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BIOLOGY OF *BYCTISCUS POPULI* (L.) (COLEOPTERA, ATTELABIDAE). PART I. LAST YEAR'S IMAGOES.

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Abstract

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The biology of *Bycticus populi* (L.) was studied on *Populus tremula* L. in Forest District Bílovice nad Svitavou (former district of Brno-venkov) in the period 2007 to 2009. Last year's imagoes occurred there from the third decade of April until the end of July. Females lived in the laboratory on average 1.5 months and damaged 7.2 to 19.2 cm^2 leaves. In nature, females live on average two months. They produce 20 to 30 leafrolls and lay 30 to 41 eggs. Every day, they roll up 0 to 4 (on average 0.4) leafrolls and lay 0 to 6 (on average 0.8) eggs. They lay 0 to 4 (on average 1.3) eggs into one leafroll, in the laboratory 0 to 8 (on average 2.2) eggs. In 67% leafrolls, leaves are rolled up by their adaxial face outwards, in 32% inward and in 1% towards both faces. The production of rolls (from the beginning of biting out holes into petioles to leafroll sticking) takes on average two hours. Two thirds of rolls persist on shoots for the period of 1 to 4 weeks. At one third of rolls, females bite out the petioles immediately after rolling up the leaf blades and rolls fall to the soil surface.[1]

Bycticus populi, Attelabidae, host tree species, occurrence and feeding the last year's imagoes, reproduction

Bycticus populi (L.) ranks among the species-small family of Attelabidae. Members of the family differ from a family Curculionidae morphologically (mainly due to uncracked antennae with the prolonged 1st segment and a pygidium visible from above) as well as biologically (mainly by their characteristic instinct of mother care of offspring). They lay eggs into young plant organs (fruits, shoots and leaves) or loosely between folds of rolled up leaves. Before egg laying, females interrupt conducting routes thus causing the wilting of plant tissues. The pre-imago development proceeds in dying out and dead plant organs, which persist on plants for a certain time or fall immediately to the soil surface. They pupate mostly in the soil having one generation only. The family includes several important pests in agriculture, fruit growing and viticulture. Far smaller damages are caused in forestry, namely to young trees.

In Central Europe, *Apoderus coryli* (L.), *Attelabus nitens* (Scop.), *Deporaus betulae* (L.), *Bycticus betulae* (L.) and *B. populi* (L.) rank among species developing in rolled up leaves and interesting from the point of view of forestry. Females of the first three species characteristically cut primarily the leaf blade and roll up only part of the blade. Females of the genus *Bycticus* roll up the entire blade. They reach wilting the leaves in such way that they bite out a deep hole into a petiole thereby restricting the flow of plant juices into the leaf blade. They often bite out holes into shoots causing the dieback of the shoot tops. Due to damages to shoots they behave similarly as species of genera *Temnocerus*, *Lasiorhynchites*,

1 The paper was prepared at the Faculty of Forestry and Wood Technology, Mendel University in Brno within the MSM 6215648902 research project.

Neocoenorrhinus and *Rhynchites*, which develop inside plant tissues.

This paper deals with the occurrence, biology and harmfulness of *B. populi*. The species shows a similar development as polyphagus *B. betulae*, which ranks among important pests of grapevine in southern and central Europe. In contradistinction to *B. betulae*, *B. populi* is known rather little. Generally, only summary entomological and forest protection publications mention the species. More detailed studies (eg, on the consumption of food, reproduction potential of imagoes and development of larvae) obviously do not exist. For example, Shevyrev (1914) and Kozłowski (1997) write about the ethology of imagoes and Lengerken (1959), Mellings (2002) and Mellings & Compton (2002) mention the species bionomics.

Schaufuss (1916) and Harde (1998) regard *B. populi* as a Palaearctic species while Legalov (2007) as a Eurasian species. Nevertheless, it is mentioned from the whole Europe, Siberia and China (Freude, Harde & Lohse, 1981). According to Arnoldi *et al.* (1974), it occurs in Europe, Siberia (as far as Yakutsk), Mongolia and northern China. For example, Vasiljev *et al.* (1974) mention its distribution in central Asia and May (1993) in New Zealand.

In central Europe, *Byctiscus populi* is abundant or even very abundant. It lives largely on young trees of *Populus tremula* L. where it sometimes locally gradates and then causes damage. In Great Britain and Latvia, it develops almost exclusively on *P. tremula* (Mellings & Compton, 2002). Other species of the genus *Populus* are searched less often. For example, Shevyrev (1914) mentions it from *P. nigra* L. and Gusev & Rimskij-Korsakov (1953) from *P. tremula*, *P. alba* L. and *P. nigra* L. var. *italica*. Also Hymen & Parsons in Mellings & Compton (2002) regard *P. alba* and *P. nigra* as host species (in addition to *P. tremula*). Tillesse *et al.* (1997) mention that adults and larvae live on poplars (preferring *P. deltoides* Marsh. and North American hybrids) and also on willows. The occurrence of *B. populi* was monitored on *P. tremula* × *P. tremuloides* Michx. clone 'Astria' and sporadically on *P. trichocarpa* Torr et Gray clone 'Muhle Larsen' by Gruppe, Fusseder & Schopf (1999) in Germany. According to Jäger (1876), Kleine (1910) and Schaufuss (1916) it lives on *Populus*, *Salix* and *Betula*. Also *Quercus* (Formánek, 1911; Roubal, 1937–1941; Legalov, 2007 etc.) ranks reputedly among host species. For example, Plavilščikov (1963) and Arnoldi *et al.* (1974) mention the same spectrum of hosts. They note that the species damages raspberry in Siberia.

The paper is divided into two parts. Part I deals with the occurrence of last year's imagoes and their reproduction. Part II deals with leafrolls, development and harmfulness.

MATERIAL AND METHODS

The study was carried out in 2007 to 2009 in Stand 372 E_{12}, Forest District Bílovice nad Svitavou (Training Forest Enterprise Masaryk Forest, former district of Brno-venkov). The locality occurs in Forest Range Resslovka, SE part of the Moravian Karst Protected Landscape Area. The stand is situated at an altitude of about 340 m. Mean annual temperature amounts to 7.7 °C, precipitation 620 mm and growing season 160 days. It referred to a spruce young-growth stand with the abundant admixture of 3 to 5-year broadleaved species from self-seeding (mainly aspen, birch and hazel). These competition species were partly felled always at the end of summer and in the next year, they created numerous annual shoots. The protected location (slightly insolated SW slope) was favourable for the development of numerous species of insect including *B. populi*.

Inspections were carried out in week intervals (in 2007, 14-day intervals), namely throughout the growing season. In addition to regular checking carried out between 10 a.m. and 3 p.m., the occurrence and living manifestations of *B. populi* were studied also another time. Imagoes were obtained by sweeping or simple collection in combination with shaking down on a mat. From part of the sample plot, all leafrolls were collected every week. From the rest of the plot, only part of leafrolls was sampled for subsequent laboratory tests.

In the laboratory, imagoes were placed into individual or mass rearing. Foliaged 20 cm long terminal parts of shoots of *P. tremula* and other tree species were used for the rearing. To limit the premature wilting of leaves shoots were placed with their lower end into small vessels with water. The throat of vessels was sealed by cotton wool. Shoots in the small vessels were placed into five-litre bottles with a 9 cm throat. To close the bottles, permeable fabric was used. Ventilation was adjusted by glass plates placed on the vessel throat. Fresh food was served to imagoes twice a week. In the laboratory, mainly damage to trees, creation of leafrolls and egg laying were studied.

RESULTS AND DISCUSSION

Host species

P. tremula is the main host species of *B. populi*. Also studies carried out at Bílovice nad Svitavou confirm the marked trophic affinity to aspen. Imagoes of the species were sporadically found on interspersed birch, willow and hazel. It damaged, however, only aspen. Leafrolls of *B. betulae* occurred rather sporadically on *Betula pendula* Roth. and *Tilia cordata* Mill.

In May 2008 and 2009, last year's (mother) imagoes were fed on leaved shoots of *P. tremula* and shoots of *P. nigra*, *P. nigra* var. *italica*, *Salix caprea* L., *S. fragilis* L. and *S.* × *rubens* Schr. In these food tests, imagoes damaged most leaves of aspen where areas of feed marks created about 90% out of the total damaged area. *P. nigra*, *P. nigra* var. *italica* and *S. caprea* were damaged much less (about 7%) and *S. fragilis*

and S. × *rubens* were damaged minimally (about 3%). The trophic value of leaves for *B. populi* is dependent not only on the species, growth stage and spatial position of a tree in a stand but also on the size and age of leaves (see Part II).

The size of imagoes

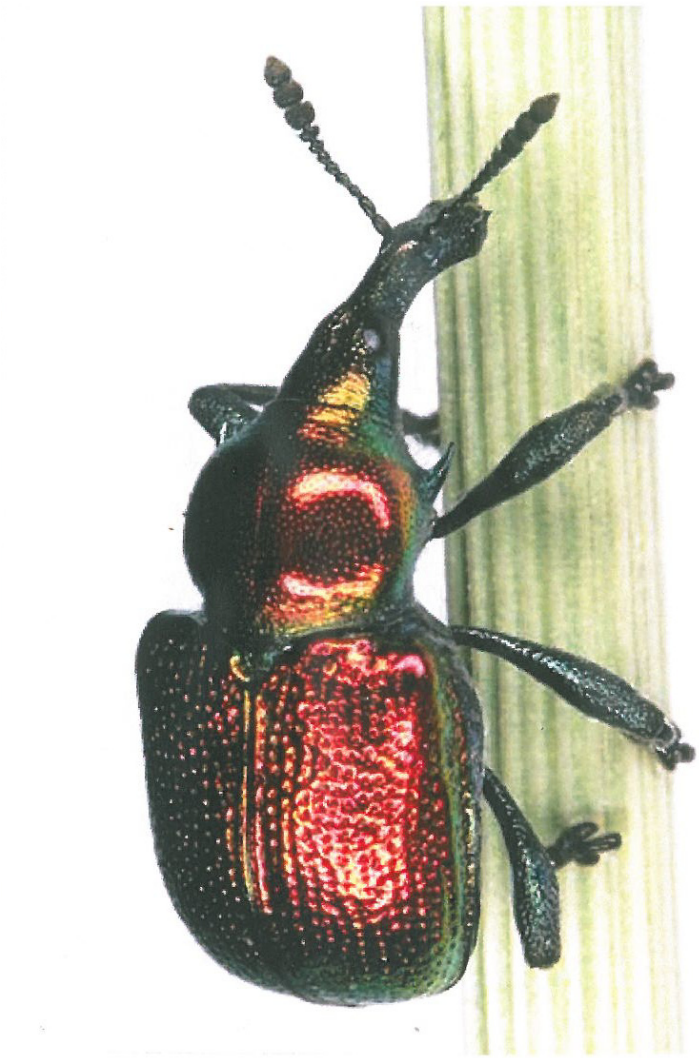
Imagoes of *B. populi* (Fig. 1) can be easily differentiated from a related species *B. betulae*. The upper side of their body is metal-glossy, green to copper-green. Their lower side is semi-glossy, dark black-blue. Ends of wing-cases are plain, non-haired. A forehead between eyes is lengthwise deep-hollowed and gently oval-dotted.

Data on the size of imagoes differ. Ratzeburg (1839) mentions that *B. populi* is smaller than *B. betulae*. According to Formánek (1911), Kuhnt (1913), Reitter (1916), Schaufuss (1916), Ter-Minasjan (1965) and others, the beetles are 4.5 to 6 mm long. Freude, Harde & Lohse (1981), Mellings (2002) and Gønget (2003) mention the length of 4 to 5.5 mm. According to Jäger (1876), beetles are 4 to 5 mm long and according to Mamaev, Medvedev & Pravdin (1976) 4 to 6 mm. Klapálek (1903) mentions the length of 4 mm and Tillesse *et al.* (1997) only 2 to 4 mm. Based on the majority of data, it is not evident if it refers to the length of imagoes with their beak in natural position (ie at an angle forward) or upright to the longitudinal axis. Data on the size of males and females are not available.

Results of measurements of the body length of males and females with their beak in natural or upright position are given in Tab. I. The table shows that imagoes with a beak in natural position are 4 to 6.2 (on average 5) mm long whereas imagoes with a beak in upright position are 3.6 to 5.6 (on average 4.4) mm long, ie 0.6 mm less. Males are on average 0.3 mm larger than females. Imagoes of *B. betulae* of a similar appearance are markedly (on average by 2.3 mm) larger.

The occurrence of imagoes after hibernation

Imagoes hibernate mainly in forest litter or in earth pupal chambers. After 7 to 8.5-month diapause,



1: *A female of Bycticus populi. Photo J. Dvořák. See: http://www.biolib.cz/cz/image/id238449.*

I: *The length of the body of imagoes with a beak orientated upright or at an angle to the longitudinal axis of the body.*

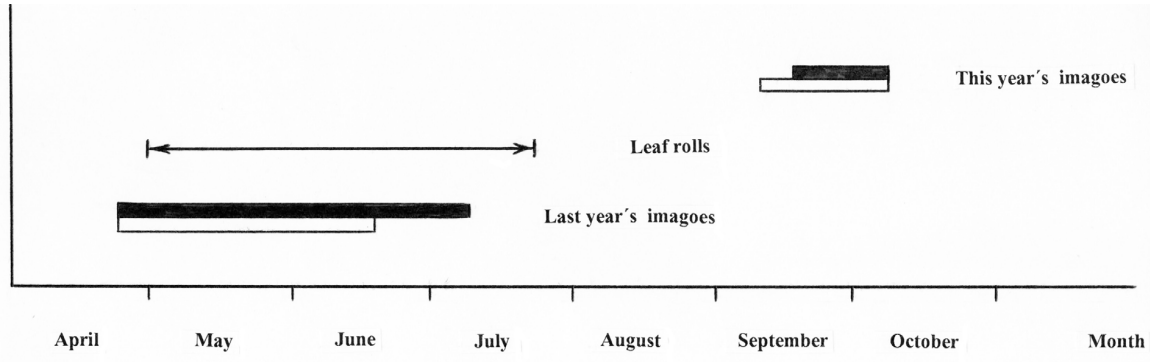
Body length (mm)	Number of measured imagoes			
	beak upright		beak at an angle	
	males	females	males	females
3.6	1	2	-	-
3.8	3	6	-	-
4.0	6	6	-	1
4.2	3	9	2	4
4.4	5	6	5	3
4.6	8	4	5	5
4.8	3	2	2	7
5.0	2	2	3	8
5.2	2	-	4	4
5.4	1	-	5	3
5.6	1	-	4	2
5.8	-	-	2	-
6.0	-	-	2	-
6.2	-	-	1	-
Number	35	37	35	37
Mean length	4.5	4.2	5.1	4.8

they leave their wintering grounds and appear on host trees where they begin to feed without delay. There is little credible knowledge on the period of the occurrence of last year's (mother) imagoes. According to Freude, Harde & Lohse (1981) beetles colonize trees from mid-April, according to Mellings & Compton (2002) as late as in May. Henschel (1895), Vasiljev *et al.* (1974) etc. mention the occurrence of last year's imagoes in May and June.

In Bílovice nad Svitavou, mother beetles were found in 2008 from 2 May to 18 July and in 2009 from 23 April to 9 July, ie for a period of 2.5 months (Tab. II, Fig. 2). Males colonized trees at the same time as females. The leave wintering grounds in the course of one week and after leaving the wintering grounds, females live on average 2 months and males 1.5 months. Females caught on 9 May 2008 lived 20 to 50 (on average 35) days in captivity. Females caught on 23 April 2009 lived 25 to 58 (on average 42) days. Males lived 11 to 35 (on average 23) days in captivity. Shevyrev (1914) mentions that females live two to three weeks. The species sex ratio is 1:1.

II: *The number of imagos and leafrolls found in the examined stand. In the numerator, data from 2008 and in the denominator, data from 2009 are given.*

Date of checking	Number of last year's imagoes		Number of this year's imagoes		Number of leafrolls
	males	females	males	females	
25. 4./23. 4.	-/7	-/3	-	-	-
2. 5. /30. 4.	-/5	1/5	-	-	-/30
9. 5. /7. 5.	5/1	7/4	-	-	13/24
16. 5./14. 5.	1/2	1/2	-	-	33/45
23. 5./21. 5.	1/-	2/1	-	-	27/35
30. 5./28. 5.	2/-	2/1	-	-	30/32
6. 6. /4. 6.	1/2	1/2	-	-	27/24
13. 6./11. 6.	1/1	2/1	-	-	60/21
20. 6./18. 6.	1/4	2/1	-	-	60/26
27. 6./25. 6.	1/-	1/3	-	-	23/15
4. 7. /2. 7.	-	1/1	-	-	16/24
11. 7. /9. 7.	-	1/1	-	-	11/40
18. 7./16. 7.	-	1/-	-	-	8/29
25. 7./23. 7.	-	-	-	-	10/18
1. 8. /30. 7.	-	-	-	-	5/-
8. 8./6. 8.	-	-	-	-	-
15.8./13.8.	-	-	1/-	-	-
22.8./20.8.	-	-	2/-	-	-
29.8./27.8.	-	-	-	1/-	-
5.9. /3.9.	-	-	-	2/-	-
12. 9./10. 9.	-	-	3/1	3/-	-
19. 9./17. 9.	-	-	-	3/1	-
26. 9./24. 9.	-	-	1/1	2/3	-
3. 10./1. 10.	-	-	2/-	3/-	-
10. 10./8. 10.	-	-	1/1	3/1	-
17. 10./15. 10.	-	-	-	-	-
24. 10./22. 10.	-	-	-	-	-
Total	13/22	22/25	10/3	17/5	323/363



2: *A period of the occurrence of imagoes and leafrolls. Bílovice n. Svitavou, 2009.*

Maturation and regeneration feeding

Beetles of *B. populi* colonize budding and newly unfolded host trees. The beetles occur most frequently on shrubby advance growth and on thickets of maximum height 2 m. Therefore, we can encounter them mainly in plantations of the 1st age class or in forest nurseries. Most frequently, they occur on the adaxial face of growing up and newly unfolded leaves. On leaves, they are evident from a distance of several meters.

They feed on young leaf tissues, rarely on buds and non-lignified shoots. The beetles bite out holes of a diameter of 0.6 to 1.0 (on average 0.8) mm from the adaxial face of a leaf blade. Holes reach usually up to the lower epidermis, which remains undamaged from 90 to 100%. Beetles arrange the wholes in a row thus feeding marks acquire a line appearance. The length of feeding marks ranges between 1 and 15 mm, their width is more or less constant (about 0.8 mm). Beetles reared on young leaves of aspen created feeding marks 1 to 8 (on average 3.5) mm long and 1.0 mm wide. Growing up and ageing blades of epidermis often crack in the place of feeding marks thereby elongated little windows as many as 15 mm long and 3 mm wide originate. Beetles do not damage leaf veins. The majority of feeding marks (on average 37%) is more or less parallel with a main vein. On average, 31% feeding marks is parallel with lateral veins. About 18% feeding marks are oriented perpendicular to the main vein and about 14% to lateral veins. Frass pellets are irregularly shaped, on average 0.5 mm long and 0.3 mm wide. After defecation, they are dark-green, later brown to black.

III: *Mean area of leaves damaged by last year's females (cm²/%). Mean number/% of leafrolls and laid eggs. Females (10) were caught on 9 May 2008. In the laboratory, they lived on average 35 days. On ovaries of dead females, there were 0 to 5 (on average 2.3) unlaid eggs.*

Period (from– to)	Damaged area	Number of rolls	Number of eggs
9. 5.–16. 5.	3.1/24.6	4.4/35.5	9.3/32.9
17. 5.–23. 5.	2.7/21.4	2.8/22.6	8.0/28.2
24. 5.–30.5.	2.5/19.9	2.6/21.0	6.3/22.3
31. 5.–6. 6.	2.4/19.0	2.3/18.5	3.7/13.1
7. 6.–13. 6.	1.8/14.3	0.3/2.4	1.0/3.5
14. 6.–18. 6.	0.1/0.8	-	-
Total	12.6/100.0	12.4/100.0	28.3/100.0
Mean/week	2.5	2.5	5.7
Mean/day	0.36	0.35	0.81
Day (from– to)	0–0.8	0–3	0–6

IV: *Leaf area damaged by a last year's female (cm²/%). Number/% leafrolls and laid eggs. The female was caught on 23 April 2009 and lived in the laboratory 52 days. In ovaries of the dead female, there were three unlaid eggs.*

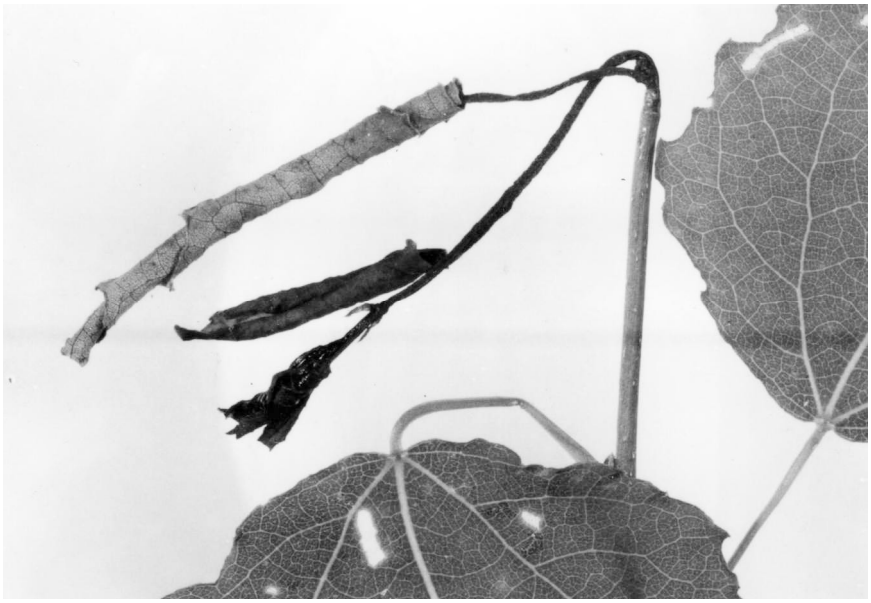
Period (from– to)	Damaged area	Number of rolls	Number of eggs
23. 4.–30. 4.	2.0/10.4	2/10.0	2/5.3
1. 5.–7. 5.	4.3/22.4	5/25.0	5/13.1
8. 5.–14. 5.	3.1/16.2	8/40.0	21/55.3
15. 5.–21. 5.	3.0/15.6	4/20.0	8/21.0
22. 5.–28. 5.	2.7/14.1	-	-
29. 5.–4. 6.	2.5/13.0	-	-
5. 6.–11. 6.	1.6/8.3	1/5.0	2/5.3
12. 6.–13. 6.	-	-	-
Total	19.2/100.0	20/100.0	38/100.0
Mean/week	2.6	2.7	5.1
Mean/day	0.37	0.38	0.73
Day (from– to)	0–0.6	0–4	0–5

The course of leaf damage in particular week intervals is given in Tabs. III and IV. Females caught 9 May 2008 (ie less than one week from the beginning of leaving winter grounds) lived in the laboratory on average 35 days. They damaged 7.2 to 17.0 (on average 12.6) cm² leaves. Thus, they damaged 0 to 0.8 (on average 0.4) cm² per day, ie 24 hours (Tab. III). The highest damage (19.2 cm²) was detected at a female caught on 23 April 2009. The female lived 52 days and during one day, it damaged 0 to 0.7 (on average 0.4) cm². It damaged the leaves most in the 2nd week of rearing. From this period, the food intake decreased and stopped two days before death (Tab. IV).

The daily activity of imagoes depends on weather. They are most active during warm, sunny and windless weather. Beetles show well developed membranous wings, which are twice longer than their abdomen. At temperatures over 20 °C, they often fly, namely even longer distances (according to Mellings, 2002 even over 100 m). Their fly is fast, straight-lined and rather unskilful. At rearing, the beetles fly rarely and after start, they run against the vessel walls and fall to bottom. They survive cold, rainy and windy weather in shelters on the ground. The beetles climb shoots only when the air temperature exceeds 14 °C and when trees dry and wind quietens. Under warm weather, leaves skeletonize even under moderate rain or wind. They do not eat wet leaves. After dipping the leaf surface they hide on the abaxial face of leaf blades. At first sight, beetles appear to be clumsy. In reality, however, they are alert and movable. They take into account surrounding events and in danger, they fall to the ground. The beetles hide in low vegetation or forest litter until stimuli signalling danger pass away. Sometimes, they escape danger by fast run and subsequent fall to the ground or by taking off. Specially adapted soles of the beetles make possible safe movement on trees. In rearing, they are able to move even on smooth walls of glass vessels.

Reproduction

After several days of feeding, beetles sexually mature and copulate repeatedly on trees. In the period of increased activity (in May), imagoes in captivity copulated 3 to 6 times during a day and 1 to 3 times at night, namely for a period of 3 to 15 (on



3: *The shoot top of P. tremula damaged by B. populi*

average 10) minutes. Then, fertilized females roll up leaves and lay eggs. Feeding, copulation, rolling the leaves and egg laying proceed for the period of two months. At the end of June and at the beginning of July, males usually die and, thus, usually only females occur on trees. In the 2nd half of July, feeding and reproduction finish and mother beetles die. The period of reproduction (exactly derived according to the creation of leafrolls) takes 2.5 to 3 months (Tab. II). In England, beetles roll up leaves from May to June (Mellings & Compton, 2002).

Females of *B. populi* roll up almost grown-up young leaves on freely growing shoots. Into the leaf petiole, they gnaw out a transverse oval hole of 0.54 × 0.37 mm and 0.55 mm deep. They always eat out the holes from the adaxial face, namely close to a leaf blade (maximally 6 mm from its base). At work, they are orientated with their head to shoots. The holes extend to the lower epidermis intersecting part of vascular bundles. The leaf blade early dies back losing its elasticity. Biting into the leaf petiole takes 8 to 12 (on average 10) minutes. As a rule, females then temporarily leave the leaf and ingest or take a bite of another leaf petiole. After 20 to 40 minutes, they return to the limp slightly saggy leaf the leaf petiole of which knee-bends in the place of injury. From the lateral side, they begin to roll up the leaf blade. If the leaf blade is not sufficiently soft laying too large resistance, the female interrupts rolling the leaf. It either passes on a petiole increasing the hole or skeletonizes the leaf or bites out a hole into another leaf petiole. The total time of eating out a hole can be extended even to 25 minutes.

In the period of the intensive creation and growth of shoots (ie in May and in the first half of June), females often stick unlignified shoots. At a distance of 5 to 10 cm from the shoot top, they eat out a hole of 1.8 × 0.8 mm. The hole is then slightly broadened in the shoot pith creating an oval cavity of 2 × 1 mm. The hole often extends up to the opposite epidermis. The shoot top above the hole begins early to die back. Females sometimes accelerate the wilting by pits in leaf petioles and sporadically also by additional holes in shoots.

Females lay eggs to the lateral fold of a leaf blade, which is then rolled up to the cylindrical form of a cigarette (Fig. 3). From May to mid-June, they create leafrolls from one to four leaves. The majority of them (60%) roll up only one leave. Later (from mid-June do the end of July), they roll always only one leaf. They roll the leaf blade from the lateral margin, viz. almost always in one direction. A cross section through a final leafroll creates a spiral. According to Shevyrev (1914), the abaxial face of the leaf blade is less flexible owing to protruding veins and, therefore, it has to be outside the leafroll. Also Lengerken (1959) mentions rolling the leaves by an adaxial face inward. According my studies investigations, leaves are rolled in both directions. The majority (75%) of one-leaf rolls is rolled by the adaxial face of a blade outwards. At leafrolls created by more leaves, blades of other leaves (wrapped on an inner leaf) are from 31 to 73% orientated by adaxial face outwards. Exceptionally, part of the leaf blade is rolled outward and part inward the rolls. Frequent (as many as tenfold) changes of the direction of rolling the leaf blade are known at *B. betulae*. It is possible to note that on average at 67% rolls, leaves are orientated by the adaxial face of a blade outwards, at 32% inward and at 1% in both faces (Tab. V).

At rolling a leaf blade, females use strong legs with specially adapted soles and a beak. By three legs they are attached to the unrolled part of the leaf blade and by three legs to the already rolled part of the blade. Through the extended end of their beak they strike

V: *The way of rolling up leaves into rolls created by various numbers of leaves (May and June 2009).*

Number of leaves in rolls	Number of examined rolls	Number/% leaves orientated by their adaxial face			Number/% leaves in total
		outside the roll	inside the roll	outside and inside the roll	
1	123	92/74.8	28/22.8	3/2.4	123/100.0
2	35	51/72.9	19/27.1	-	70/100.0
3	14	21/50.0	21/50.0	-	42/100.0
4	4	5/31.3	11/68.7	-	16/100.0
5	3	9/60.0	6/40.0	-	15/100.0
Total/ %	179	178/66.9	85/32.0	3/1.1	266/100.0

at the leaf blade in short intervals (about 2 times per second). Thus, the blade becomes more pliable and the leafroll more compact. At compressing the leaf blade, females use also their abdomen. The initial stage of creating the leafrolls appears to be most difficult and time consuming. The blade margin has to be processed very thoroughly by their beak the female to be able to bend it. As soon as the female makes the first whorl then usually other rolling does not take long time. The female works strenuously and almost without rest. If the certain part of the blade is processed and fits tightly to the rolled part, the female can carefully go to the apical part of a future leafroll. From here, it continues in rolling the leaf blade in the longitudinal line of a fold (towards the blade base).

In the period of the leafrolls making, the leaf blade is usually saggy. The female is, therefore, orientated at work by its head down gradually receding to the blade base (ie upwards). Then, it carefully comes to the top of a future leafroll holding the completed part of the leafroll by its legs for it not to be unfolded. This procedure is repeated several times. However, the leaf elasticity sometimes wins over the endeavour of a female and part of the leafroll unfolds. The female patiently and untiringly rolls again the leaf blade and processes its elastic and tough parts. In the laboratory, a female was monitored where its leafroll unfolded three times. Nevertheless, the female completed it successfully. Uncompleted leafrolls occur in nature rarely. The actual rolling of a leaf blade takes 30 to 140 (on average 60) minutes. Usually, only one female rolls leaves, sometimes two (and exceptionally even three) females. According to Mellings (2002), at making a leafroll as many as four beetles (mostly females) can cooperate. It is, therefore, possible that some leafrolls contain eggs of more females.

After rolling up the whole leaf blade, the female usually reinforces a leafroll in such a way that it sticks dents at the lateral margin of the blade to a leafroll. For this purpose, it uses the secretion of accessory glands in its abdomen. According to former literature, it uses sticky liquid excreted by leaf glands at margins of hypertrophied dents. It sticks one-leaf leafrolls maximally on 5 (on average on 2.4) places (Tab. VI), multi-leaf rolls even on 12 places. The sticking takes on average 10 minutes. The

VI: *Number of places stuck together on rolls made of one leave.*

Number of places stuck together	Number/% rolls		
	2008	2009	total
0	3/2.4	3/2.9	6/2.6
1	18/14.3	6/5.7	24/10.4
2	61/48.4	36/34.3	97/42.0
3	36/28.6	33/31.4	69/29.9
4	8/6.3	24/22.8	32/13.8
5	-	3/2.9	3/1.3
Total	126/100.0	105/100.0	231/100.0
Mean	2.2	2.7	2.4

total time of making a leafroll (from the beginning of biting out a hole to sticking the leafroll) takes one to three (on average two) hours, at the cooperation of two females about 40 minutes less. The older a leaf the longer the time to make the leafroll.

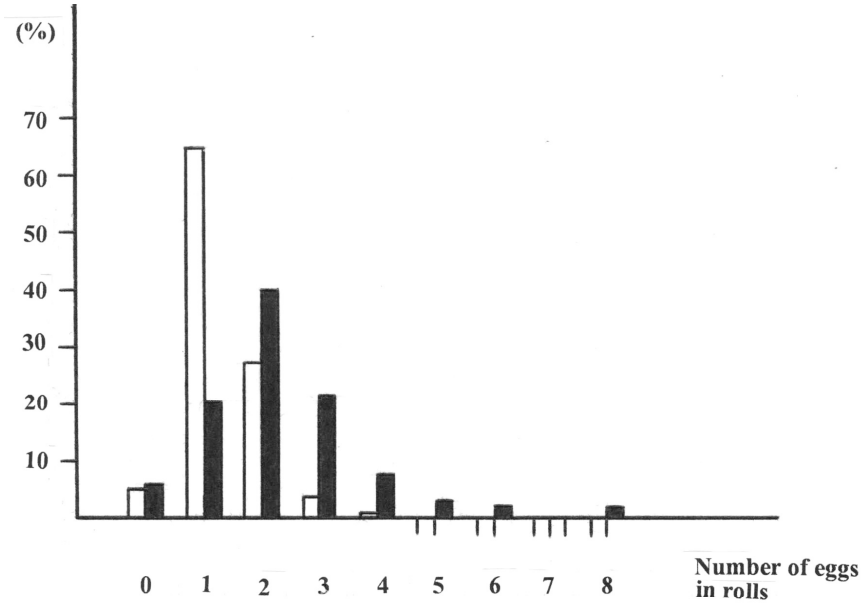
Leafrolls persist on shoots for the period of several weeks. Nevertheless, females detach some leafrolls from trees immediately after their making (Mellings & Compton, 2002). In the first case, dried up, brown or even black leafrolls fall to the ground; in the second case, green leafrolls with an eaten out hole in a petiole. Females climb to the petiole of a newly rolled up leaf and turn their head towards a leafroll. Then, in the course of a very short time (on average two minutes), they bite off a petiole near the leafroll (at a distance of 7 mm from its base). Such behaviour of females was commonly observed also in the laboratory.

Beetles are photophilous and, therefore, they are most active during warm sunny days. Under favourable weather, they roll up leaves day and night (according to Mellings, 2002 from early morning until nightfall). In the laboratory, a female was observed, which made four leafrolls from 28 to 29 April between 6 p.m. and 6 a.m. (ie during 12 night hours). Females do not interrupt their work even under cloudy sky and slack wind. They lay eggs into the lateral fold of a blade at the beginning of rolling the blade. Therefore, in completed leafrolls, eggs occur always in the inner quarter of a leafroll, ie close to their centre. Within their life (in the course of two months), they make as many as 20 to 30 leafrolls and lay 30 to 41 eggs. The females roll up 0 to 4 (on

average 0.4) leafrolls and lay 0 to 6 (on average 0.8) eggs per day (Tabs. III and IV). Into one leafroll, they lay 0 to 4 (on average 1.3) eggs. The proportion of leafrolls without eggs is minimal (on average 4.5%). Four eggs in a leafroll occur only exceptionally (in 0.4%). In leafrolls made in the laboratory, 0 to 8 (on average 2.2) eggs were laid (Tab. VII, Fig. 4). The markedly higher number of eggs in leafrolls in the laboratory signalizes that in rearing, conditions for the creation of leafrolls are worse than in nature.

VII: *Number of eggs in leafrolls made in nature and in the laboratory*

Number of eggs in rolls	Number/% analysed rolls made in nature				Number/% analysed rolls made in the laboratory			
	2007	2008	2009	total	2007	2008	2009	total
0	12/4.8	2/2.7	19/9.8	23/4.5	1/3.2	4/4.8	5/7.9	10/5.6
1	191/76.4	30/41.1	103/53.1	324/63.9	9/29.0	11/13.1	17/27.0	37/20.8
2	42/16.8	36/49.3	61/31.5	139/27.4	10/32.3	33/39.3	28/44.5	71/39.9
3	5/2.0	5/6.9	9/4.6	19/3.8	7/22.6	24/28.5	7/11.1	38/21.3
4	-	-	2/1.0	2/0.4	2/6.5	6/7.1	5/7.9	13/7.3
5	-	-	-	-	1/3.2	3/3.6	1/1.6	5/2.8
6	-	-	-	-	1/3.2	2/2.4	-	3/1.7
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	1/1.2	-	1/0.6
Total	250/100.0	73/100.0	194/100.0	507/100.0	31/100.0	84/100.0	63/100.0	178/100.0
Mean	1.2	1.6	1.3	1.3	2.2	2.5	1.9	2.2



4: *The percentage proportion of leafrolls according to the number of eggs in nature – light columns and in the laboratory – dark columns. Bílovice n. Svitavou, 2007 to 2009.*

SUMMARY

The biology of *Bycticscus populi* (L.) was studied on *Populus tremula* L. in Forest District Bílovice nad Svitavou (former district of Brno-venkov) in the period 2007 to 2009. Last year's imagoes occurred there from the third decade of April until the end of July. Females lived in the laboratory on average 1.5 months and damaged 7.2 to 19.2 cm^2 leaves. In nature, females live on average two months. They produce 20 to 30 leafrolls and lay 30 to 41 eggs. Every day, they roll up 0 to 4 (on average 0.4) leafrolls and lay 0 to 6 (on average 0.8) eggs. They lay 0 to 4 (on average 1.3) eggs into one leafroll, in the laboratory 0 to 8 (on average 2.2) eggs. In 67% leafrolls, leaves are rolled up by their adaxial face outwards, in 32% inward and in 1% towards both faces. The production of rolls (from the beginning of biting out holes

into petioles to leafroll sticking) takes on average two hours. Two thirds of rolls persist on shoots for the period of 1 to 4 weeks. At one third of rolls, females bite out the petioles immediately after rolling up the leaf blades and rolls fall to the soil surface

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