessary to correct and complete data on the size of *C. aurata*.

II: *The body length of last year's and this year's males and females of C. aurata caught on S. caprea. Bílovice n. Svitavou, May to November 2010.*

Body length (mm)	Number of last year's imagoes			Number of this year's imagoes			Total number of imagoes		
	♂♂	♀♀	Total	♂♂	♀♀	Total	♂♂	♀♀	Total
2.2	13	-	13	4	1	5	17	1	18
2.4	85	8	93	22	4	26	107	12	119
2.6	174	49	223	71	27	98	245	76	321
2.8	193	106	299	67	49	116	260	155	415
3.0	121	217	338	67	142	209	188	359	547
3.2	21	114	135	12	52	64	33	166	199
3.4	-	32	32	4	24	28	4	56	60
3.6	-	3	3	1	6	7	1	9	10
3.8	-	3	3	-	4	4	-	7	7
4.0	-	1	1	-	1	1	-	2	2
Total number of imagoes	607	533	1 140	248	310	558	855	843	1 698
(%)	53.2	46.8	100.0	44.4	55.6	100.0	50.4	49.6	100.0
Mean body length	2.73	2.99	2.85	2.78	3.01	2.91	2.74	3.00	2.87



3: *The body length of males (light) and females (dark) of C. aurata. Bílovice n. Svitavou, 2010.*

Feeding the last year's beetles

Shortly after the cessation of hibernation, last year's beetles of *C. aurata* occur on host trees. They appear on newly flushed (growing up and grown) leaves and begin to bite out minute feeding marks into their leave blade. Beetles perforate leaves of *S. caprea* always from the adaxial face. Damage to the leaves from the abaxial face is inhibited by heavy hairiness. Leaves of *P. tremula* are smooth from both sides. Last year's beetles usually perforate newly flushed leaves of *P. tremula*, older leaves are skeletonized and less frequently perforated. Leaves of aspen are damaged mainly from the abaxial face and a good many times also from the adaxial face. Under laboratory conditions, last year's beetles nearly always perforated leaves of *S. caprea*, namely only from the adaxial face. Leaves of *P. tremula* were 80% skeletonized and 20% perforated. Leaves were damaged from the abaxial face from 60% and from the adaxial face from 40%.

Beetles bite out irregular oval holes ("windows") into the leave blade 0.2 to 1.0 (on average 0.7) mm long and 0.2 to 0.8 (on average 0.5) mm wide. These minute feeding marks are usually placed closely side by side into straight or wavy lines and thus the damage obtains a line appearance. At the beginning of the period of feeding (i.e. in the first half of May), these "combined" feeding marks are 0.4 to 6.0 (on average 2.0) mm long and 0.3 to 1.1 (on average 0.6) mm wide. Beetles do not damage leaf veins and mostly also vein anastomoses. Through the growth of leaves dimensions of feeding marks generally

increase and leaf anastomoses often sever. At the end of June and at the beginning of July, particular feeding marks are on average 0.8 mm long and 0.6 mm wide. "Combined" feeding marks are on average 3.5 mm long and 1.0 mm wide. In laboratory rearings, last year's beetles damaged often leaves also in their area. Areal feeding was noted both on leaves of *S. caprea* and leaves of *P. tremula*. Also in the open, line damage changes at the pest outbreak to areal damage affecting considerable part (even over 50%) of the leaf blade area.

After wintering, beetles lived relatively for a long time (two to six months). They are most active in the second half of May and in June. They ingest food intensively, copulate and females lay eggs. In a mass laboratory rearing on *S. caprea* carried out in 2010, beetles lived 2 to 2.5 months. During this period, they damaged on average 19.1 cm² leaf blades, which roughly corresponded to the reduced area of one average leaf (Tab. III). In an individual rearing on *P. tremula*, a female lived two months and damaged 9.5 cm² leaf blades (Tab. IV).

Defecation

In the course of feeding, beetles produce a large number of frass pellets. Fresh (new) frass pellets are 0.25 to 1.1 (on average 0.4) mm long and 0.05 to 0.20 (on average 0.12) mm wide. They are of fusiform to cylindrical form being slightly rough on their surface. At defecation, unnecessary and indigestible substances are shaped to a long and very thin "strand" of a diameter only 0.05 mm in the end part of a hind-gut. Frass pellets of dimensions mentioned above originate only after the close spiral coiling this "strand". The way of shaping frass pellets is best distinguished if we place frass pellets into the very moist environment. Frass pellets then absorb water (through osmosis) from the outer

III: *The course of feeding, egg laying and defecation of last year's imagoes of C. aurata on S. caprea. Laboratory examination, 2010.*

Period (from-to)	Number of living ♂♂/♀♀	Average per week						
		Damaged area (cm²)	Number of laid eggs	Number of frass pellets	Length/ width of frass pellets (mm)	Volume of one frass pellet (mm³)	Volume of frass pellets (mm³)	Volume of frass pellets / cm² leaf (mm³)
9.–15. 5.	3/4	1.2	7.5	143.7	0.41/0.10	0.0032	0.4598	0.38
16.–22. 5.	3/4	1.7	13.2	215.0	0.41/0.11	0.0039	0.8385	0.49
23.–29. 5.	3/4	2.5	15.0	281.7	0.42/0.11	0.0040	1.1268	0.45
30.–5. 6.	3/4	2.3	16.0	266.3	0.42/0.11	0.0040	1.0652	0.46
6.–12. 6.	3/4	1.9	17.7	254.3	0.43/0.11	0.0041	1.0426	0.55
13.–19. 6.	3/4	2.6	50.0	245.0	0.42/0.12	0.0047	1.1515	0.44
20.–26. 6.	3/4	3.4	82.3	363.0	0.42/0.13	0.0056	2.0328	0.60
27.–3. 7.	2–3/4	2.0	44.8	184.3	0.40/0.11	0.0038	0.7003	0.35
4.–10. 7.	1–2/3–4	1.4	-	138.6	0.38/0.11	0.0036	0.4989	0.36
11.–16. 7.	0–1/0–3	0.1	-	11.4	0.38/0.11	0.0036	0.0410	0.41
Total average	-	19.1	246.5	2 103.3	0.415/0.114	0.00425	8.9574	0.47

IV: *The course of feeding, egg laying and defecation of a last year's female of C. aurata on P. tremula. Laboratory examination, 2010.*

Period (from-to)	Weekly						
	Damaged area (cm²)	Number of laid eggs	Number of frass pellets	Length/ width of frass pellets (mm)	Volume of one frass pellet (mm³)	Volume of frass pellets (mm³)	Volume of frass pellets / cm² leaf (mm³)
8.–14. 5.	0.55	-	157	0.47/0.14	0.0072	1.1304	2.06
15.–21. 5.	1.40	24	318	0.56/0.11	0.0053	1.6854	1.20
22.–28. 5.	1.08	4	200	0.38/0.14	0.0058	1.1600	1.07
29.–4. 6.	0.36	3	52	0.39/0.15	0.0069	0.3588	0.99
5.–11. 6.	2.30	-	362	0.47/0.13	0.0062	2.2444	0.98
12.–18. 6.	0.80	-	93	0.42/0.15	0.0074	0.6882	0.86
19.–25. 6.	1.50	54	302	0.48/0.13	0.0064	1.9328	1.29
26.–2. 7.	1.00	-	232	0.46/0.13	0.0061	1.4152	1.42
3.–9. 7.	0.50	-	124	0.41/0.14	0.0063	0.7812	1.56
Total	9.49	85	1 840	0.467/0.13	0.0062	11.3964	1.20

environment and disintegrate to funicular sections mentioned above. Fresh frass pellets are dark green, later brown to black. In the dry environment, they shrink fast changing shape and size. They do not stick to leaves and immediately after defecation or early after it they fall to the earth. In rearings on *S. caprea*, however, as many as 80% frass pellets were localized on leaves.

In 2010, last year's beetles of *C. aurata* damaged on average 19.1 cm² leaves of *S. caprea* and produced on average 2 103 frass pellets. Average dimensions of frass pellets were 0.41 × 0.11 mm and a mean volume was 0.0042 mm³. Beetles produced on average 8.96 mm³ frass pellets. From 1 cm² damaged leaf defecated on average 110.1 frass pellets of a total volume of 0.47 mm³ (Tab. III). A last year's female damaged 9.5 cm² leaves of *P. tremula* and produced 1 840 frass pellets of an average size 0.47 × 0.13 mm and mean volume 0.0062 mm³. In total, it defecated 11.40 mm³ frass pellets. Out of 1 cm² damaged leaf, it defecated on average 193.9 frass pellets of a total volume of 1.20 mm³ (Tab. IV). On *P. tremula*, a female generally damaged twice smaller area of leaves (compared to beetles reared on *S. caprea*) and produced 1.27 times larger volume of frass pellets. From 1 cm² damaged area it defecated even 2.6 times larger volume of frass pellets.

Reproduction

Early after the invasion on host species, last year's beetles *C. aurata* mate first. At Řícmanice (former district of Brno-country), the first copulating pairs were noted already on 28 April 1999 under warm and sunny weather. However, in 2010, at Forest District Bílovice n. Svitavou, the first copulation was found as lately as 5th May. The sexual activity of *C. aurata* is (as well as at *C. aurea*) much lower than e.g. at *Lochmaea caprea* (L.) (= *L. capreae* /L./), *Galerucella lineola* (F.), *Chrysomela populi* L., *Plagiodera versicolora* (Laich.) and most of other species of the family Chrysomelidae. In laboratory rearings, copulating beetles were observed only rarely.

Eggs developed in ovaries of last year's females, namely during their maturation and regeneration feeding on leaves of host species. During the maturation feeding of this year's females, eggs never create. Eggs mature gradually, however, they are laid in groups at 10 to 26 (on average at 16) pieces. The first eggs are laid already after several days of feeding, i.e. usually about 5 May. Females in captivity laid eggs always into the surface layer of garden earth. If earth was not available then 48.5% eggs were laid among hairs on the abaxial face of leaves *S. caprea*, 46.9% eggs were laid into the surface layer of slightly moistened cotton wool and 4.6% eggs were laid on walls and bottom of glass rearing vessels. Females use for laying eggs a false ovipositor, which can be pushed out more than 2 mm.

The natality of females *C. aurata* is relatively high. Females reared in 2010 on *S. caprea* laid on average 246.5 eggs during 55 days. After the completion of egg laying they died in the course of 2 to 13 days. In ovaries of died females, no unlaid eggs were found. During the whole period of reproduction, females laid on average 15.4 clutches (on average at 16 eggs), i.e. on average one clutch during 3.5 days. In the period of the most intensive reproduction (in the third decade of June), females laid on average 82.3 eggs during seven days, i.e. on average 5.1 clutches. In this period, females laid one clutch already on average after 1.4 days (Tab. III). On the other hand, rearings of *C. aurata* on *P. tremula* were little successful. Beetles consumed leaves of aspen less willingly and laid only small number of eggs (at the most 85) (Tab. IV).

Eggs of *C. aurata* are lengthwise oval, yellow-white, smooth and glossy. Their chorion is soft and elastic. In the dry environment, they become dry

V: *The frequency of egg occurrence in ovaries of females of C. aurata. Bílovice n. Svitavou, June, July, 2010.*

Number of eggs in ovaries	Number		(%)
	females	eggs	
0	287	-	-
1	1	1	0.2
2	-	-	-
3	1	3	0.6
4	-	-	-
5	-	-	-
6	1	6	1.2
7	1	7	1.3
8	-	-	-
9	2	18	3.4
10	2	20	3.8
11	2	22	4.2
12	2	24	4.6
13	4	52	9.9
14	5	70	13.4
15	-	-	-
16	4	64	12.2
17	1	17	3.3
18	6	108	20.7
19	-	-	-
20	1	20	3.8
21	1	21	4.0
22	2	44	8.4
23	-	-	-
24	-	-	-
25	-	-	-
26	1	26	5.0
Total	324	523	100.0
Average/ female with eggs	-	14.1	-
Average/ female	-	1.6	-

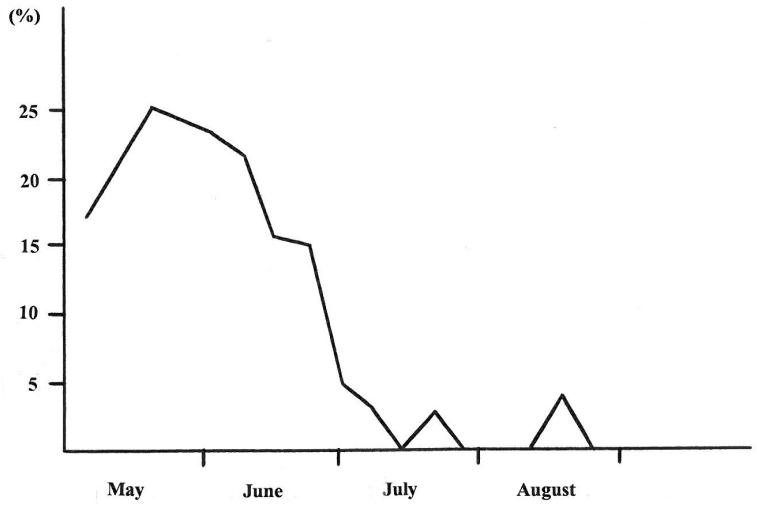
and embryos in them die, in the moist environment they absorb water and swell. Immediately after oviposition, they are 0.54 to 0.64 (on average 0.60) mm long and 0.22 to 0.30 (on average 0.26) mm wide. During the embryonic development, the size of eggs slightly increase.

The number of eggs in particular clutches corresponds to the number of functional ovariols in pair ovaries. Through the microscopic dissection of ovaries of 324 last year's females caught in June and July 2010 on *S. caprea*, eggs occurred only at 37 (i.e. at 11.4%) females. The number of eggs in ovaries fluctuated from 0 to 26 pcs. Out of total number of females with eggs, 64.9% females showed the even number of eggs. Thus, 73.1% eggs were with the even number and 26.9% eggs with the odd number of eggs (i.e. 2.7 times less) (Tab. V). Results of the analysis of ovaries of females of *C. aurata* are markedly identical with results obtained at a relative species *C. aurea* (Urban, in print). These findings reflect the pair structure of ovaries and rather regular function of particular ovarioles.

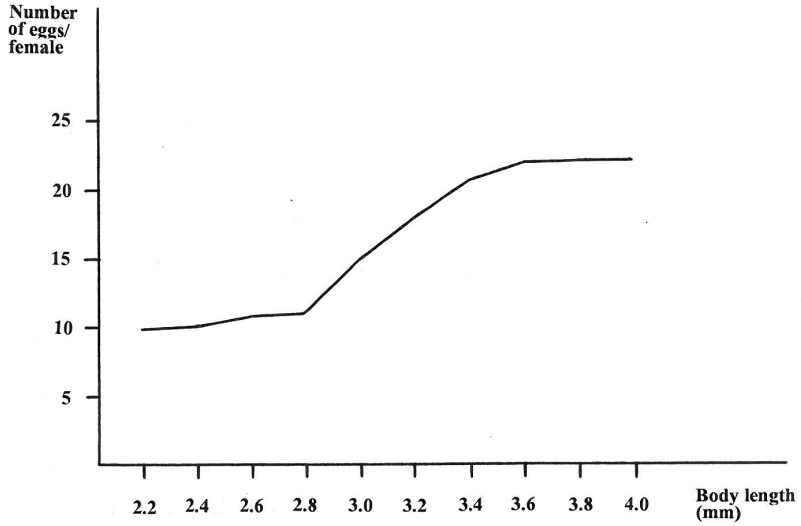
The total period of reproduction of *C. aurata* is rather long. Females lay eggs usually from the end of the first week in May until the end of July, sporadically also in August. They lay eggs most intensively in the second half of May and in the first half of June (Fig. 4). The number of eggs in ovaries and their size significantly increase with the female body length (Figs. 5 and 6). The same dependence was also found at *C. aurea* (Urban, 2011).

Feeding this year's beetles

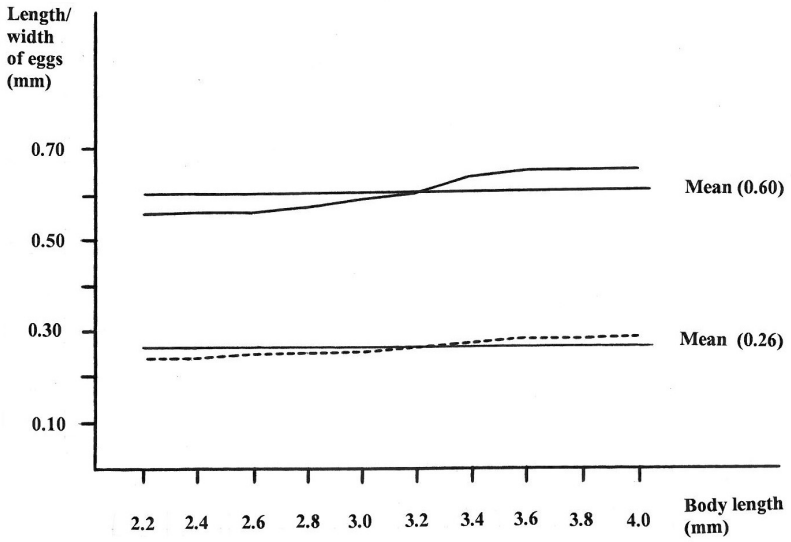
Steinhausen (2005) included Central-European species of the genus *Crepidodera* into a phenological type, where beetles of a new generation hatched



4: *The percentage proportion of females of C. aurata with eggs in ovaries. Females were caught on S. caprea. Bílovice n. Svitavou, 2010.*



5: *The average number of eggs in ovaries of females of C. aurata (according to the body length of females). Bílovice n. Svitavou, 2010.*



6: *The average length of eggs (fully) and egg width in ovaries of females of C. aurata (dashed line) (according to the body length of females). Bílovice n. Svitavou, 2010.*

(and colonized woody species) still in the same year. In climatic-meteorological conditions of the CR, beetles of *C. aurata* occur on host trees either at the end of summer and at the beginning of autumn or as late as spring of the next year. For example, in a willow plantation at Skalička near Hranice in Moravia (former district of Přerov), only about 20% (and in 1972 even 0%) individuals of a new generation left their pupal chambers at the end of the growing season 1969. However, in a substantially warmer and drier willow plantation at Pouzdřany (former district of Břeclav), the development of *C. aurata* was considerably accelerated. In 1975 and 1976, the whole new generation of beetles occurred there on woody species before hibernation. As well as in 1976 in a willow plantation of the Mendel University Arboretum, which is localized at a protected SW sunny location. At the Bílovice n. Svitavou Forest District in 2010, about 30% beetles of a new generation occurred before hibernation.

Thus, it is evident, that in the area of central and northern Moravia, beetles *C. aurata* either do not appear in the open before hibernation or only part of the population appears in the open. We can catch these beetles on woody species usually from the end of August (or from the beginning of September) to the end of October. In the region of Brno, considerable part (or even whole) of the population of this year's beetles leaves pupal chambers. In 2010 at Bílovice n. Svitavou Forest District, young beetles occurred on trees from the end of July until about half of November, most abundantly in September. Females slightly numerically predominated among caught beetles (Tab. I). In the same year, only about 16% this year's beetles *C. aurea* occurred at Forest District Bílovice n. Svitavou before hibernation, namely in principle in the same period and sex ratio (Urban, 2011). In the warmest areas of southern Moravia, all this year's beetles *C. aurata* occur on woody species before hibernation.

The whole period of the occurrence of beetles on trees is rather long (two to three months). As a matter of fact, however, the period of maturation feeding of beetles before their departure to wintering grounds is substantially shorter (only about three or four weeks). During this period, beetles damage much smaller area of leaves than in the next year when beetles reproduce. Males in individual laboratory rearings (carried out at the end of August and in September) damaged on average 6.1 (females 7.0) cm^2 leaves *P. tremula*. This year's beetles (unlike last year's beetles) consumed 97% leaves of *P. tremula* and only 3% leaves of *S. caprea*. Leaves of *P. tremula* were mostly skeletonized from both faces. Leaves of *S. caprea* were perforated, namely only from the adaxial face. Beetles did not damage leaf veins and mostly also vein anastomoses. After two to three weeks of feeding the beetles hid in leaves, under moist cotton wool etc. They survived a certain time after the start of a heating season (27 September 2010) in hiding places. From mid-October until the end of January of the next year (when rearing was terminated for the absence of suitable food) they slightly ingested. During this nearly 4-month period, males damaged on average 1.7 (females 1.9) cm^2 leaves.

It is of interest that the proportion of imagoes of *C. aurata* in sweepings on young self-seeding aspens *P. tremula* gradually increased from 0.3 to 17.7% during May to October 2010. On the contrary, the proportion of imagoes of *C. aurea* gradually decreased from 99.7 to 82.3% during May to October. This increase of the population density of *C. aurata* on *P. tremula* is attributed mainly to the immigration of young beetles from neighbouring *S. caprea*. Juicy leaves of young self-seeding aspens were trophicly more attractive for beetles at the end of the growing season than slightly tougher older leaves of full-

grown *S. caprea*. Changes in the trophic affinity of beetles during the growing season were also confirmed by numerous laboratory rearings. No data are available in literature concerning flying over young beetles *C. aurata* from a main host species *S. caprea* to a trophicly less attractive *P. tremula*.

Harmfulness

Willow flea beetle (*C. aurata*) ranks among the most common pests on willows (*Salix* spp.), less frequently on poplars (*Populus* spp.). Particular species are damaged differently and only a small number of species is quite refused. It occurs very abundantly to massively in willow/osier plantations *Salix viminalis* and outside willow plantations also *S. caprea* rank among mostly damaged species. It occurs very often (but usually harmlessly in our country) also on *P. tremula*. Many authors mention gradations of *C. aurata* on willows. Information on its harmful occurrence on poplars (e.g. in parental stock nurseries, shelter-belts, parks or forest stands) (Gusev, Rimskij-Korsakov, 1953; Maisner, 1974; Vasiljev *et al.*, 1975; Georgiev, 2000; Tozlu, 2001; Tozlu *et al.*, 2010 etc.) is less frequent.

Last year's beetles are most harmful. These beetles intensively damage young freshly developed leaves and rarely also buds, namely in spring. For example, on *S. caprea*, beetles damaged on average 19.1 cm^2 leaves during intensive maturation and regeneration feeding, which corresponded roughly to the reduced area of an average leaf. If young beetles occur on woody species also before hibernation then, e.g. on *P. tremula,* they damage about 6.5 cm^2 leaves. Particularly young, growth-active woody species of the first age class are endangered (i.e. plants, advance growth, young-growth stands). In consequence of the loss of assimilatory area the increment of trees is small. During summer, the trees create substitute shoots, which mature badly being often damaged by early frosts.

It is not necessary to control *C. aurata*. In case of the enormous outbreak (e.g. in willow plantations), it is possible to control last year's beetles effectively, namely in the first decade of May.

SUMMARY

Willow flea beetle (*Crepidodera aurata* /Marsh./) is one of the most abundant phytophagous species of Coleoptera on woody species of the family Salicaceae. The beetles are phylophagous, larvae rhizophagous. With respect to the hidden preimaginal development, it is known only very little. The presented paper deals mainly with the occurrence, feeding, reproduction and harmfulness of the beetles. The problems were dealt with at Forest District Bílovice n. Svitavou in 2007 to 2010 (FTE Masaryk Forest in Křtiny near Brno) and in the university laboratory. Main results:

1) Flea beetle *C. aurata* shows high trophic affinity to many shrubby and arborescent species of *Salix* spp. and some species of *Populus* spp. In the studied area, *Salix caprea* L. was its main host species and *Populus tremula* L. was its secondary (additional) host species.
2) About 70% beetles of a new generation wintered there in the place of hatching, i.e. in earth pupal chambers. About 30% young beetles left pupal chambers and after regeneration feeding looked for wintering places.
3) Last year's beetles occurred on trees and shrubs from the beginning of May to mid-October (mostly in June). In consequence of the early departure of females to lay eggs into the earth, males were more abundant than females in May and June (sex ratio 1.6:1). Males were 2.2 to 3.6 (on average 2.7) mm long and females 2.2 to 4.0 (on average 3.0) mm.
4) Last year's beetles perforate leaves of *S. caprea* always from the adaxial face. Beetles perforate freshly (newly) flushed leaves of *P. tremula*, older leaves are skeletonized, namely from the abaxial face of leaves. Beetles do not disturb leaf veins and mostly also vein anastomoses. Particular feeding marks of a size about 0.7 × 0.5 mm are placed in a row and so the damage is of a line character. At outbreaks, the line damage changes to area damage. In a laboratory, beetles lived 2 to 2.5 months and damaged on average 19.1 cm^2 leaves *S. caprea*. They defecated on average 2 103 fusiform to cylindrical frass pellets of an average length 0.47 mm and width 0.11 mm.
5) Females reared on *S. caprea* laid on average 246.5 eggs during two months, i.e. 15.4 clutches at 16 eggs. In the period of the most intensive reproduction (in the third decade of June), they laid on average one clutch already within 1.4 day. Females reared on *P. tremula* laid at the most 85 eggs.
6) This year's beetles occurred on trees and shrubs from the second decade of July until the beginning of November (mostly in September). Females slightly predominated over males (0.8:1). At the end of the growing season (mainly in September and October), young beetles often flied over from *S. caprea* to young intensively growing *P. tremula*. Therefore, the proportion of *C. aurata* in sweepings on *P. tremula* gradually increased from 0.3 (in May) to 17.7% (in October). On the other hand, the proportion of imagoes *C. aurea* (Geoffr.) on *P. tremula* gradually decreased in this period from 99.7 (in May) to 82.3% (in October). Changes in the trophic affinity of beetles of *C. aurata* were confirmed also in laboratory rearings. In the course of three to four weeks of maturation feeding, males damaged on average 6.1 (females 7.0) cm^2 leaves of *P. tremula*.

7) This year's beetles do not mate before hibernation and eggs do not develop in ovaries of females before hibernation. The development is obligatorily univoltine,
8) Flea beetle *C. aurata* shows considerable tendencies to gradations. It occurs very abundantly or even massively in willow plantations (particularly at *S. viminalis*) and outside the plantations e.g. on *S. caprea*. Its harmful occurrence is less frequent on *Populus* spp. Through maturation and regeneration feeding, beetles damage most growth-active young trees and shrubs, namely in spring.

REFERENCES

ASLAN, I., GRUEV, B. & ÖZBEK, H, 1999: A preliminary review of the subfamily Alticinae Coleoptera, Chrysomelidae) in Turkey. Turkish Journal of Zoology, 23: 373–414.

BAIL, J. G., 2007: Arborikole Lebensgemeinschaften xylobionter und phyllophager Käfer (Coleoptera) in naturnahen und anthropogen beeinflussten Donau-Auwäldern. Friedrich- Alexander-Universität Erlangen-Nürnberg: 1–225.

BRACKENBURG, J. & WANG, R., 1995: Ballistics and visual targeting in flea-beetles (Alticinae). Journal of Experimental Biology, 198: 1 931–1 942.

BRAUNS, A., 1964: Taschenbuch der Waldinsekten. Jena, VEB G. Fischer Verlag: 1–817.

BUKEJS, A., 2009: To the knowledge of flea beetles (Coleoptera: Chrysomelidae: Alticinae) of the fauna of Latvia. Acta Zoologica Lituanica, 19: 109–119.

CZERNIAKOWSKI, Z. W., 2002: Chrząszcze stonkowate (Col., Chrysomelidae) na plantacjach wikliny amerykanki (*Salix americana* Hoedt.). Progress in Plant Protection. Postępy v Ochronie Roślin, 42: 215–219.

D'ALESSANDRO, P. & BIONDI, M., 2008: Contribution to the knowledge of the Chrysomelidae of Vincheto di Celarda (Coleoptera). Quaderni Conservazione Habitat, 5: 153–179.

FLEISCHER, A., 1927–1930: Přehled brouků fauny Československé republiky. Brno, Nákladem Moravského musea zemského: 1–483.

FORST, P. *et al.*, 1985: Ochrana lesů a přírodního prostředí. Praha, Státní zemědělské nakladatelství: 1–416.

GEORGIEV, G., 2000: Species composition and impact of the phytophagous insects on the poplars (*Populus* spp.) in Bulgaria. Nauka za Gorata, 2/3: 45–54.

GHARADJEDAGHI, B., 1997: Phytophage Arthropoden an Erlen (*Alnus* spp.) in bachbegleitenden Gehölzsäumen Oberfrankens. Teil 1: Klopfprobenuntersuchung. Forstwissenschaftliches Centralblatt, 116: 157–177.

GRUEV, B. A., 2004: The leaf beetles (Insecta, Coleoptera, Chrysomelidae) of the Sredna Gora Mountains (Bulgaria). Animalia, 40: 77–96.

GRUEV, B. A., 2005: A comparative list of the leaf beetles of the Balkan countries (Coleoptera, Chrysomelidae). Animalia, 41: 23–46.

GRUEV, B., 2006: The leaf beetles (Coleoptera, Chrysomelidae) of the Pirin Mountain (Bulgaria). Historia Naturalis Bulgarica, 17: 51–79.

GUSEV, V. I. & RIMSKIJ-KORSAKOV, M. N., 1953: Klíč k určování škůdců lesních a okrasných stromů a keřů evropské části SSSR. Praha, SZN: 1–532.

HEIKERTINGER, F., 1948: Bestimmungstabellen europaeischer Käfer. 82. Fam. Chrysomelidae. 5. Subfam. Halticinae. Koleopterologische Rundschau, 31:15–139.

HEIKERTINGER, F., 1954: Halticinae, Erdflöhe, Flohkäfer. In: Blunck, H., Handbuch der Pflanzenkrankheiten. 5. Band, 2. Teil. Berlin & Hamburg, P. Parey: 313–343.

HELLÉN, W. *et al.*, 1939: Catalogus Coleopterorum Daniae et Fennoscandiae. Helsingforsiae, Societas pro Fauna et Flora Fennica: 1–129.

HUBBLE, D., 2010: Keys to the adults of seed and leaf beetles of the British Isles. AIDGAP, FSC, Bringing environmental understanding to all: 1–92.

JANUŠ, J., 2004: Výsledky inventarizačního průzkumu brouků (Coleoptera) čeledi Chrysomelidae *s. lato* na území Chráněné krajinné oblasti a Biosférické rezervace Křivoklátsko. Klapalekiana, 40: 55–121.

JAVOREK, V., 1947: Klíč k určování brouků ČSR. Olomouc, R. Promberger: 1–955.

KADŁUBOWSKI, W. & CZALEJ, B., 1962: Skład gatunkowy i dynamika populacji chrząszczy występujących na plantacjach wikliny w powiecie Nowy Tomyśl. Práce Komisji Nauk Rolniczych i Komisji Nauk Leśnych, 13: 51–69.

KINELSKI, S. & SZUJECKI, A., 1972: Wpływ niektórych herbicydów na występowanie szkodliwych owadów na wiklinie w okolicy Góry Kalwarii. Zeszyty Naukowe SGGW- Leśnictwo, 17: 65–74.

KOEHLER, W. & SCHNAIDER, Z., 1972: Owady naszych lasów. Warszawa, Państwowe Wydawnictwo Rolnicze i Leśne: 1–99.

KUHNT, P., 1913: Illustrierte Bestimmungs-Tabellen der Käfer Deutschlands. Stuttgart, E. Schweizerbartische Verlagsbuchhandlung, 1–1 138.

LOPATIN, I. K., 1960: Materialy po faune i ekologii žukov-listoedov (Coleoptera, Chrysomelidae) južnogo Zadneprovja. Entomologičeskoe Obozrenie, 39: 629–642.

MAICAN, S., & SERAFIM, R., 2001: Chrysomelidae (Coleoptera) from Maramureş (Romania). Travaux

du Muséum National d'Histoire Naturelle „Grigore Antipa", 43: 199–233.
MAICAN, S. & SERAFIM, R., 2004: Leaf beetles (Coleoptera, Chrysomelidae) from Maramureş (Romania). Travaux du Muséum National d'Histoire Naturelle „Grigore Antipa", 46: 136–159.
MAISNER, N., 1974: Chrysomelidae, Blattkäfer. In: Schwenke, W., Die Forstschädlinge Europas. 2. Hamburg & Berlin, Verlag P. Parey: 202–236.
MEDVEDEV, L. N. & ŠAPIRO, D. S., 1965: Sem. Chrysomelidae- listoedy. In: Bej-Bienko, G. J. *et al.*, Opredelitel nasekomych evropejskoj časti SSSR. II. Moskva & Leningrad, Izdateľstvo Nauka: 419–474.
MOHR, K. H., 1960: Erdflöhe (Col., Chrys., Halticinae). Wittenberg & Lutherstadt, A. Ziemsen Verlag: 1–48.
MOHR, K. H., 1966: 88. Familie: Chrysomelidae. In: Freude, H., Harde, K. W. & Lohse, G. A., Die Käfer Mitteleuropas. 9. Krefeld, Goecke & Evers Verlag, 95–280.
MRKVA, R., 1963: Škodlivý výskyt dřepčíka vrbového (*Chalcoides aurata* Marsh.) na topolech. Lesnická Práce, 43: 188–189.
MURÁNSKY, P., 1999: Liskavky (Coleoptera, Chrysomelidae) inundačného pásma Dunaja. Folia Faunistica Slovaca, 4: 121–128.
NADEIN, K. S., 2010: Spisok vidov listoedov podsemejstva Alticinae (Chrysomelidae) stran byvšego SSSR. Electronic version- http://www.zin.ru/animalia/coleoptera/rus/alticsng.htm. Accessed 30 November 2010.
NETOLITZKY, F., 1912: Eine Sammelreise nach Bulgarien (Schluss). Coleopterologische Rundschau (Wien), 1: 156–161.
NOVOTNÝ, V., DROZD, P., MILLER, S. E., KULFAN, M., JANDA, M., BASSET, Y. & WEIBLEN, G. D., 2006: Supporting online material for. Why are there so many species of herbivorous insects in tropical rainforests? Electronic version- www.sciencemag.org/cgi/content/full/1129237/DC1. Accessed 30 November 2010.
PERNERSDORFER, M., 1941: Untersuchungen über die Futterpflanzen einheimischer Chrysomeliden unter Ausschluss der Halticinen. Verhandlungen Naturhist.- Medizinischen Vereins zu Heidelberg, 18: 332–361.
PETITPIERRE, E., 1999: Catàleg dels coleòpters crisomèlids de Catalunya. 4. Alticinae. Butll. de la Institució Catalana d'Historie Natural, 67: 91–129.
PFEFFER, A. *et al.*, 1954: Lesnická zoologie. II. Praha, Státní zemědělské nakladatelství: 1–622.
PFEFFER, A. *et al.*, 1961: Ochrana lesů. Praha, Státní zemědělské nakladatelství: 1–839.
REITTER, E., 1912: Fauna Germanica. IV. Stuttgart, K. G. Lutz Verlag, 1–236.
ROUBAL, J., 1937–1941: Katalog Coleopter (brouků) Slovenska a východních Karpat. III. Praha, Nakladatelství Orbis: 1–363.
ROZNER, I., 2003: A Látrányi Puszta Természetvédelmi Terület levélbogár faunája (Coleoptera: Chrysomelidae). Natura Somogyiensis, 5: 179–191.
ROZNER, I. & ROZNER, G., 2008: Data to the leaf-beetle fauna of Macedonia (Coleoptera, Chrysomelidae). Natura Somogyiensis, 12: 111–131.
SADEJ, W., WALERYS, G. & SZCZUKOWSKI, S., 2006: Leaf beetles (Coleoptera, Chrysomelidae) threatening plantations of the willow (*Salix* spp.) grown near the town of Olsztyn. Progress in Plant Protection, 46: 416–419.
SCHAUFUSS, C., 1916: Calwer's Käferbuch. II. Stuttgart, E. Schweizerbartische Verlagsbuchhandlung: 1–1 390.
SCHEERPELZ, O. & WINKLER, A., 1930: 15. Ordnung: Käfer, Coleoptera. In: Brohmer, P., Ehrmann, P. & Ulmer, G., Die Tierwelt Mitteleuropas. Band V. Insekten, 2. Teil. Leipzig, Verlag von Quelle & Meyer: 1–272.
SCHIMITSCHEK, E., 1944: Forstinsekten der Türkei und ihre Umwelt. Prag, Amsterdam, Berlin & Wien, Volk & Reich Verlag: 1–371.
SCHMITT, M., 2004: Jumping flea beetles: structure and performance (Insecta, Chrysomelidae, Alticinae). In: Jolivet, P., Santiago-Blay, J. A. & Schmitt, M., New development in the biology of Chrysomelidae. The Hague (the Netherlands), SPB Academic Publishing: 161–169.
SCHNAIDER, Z., 1972: Szkodniki wikliny i ich zwalczanie. Warszawa, Akademia Rolnicza: 1–57.
SCHWERDTFEGER, F., 1970: Die Waldkrankheiten. Hamburg & Berlin, Verlag P. Parey: 1–509.
STEINHAUSEN, W. R., 1998: Ein Beitrag zur Kenntnis der Blattkäferfauna aus der Umgebung des Plattensees (Balaton) in Ungarn (Coleoptera, Chrysomelidae). Zeitschrift für Entomologie, 19: 45–52.
STEINHAUSEN, W. R., 2005: Phänologie mitteleuropäischer Blattflohkäfer (Coleoptera: Chrysomelidae: Alticinae). Innsbruck, Berichte des Naturwissenschaftlich-medizinischen Vereins, 92: 221–232.
STREJČEK, J., 1993: Chrysomelidae. In: Jelínek, J. *et al.*, Check-list of Czechoslovak Insects. IV. (Coleoptera). Supplementum 1. Praha, Folia Heyrovskyana: 123–132.
ŠVESTKA, M., HOCHMUT, R. & JANČAŘÍK, V., 1996: Praktické metody v ochraně lesa. Praha, Nakladatelství Silva Regina: 1–309.
TIMČENKO, G. A. & TREML, A. G., 1963: Vrediteli topolej v vostočnoj časti Ukrainy i Krymu. Entomologičeskoe Obozrenie, 42: 793–816.
TOPP, W., KULFAN, J., ZACH, P. & NICOLINI, F., 2002: Beetle assemblages on willow trees: do phenolic glycosides matter? Diversity and Distributions, 8: 85–106.
TOZLU, G., 2001: Sarıkamış (Kars)'ta Titrek Kavak (*Populus tremula* L.)'ta zarah japan böcek türlerinin tespiti ve bunlardan bazı önemli türlerin biyolojisi üzerinde çalışmalar. Türkiye Entomoloji Dergisi, 25: 133–146.

TOZLU, G., GÖKTÜRK, T. & GÜLTEKIN, L., 2010: Sarıkamış (Kars) ormanlarında sarıçam (*Pinus sylvestris* L.) ve titrek kavak (*Populus tremula* L.)'da zararli Coleoptera türleri. III. Ulusal Karadeniz Ormancılık Kongresi, 20–22 Mayıs 2010, Sayfa: 1 377–1 382.

URBAN, J., 1981: O škodlivosti dřepčíka vrbového (*Chalcoides aurata* Marsh.) na vrbách. Acta Universitatis Agriculturae (Brno). Ser. A, 29: 407–416.

URBAN, J., 1982: Výsledky studia bionomie a hospodářského významu salicikolních mandelinkovitých (Chrysomelidae) ve vrbovnách na Moravě. II. Acta Universitatis Agriculturae (Brno). Ser. C, 51: 107–129.

URBAN, J., 1983: Přehled škodlivých činitelů ve vrbovnách na Moravě. Acta Universitatis Agriculturae (Brno). Ser. C, 52: 309–333.

URBAN, J., 1993: Beitrag zum gegenwärtigen Zustand unserer Kenntnisse über salicikole Insektenarten in den Weidenanlagen Mährens. Acta Scientiarum Naturalium (Brno), 27: 1–42.

URBAN, J., 2011: K výskytu, bionomii a škodlivosti *Crepidodera aurea* (Geoffr.) (Coleoptera, Alticidae). Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 59: 279–307.

VASILJEV, V. P. *et al.*, 1974: Vrediteli selskochozjajstvennych kultur i lesnych nasaždenij. II. Kiev, Izdateľstvo Urožaj: 1–500.

VASILJEV, V. P. *et al.*, 1975: Vrediteli selskochozjajstvennych kultur i lesnych nasaždenij. III. Kiev, Izdateľstvo Urožaj: 1–526.

VIG, K., 1997: Leaf beetle collection of the Mátra Museum, Gyöngyös, Hungary (Coleoptera, Chrysomelidae *sensu lato*). Folia Historico Naturalia Musei Matraensis, 22: 175–201.

WAGNER, H. & ORTMANN, C., 1959: Anbau und Nutzung der Flechtweiden. Berlin, Deutscher Bauernverlag: 1–206.

WALERYS, G. & SADEJ, W., 2008: The beetles (Coleoptera) threatening shrub willow (*Salix* spp.) plantation near Olsztyn. Progress in Plant Protection, 48: 993–997.

WARCHALOWSKI, A., 1974: Übersicht der Blattkäfer Bulgariens (Coleoptera, Chrysomelidae). Polskie Pismo Entomologiczne, 44: 473–542.

Address

prof. RNDr. Ing. Jaroslav Urban, CSc., Ústav ochrany lesů a myslivosti, Mendelova univerzita v Brně, Zemědělská 1, 613 00 Brno, Česká republika