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REMARKABLE, HOWEVER BIOLOGICALLY UNKNOWN SAWFLY *CRAESUS LATIPES* (VILLARET) (HYMENOPTERA, TENTHREDINIDAE)

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Abstract

URBAN, J.: *Remarcable, however biologically unknown sawfly Craesus latipes (Villaret) (Hymenoptera, Tenthredinidae).* Acta univ. agric. et silvic. Mendel. Brun., 2012, LX, No. 3, pp. 179–198

In 2009 to 2011, a rather frequent occurrence of *Craesus latipes* (Vill.) was noted on *Betula pendula* Roth. in the Brno region. Part of the sawfly population showed bivoltine and part univoltine development. At the bivoltine development, imagoes occurred for the first time in the second half of May and at the beginning of June, for the second time in August. At the univoltine development, imagoes flew in the second half of June and in the first half of July. Females lay eggs into longitudinal slits in veins on the abaxial face of leaves. During several days (in the laboratory already during first three days) they lay 91 as many as 133 eggs on seven to ten leaves. They die one to three days after oviposition. The embryonal development takes six to seven (in the laboratory four to five) days. Male larvae eat for two weeks (in the laboratory 12 days) and show five instars. Female larvae eat for three weeks (in the laboratory 16 days) and show six instars. Male larvae destroyed in captivity on average 19.8 cm^2 (female 60.0 cm^2) leaves of *B. pendula*. Larvae of the bivoltine subpopulation occurred on trees for the first time at the end of May and in June, for the second time in the second half of August and in the first half of September. Larvae of the univoltine subpopulation occurred from the second decade of June till the end of August, exceptionally even later. Eating larvae could be noted locally and in small numbers for nearly the whole growing season[1].

Tenthredinidae, *Craesus* (= *Croesus*) *latipes*, occurrence, reproduction, development of larvae, food consumption, generation conditions, importance

A sawfly *Craesus latipes* (Villaret, 1832) is one of four species of the genus *Craesus* Leach, 1817 in the Czech Republic. The genus was until recently wrongly named as *Croesus* Curtis, 1824. It ranks among a superfamily Tenthredinoidea, namely into its species-richest family Tenthredinidae. Taxonomically, it is included in a subfamily Nematinae, tribe Nematini. Morphologically, the genus *Craesus* is very close to a species-numerous and more important genus *Nematus* Panzer, 1801. In older literature, a name *Nematus* (Rörig, 1906; Nüsslin & Rhumbler, 1922; Salač, 1924; Gusev & Rimskij-Korsakov, 1953 etc.) was, therefore, often used for species of the genus *Craesus* (= *Croesus*). However, the most abundant and widespread species of the genus *C. septentrionalis* (Linnaeus, 1758) was originally described as *Tenthredo septentrionalis* (Linnaeus, 1758). Also other species of the genus

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

Craesus were included into the genus *Tenthredo* (which ranks among the subfamily Tenthrediniinae, tribe Tenthredinini) in the past.

In addition to *Craesus latipes* (Villaret, 1832) (= *Croesus laticrus* Eversmann, 1847; *Nematus betularius* Tischbein, 1852) and *C. septentrionalis* mentioned above, also *C. alniastri* (Scharfenberg, 1805) (= *C. varus* Villaret, 1832) and *C. brischkei* (Zaddach, 1876) occur in the CR and in the best part of Europe. The biology of *C. septentrionalis* is known very few so far and the biology of other species including *C. latipes* is not known at all.

Imagoes of *C. latipes* and other European species of the genus *Craesus* are up to 11 mm long and stocky. Except the melanistic form of *C. septentrionalis* they have got a black abdomen with a red strip in the centre. Morphologically, they are remarkable according to the apical enlargement of rear shins and particularly according to the foliaceous enlargement of the first article of soles of rear legs. Females lay eggs in rows into slits in main and lateral veins on the abaxial face of leaves. Larvae resemble morphologically and biologically species of the genus *Nematus* and unlike imagoes they are rather species-distinguishable from each other. Larvae live gregariously (rarely separately) at the edge of leaves of host tree species. In case of interruption, they sharply shoot up their abdomen to the form of a letter S. In this position they remain or swing more or less rhythmically by their abdomen until symptoms signalling danger do not pass away.

In 2009 to 2011, larvae of *C. latipes* were found rather frequently on leaves of *Betula pendula* Roth. in the Brno region. This fact was used for field and laboratory research into its occurrence, life pattern and harmfulness.

Geographical distribution

According to Schmiedeknecht (1907), Pschorn-Walcher (1982) etc., *C. latipes* is a rather rare, however, widespread European species. The centre of its occurrence is in Central Europe (Kieffer, 1914; Hedicke, 1930; Pschorn-Walcher & Altenhofer, 2000 etc.). According to Berland (1947), it is known from France, the British Isles, Belgium, the Netherlands, Germany, Austria and Russia. For example, Magis (2006) mentions its occurrence in Belgium and Liston & Shepard (2008) in England, Wales, Scotland and Ireland. On the large part of Saxony (eastern Germany), it belongs recently to endangered species (Taeger *et al.*, 1998). The southern limit of its area of distribution reaches Italy (Masutti & Pesarini, 1995), the northern limit to Finland (Kontuniemi, 1960). The species occurs also in the European part of the former Soviet Union (Gusev & Rimskij-Korsakov, 1953) and even in western Siberia, e.g. the region of Krasnoyarsk in Russia (about 100 km west of Lake Baikal) (Muchašova, 2008/2009). Findings prove that *C. latipes* is evidently a Eurosiberian species.

Generally, *C. latipes* (together with *C. brischkei* and usually also *C. varus*) is considered to be a rather rare sporadic species. Beneš (1989) mentions the species only from Bohemia and Moravia of former Czechoslovakia. In various summary (aggregate) entomological and entomological-forest protection publications only the most important species, namely *C. septentrionalis* (Ratzeburg, 1844; Rörig, 1906; Schmiedeknecht, 1907; Nüsslin & Rhumbler, 1922; Salač, 1924; Escherich, 1942; Stark *et al.*, 1951; Francke-Grosmann, 1953; Schimitschek, 1955; Pfeffer & Kudela, 1960; Chararas, 1962; Brauns, 1964; Iljinskij & Tropin, 1965; Schwerdtfeger, 1970; Koehler & Schnaider, 1972; Stroganova, 1982; Sedlag, 1986; Křístek & Urban, 2004 etc.) is mostly mentioned from the genus *Craesus*.

Host species

Craesus latipes shows a trend to oligophagous species. According to the majority of authors, its larvae occur on species of the genus *Betula* (Kieffer, 1914; Hedicke, 1930; Berland, 1947; Pfeffer *et al.*, 1954; Lorenz & Kraus, 1957; Kontuniemi, 1960; Pschorn-Walcher, 1982; Schedl, 1991; Muchašova, 2008/2009 etc.). For example, Gusev & Rimskij-Korsakov (1953) mention trophic relations to *B. pendula* Roth. (syn. *B. verrucosa* Ehrh.) and *B. pubescens* Ehrh. In the Alps (altitudes ≤ 1 500 m), larvae develop also on *Duschekia alnobetula* (Ehrh.) Pouzar (syn. *Alnus viridis* /Chaix/ DC., *Alnaster viridis* /Chaix/ Spach.) (Taeger *et al.*, 1998; Pschorn-Walcher & Altenhofer, 2000 etc.). Thus, it is evident that *C. latipes* demonstrates its trophic affinity to some species of the family Betulaceae.

C. septentrionalis shows the broader spectrum of hosts. *B. pendula*, *B. pubescens*, *Alnus glutinosa* Gaertn. and *A. incana* Moench. rank among its main hosts. According to Ratzeburg (1844), it lives also on *Salix*, *Corylus* and *Populus*. Berland (1947) mentions the possible occurrence of the larvae on *Sorbus*, *Corylus*, *Salix pentandra* L. and *Populus nigra* L. *Betula* is evidently its most frequent host, less frequent is *Alnus* including *D. alnobetula*. According to Pschorn-Walcher (1982), it also occurs rarely on *Salix*, *Corylus*, *Populus*, *Sorbus*, *Carpinus*, *Acer* and *Fraxinus*. Generally rather rare species *C. alniastri* is known from *Alnus* and the most rare species *C. brischkei* from *Carpinus* and *Corylus*. A simplified statement of some authors that European species of the genus *Craesus* live on trees of the family Betulaceae is not correct because it is fully relevant only to *C. latipes*.

Life pattern

As for European species of the genus *Craesus*, the largest attention was paid so far to *C. septentrionalis* (Ratzeburg, 1844; Escherich, 1942; Stark *et al.*, 1951; Chararas, 1962; Iljinskij & Tropin, 1965; Koehler & Schnaider, 1972 etc.). The occurrence, bionomics, and harmfulness of other less numerous species are nearly not known at all. At *C. latipes* (similarly as at *C. septentrionalis*), arrhenotoky was detected, i.e. the form of parthenogenesis where a progeny consists only of males (Cameron, 1884; Berland, 1947). For example, Lorenz & Kraus (1957) mention the time of occurrence and the specific behaviour of larvae on trees. Pschorn-Walcher (1982) and Pschorn-Walcher & Altenhofer (2000) mention that colonies of *C. latipes* are thinner and less abundant as against *C. septentrionalis*. *C. latipes* has one or two (under optimum conditions of a forest-steppe zone exceptionally perhaps even three) generations per year, the second generation being more abundant. According to Pschorn-Walcher & Altenhofer (2000), at bivoltine development, larvae occur for the first time in June and July and for the second time in August and September. At higher locations of the Alps, the sawfly shows mostly a univoltine developmental cycle with larvae from July to September.

In the development of larvae from the subfamily Nematinae, large unpaired follicular glands show unsubstitutable importance. These glands lead on the outside to an abdomen between pseudopods. In case of disquietness, larvae upright their abdomen and excrete defense secret from ventral glands. Secretion of *C. latipes*, *C. alniastri* and *C. septentrionalis* was studied in detail by Boevé & Heilporn (2009). The authors found that monoterpene dolichodial was the main component of the secret of glands of these sawflies. Except sawflies of the genus *Craesus*, dolichodial was also detected at some species of the genus *Nematus* (Boevé, 2004). Zinnert (1969), Kasparyan (1977) etc. mention the larval parasitoids of *C. latipes*. The species spectrum of parasitoids and predators of *C. latipes* is numerous and essentially the same as in *C. septentrionalis* (Pschorn-Walcher, 1982).

Sawflies of the genus *Craesus* live mainly on young free-growing and well illuminated trees until ten years. In closed dense stands with full-grown trees they almost do not occur at all. Larvae cause occasional local defoliations of particular branches, seldom even of whole trees. Damaged trees become green again as a rule in the same year. Forestry importance of sawflies is slight and virtually neglectable. Only *C. septentrionalis* (Ratzeburg, 1844; Stark *et al*., 1951; Pfeffer & Kudela, 1960; Iljinskij & Tropin, 1965; Trjapicyn & Zhelochovtsev, 1981; Stroganova, 1982 etc.) is sometimes considered to be an occasional pest of shelter belts, young park plantations, advance regeneration and young-growth stands.

MATERIAL AND METHODS

Sawflies *C. latipes* were studied at the Bílovice nad Svitavou Forest District, Forest Range Resslovka (Training Forest Enterprise Masaryk Forest, Křtiny) in 2009 to 2011. Geo- morphologically, the area belongs to the Drahanská vrchovina Upland, subregion Moravian Karst. Examined stands 380 A, 380 B and 381 B occur on the NE margin of the city of Brno in the Hádecká planinka National Nature Reserve (altitude about 400 m). Stand 373 D occurs on the near gentle SW slope running into the Těsnohlídkovo údolí valley (average altitude 340 m). The mean annual temperature in the stand amounts to 7.7 °C (in April to September 14.1 °C), mean annual precipitation 620 mm (in April to September 388 mm). The growing season duration ranges about 60 days. Partial surveys were carried out in stands at the western edge of Brno, Forest Range Obora-Holedná (Forests of the City of Brno, a. s., Kuřim).

Young stands were monitored of the 1st age class originated by natural regeneration, planting or their combination. In addition to target commercial species (mainly oak and in stand 373 D also spruce) numerous accompanying broadleaved species occurred in the species composition including self-seeding birch *Betula pendula*. The stands were visited in regular week intervals, namely from the end of April until the beginning of November. Particularly the occurrence of larvae on birch trees, the growth degree of the larvae, their ethology and the course of defoliation were monitored.

Simultaneously with field observations, *C. latipes* was examined in detail in the laboratory. At larvae transported from nature, the width of cranium was measured micrometrically and the length of body was noted. Then, the larvae were placed separately or in groups into glass Drigalsky dishes, diameter 15 (20) cm and height 6 (7) cm. Foliated branch sections of *B. pendula* 7 to 10 cm long were placed into the dishes. The area of particular leaves was measured previously (using planimetry) and marked on cards fixed to petioles. Ends of the sections were dipped into water in small glass vessels and throats of the vessels were sealed by cotton wool.

Under laboratory conditions, the time of feeding was daily monitored as well as the damaged area of leaves, the number and dimensions of defecated frass pellets etc. Particular instars (growth degrees) of larvae were determined according to the head width. Garden or forest soil was placed into the dishes with growing up larvae. In the soil, grown-up larvae could then produce cocoons. The course of hatching, the sex of imagoes, the length of body and antennas and the span of wings etc. were noted.

Freshly hatched imagoes were inserted into glass vessels on foliated sections of birch shoots. The arrangement of this rearing was the same as in the rearing of larvae from nature. Among others, the course of laying eggs and their localization on leave veins were examined. Every day, dimensions of eggs were measured micrometrically during the embryonal development. With respect to the gregarious way of life larvae were usually reared in groups of 5, 10 and 15 members. Larvae survived the period of summer and winter diapause in the laboratory or under outdoor conditions. To the laboratory, they were transferred as lately as in spring in the period of unfolding birch leaves.

RESULTS AND DISCUSSION

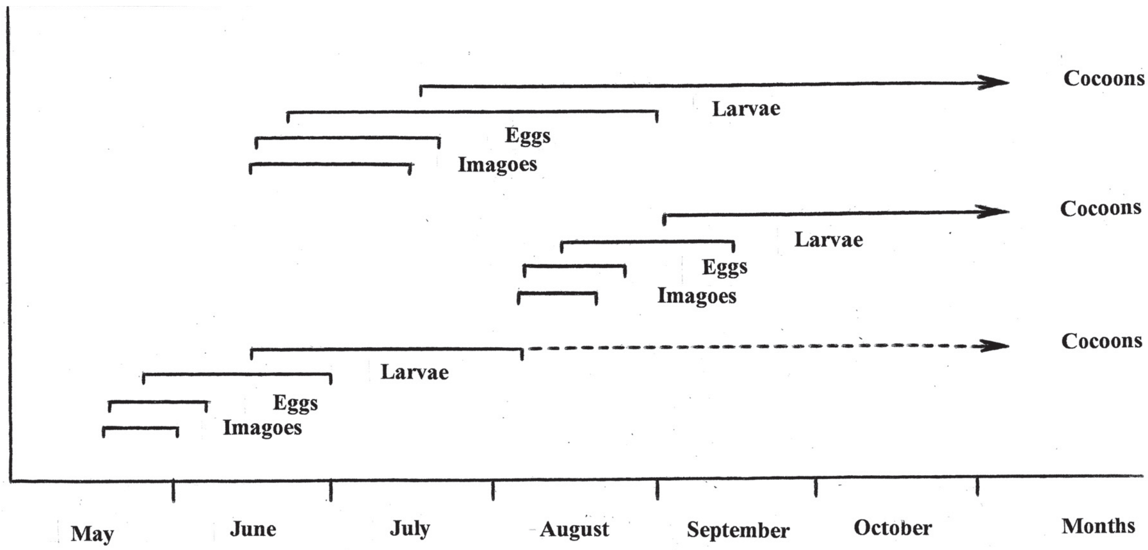
Imagoes and the period of their occurrence

According to Hedicke (1930), imagoes of *C. latipes* are 7.5 to 10 mm long, according to Berland

1: *A female of Craesus latipes.*

(1947) 7 to 10 mm. According to our examinations, females (Fig. 1) are larger and stockier than males. Females are 9 to 11 mm long. Their antennas are 7 to 7.5 mm and wingspan 19 to 22 mm. Males are 7 to 8 mm long. Their antennas are 5 to 5.5 mm long and wingspan 13 to 15 mm. Imagoes have got dull and densely dotted mesopleuron. Rear metatarsa are almost three times long than wide, flatly curved from above. The apical half of front wings is slightly brown murky with somewhat darker transverse strip behind pterostigma. There are two or three central red tergites on their abdomen.

There are no more exact data on the period of occurrence of imagoes in available literature. Magis (2006) mentions several finds of females from Belgium from the period of 6 June to 16 September. The probable time of emergence of imagoes could be derived from the period of occurrence of larvae



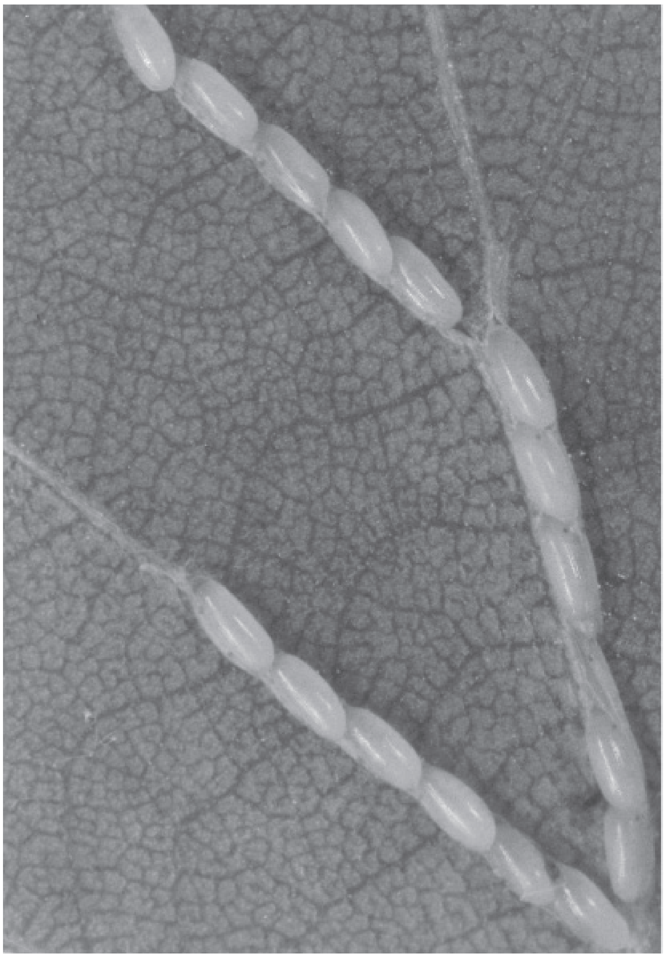
2: *The basic scheme of a bivoltine generation cycle (at the bottom and in the middle) and the univoltine cycle of C. latipes (above). Bílovice n. Svitavou, 2010.*

on trees (Lorenz & Kraus, 1957; Pschorn-Walcher & Altenhofer, 2000).

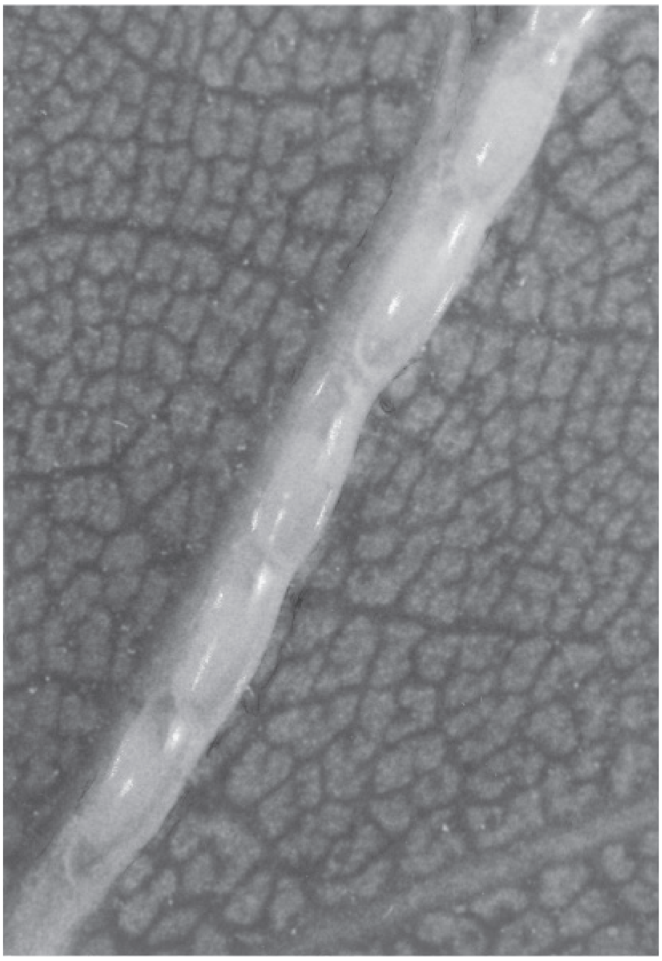
At studied localities in the Bílovice nad Svitavou Forest District, part of the sawfly population showed a bivoltine and part a univoltine development cycle. At the bivoltine generation cycle, imagoes occurred first in the second half of May and at the beginning of June, for the second time in August. From the part of wintering cocoons, imagoes hatched 1 month to 1.5 month later and a subpopulation founded by them showed univoltine development. At the one-year generation cycle, imagoes occurred in the second half of June and in the first half of July (Fig. 2). In the small part of cocoons (according to laboratory rearing about 20%), eonymphs died in consequence of parasitization caused by larvae of Ichneumonidae or diapaused for the second time till the following year. Thus, it is possible to say that adults of *C. latipes* occurred in the respective area continually from mid-May to about the end of August, i.e. almost 3.5 months.

Reproduction

Early after the emergence from cocoons, imagos of *C. latipes* mate and females lay eggs (Figs. 3 to 5). They lay eggs into longitudinal incisions in main (central) veins, more rarely in lateral veins, viz from the abaxial (sporadically also adaxial) face of leaves. The incisions reach the half of veins, at thinner veins almost their opposite face. Particular clutches resemble uninterrupted (sometimes partly interrupted) chains created by eggs placed in rows one after another. The eggs are partly (about ¼) inserted into the incisions. At laying into main veins, females are oriented by their heads to the vein base, i.e. petioles. At laying into lateral veins, females are oriented by their heads to their base. Laid eggs are oriented by head ends to the apical end of veins and somewhat more inserted into incisions. Head ends of eggs are mostly slightly (from 0 to 20% egg length) passed under neighbouring looser rear ends of eggs. The overlap of eggs amounts to 0 to 0.4 (on average 0.2) mm. It is of interest that longitudinal incisions in veins are often placed eccentrically. Therefore, eggs are sometimes partly (up to 1/3 egg width) covered from one lateral side by greenish leaf epidermis. Chains of eggs are usually covered by an indistinct longitudinal strip of solidified secret. This colourless strip passes from one egg to the other and at ends of egg groups passes up to leaf veins. Its



3: *Eggs of C. latipes on the main vein and two lateral veins of leaves of Betula pendula. Laboratory rearing, laid on 6 July, photo on 10 July 2010.*



4: *Eggs of C. latipes on the main vein of the birch leaf (detail). Laboratory rearing, laid on 2 July, photo on 5 July 2010.*

width is 0.03 to 0.15 (on average 0.09) mm and height 0.02 to 0.09 (on average 0.05) mm. The strip probably protects and strengthens the eggs.

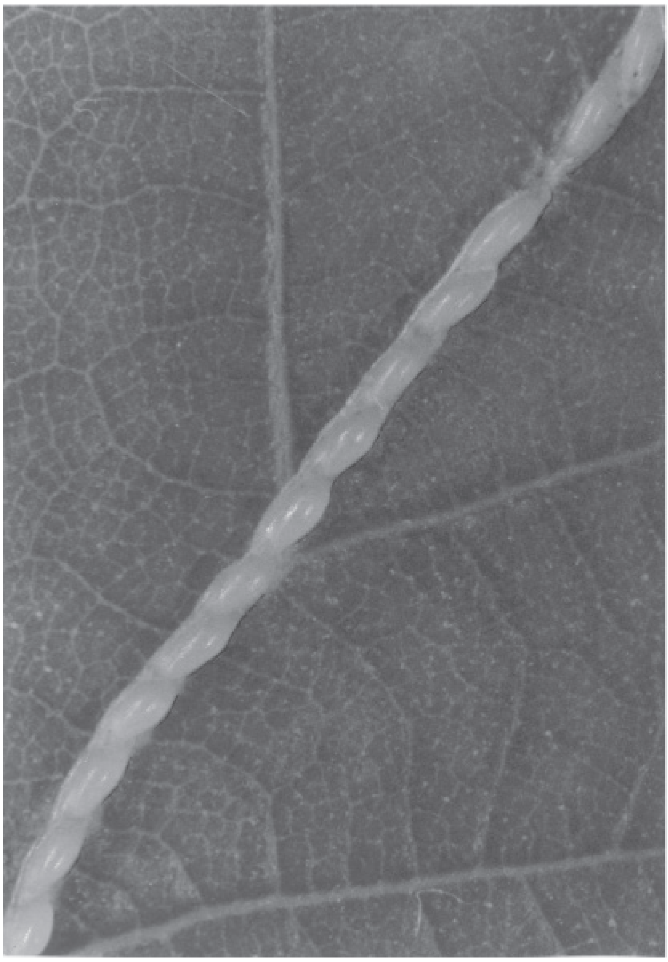
In captivity, an overwhelming majority (on average 93.7%) of eggs was laid on main veins. Rather small number of eggs (on average 5.4%) was laid on lateral veins. Rarely (on average 1.5%), eggs were laid outside veins from the adaxial face of a leaf blade (Tab. I). In laid sections, main veins were wider than eggs in 35%, in 42% main veins were of the same width as eggs and in 23% main veins were narrower than eggs. Laid lateral veins were always narrower than eggs.

In the laboratory, females laid 1 to 28 (on average 10.8) eggs on main veins into one clutch (group) (Fig. 6). On leaves of average length 5.5 cm, width 4.0 cm and area 12.9 cm^2 sections of veins 1.6 to 37 (on average 15) mm long were laid. It is evident from Tab. I and Fig. 7, that on main vein, the majority of eggs (45.9%) were localized in their basal and second quarter. On lateral veins, eggs were always laid only on their basal third. Generally, females never lay eggs on veins in their apical quarter (i.e. at the leaf blade edge).

Eggs are laid both by fertilized and unfertilized females. From unfertilized eggs, only males are always hatched (arrhenogenic parthenogenesis). Imagoes live in nature about seven days, in the laboratory only two to five (on average 3.5) days. In captivity, females laid eggs for the period of one to three (exceptionally four) days. Mostly eggs were laid (on average 50.6%) in the course of the second day (Fig. 8). Eggs were laid both during light and dark part of the day. An average (partial) clutch (eleven eggs) was laid in the course of 20 minutes, i.e. one egg on average in 2 minutes.

The actual (ecological) natality of *C. latipes* females is rather high, namely 91 to 133 (on average 112) eggs. The majority of females laid all eggs in the laboratory. After the cessation of egg laying, 0 to 14 (on average three) unlaid eggs were found in ovaries of naturally died females, i.e. less than three percent of the whole reserve of eggs. The females laid on average 13 eggs on one leaf. The whole clutch (91 to 133 eggs) was laid on seven to ten (on average 8.5) leaves.

At rearing, females often incised leaf blades by their ovipositor. The cuts (3 to 30 mm long) were passed through the whole leaf blade, namely usually



5: *Sporadic localization of eggs of C. latipes on a main vein from the adaxial face of a leaf. Laboratory rearing, laid on 6 July, photo on 9 July 2010.*

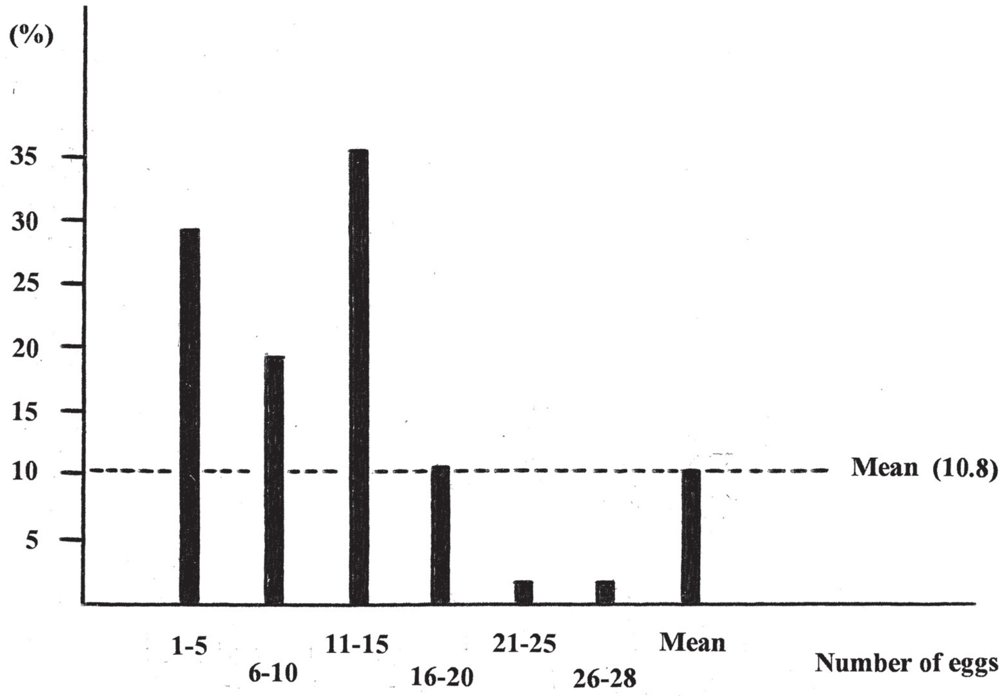
I: *Localization of eggs of C. latipes on leaves of B. pendula. Laboratory examination, 2010–2011.*

Localization of eggs on leaves		Number of eggs	(%)	Number of eggs	(%)
Main veins	1st (basal) fourth	9	2.2	377	93.1
	2nd fourth	36	8.9		
	3rd fourth	33	8.2		
	4th (apical) fourth	-	-		
	1st + 2nd fourth	186	45.9		
	2nd + 3rd fourth	63	15.6		
	1st + 2nd + 3rd fourth	50	12.3		
Lateral veins		22	5.4	22	5.4
Adaxial face of leaf blades		6	1.5	6	1.5
Total		405	100.0	405	100.0

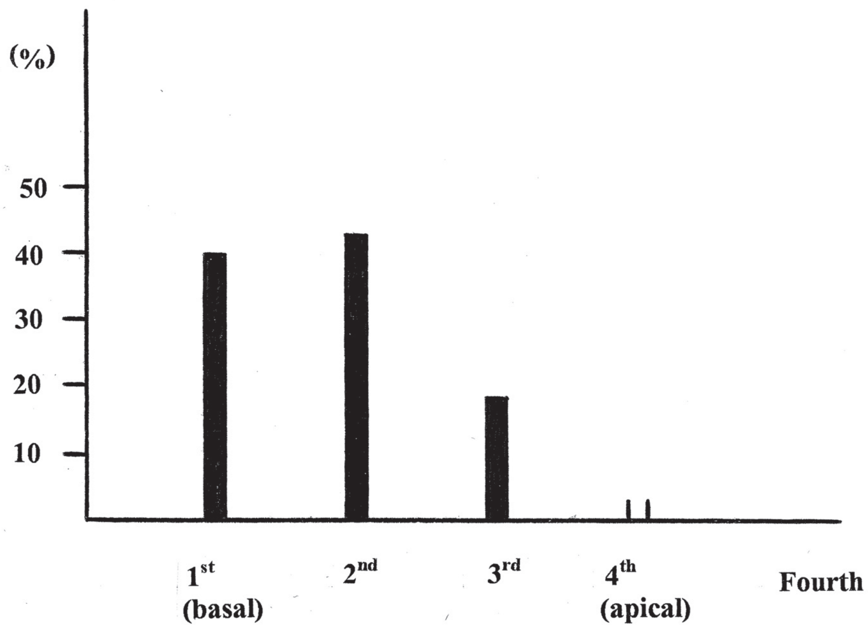
close to main and lateral veins (Figs. 9 and 10). The cuts seldom damaged the leaf blade outside nervation (Fig. 11). In nature, leaves damaged in this way were never found.

The appearance and size of eggs

Eggs of *C. latipes* are lengthwise oval to fusiform, slightly arched-curved. At their head end, they are slightly narrowed in the rear being slightly extended. They show (similarly as leaf veins) whitish to yellow-white colouring. The surface of eggs is nearly smooth, slightly glossy and very gently sculptured. The secondary egg membrane (chorion) is rather thin, elastic and rather firm. Eggs are about ¼ inserted into median- or eccentric-placed notches in veins. Laterally, they are often covered (up to 1/3 width) by leaf epidermis. From above, they are often



6: *The percentage occurrence of eggs of C. latipes on leaves of birch (according to the number of eggs in groups on veins of birch leaves). Laboratory examination, 2009–2011.*



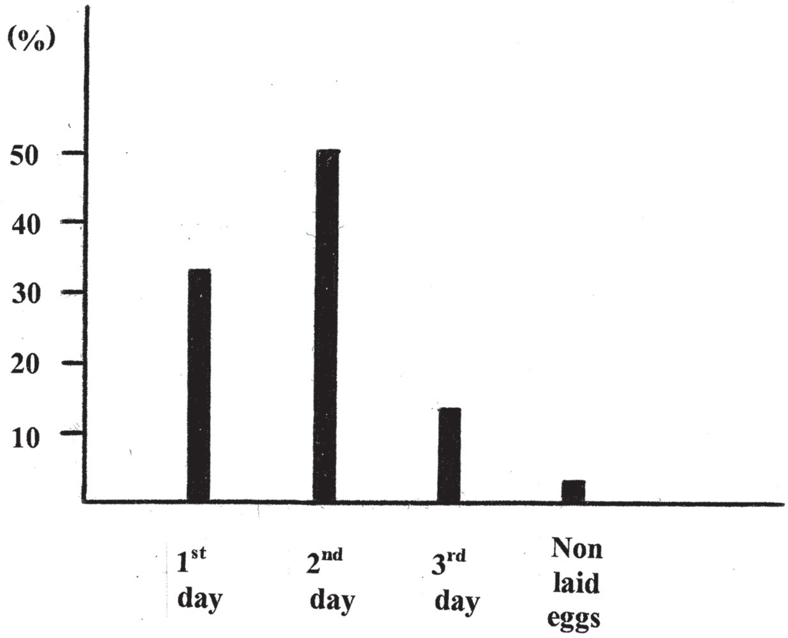
7: *Localization of eggs of C. latipes on main veins of birch leaves. Laboratory examination, 2010–2011.*

covered by an imperceptible strip of the solidified secret of accessory glands.

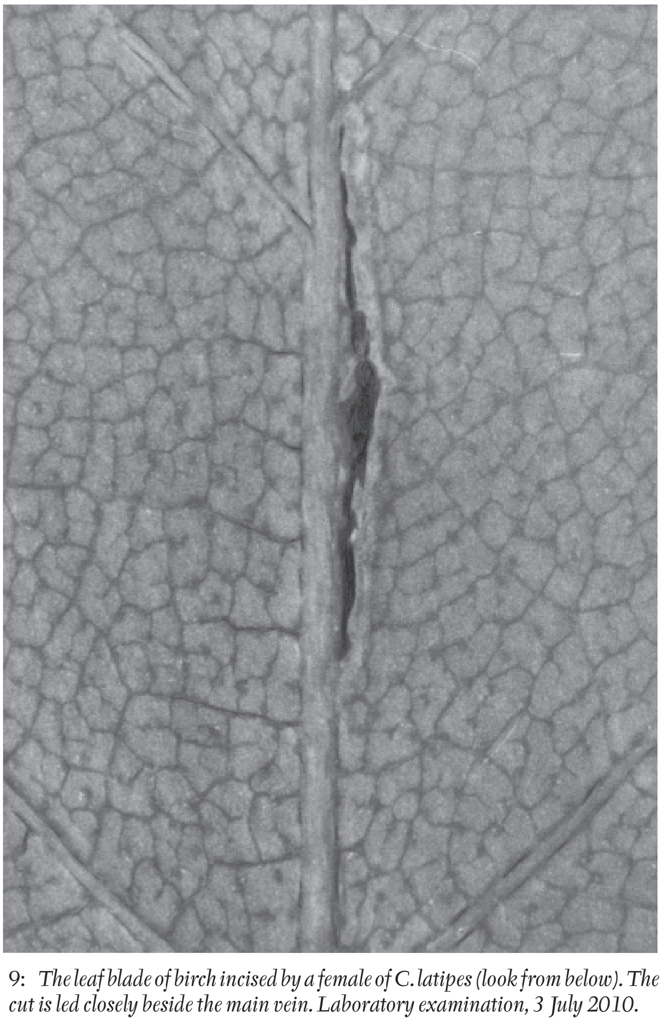
Newly laid eggs are 1.4 to 1.7 (on average 1.55) mm long and 0.4 to 0.6 (on average 0.5) mm wide. During their embryonal development, they obtain water through imbibition from the surroundings (particularly from a leaf) and thus, their volume gradually increases. The length of eggs does not almost change; however, their width evidently increases (Fig. 12). In the course of the conversion of embryos to larvae, the centre of eggs becomes evidently light. The embryonal development takes six to seven days, under laboratory conditions four to five days.

The development of larvae

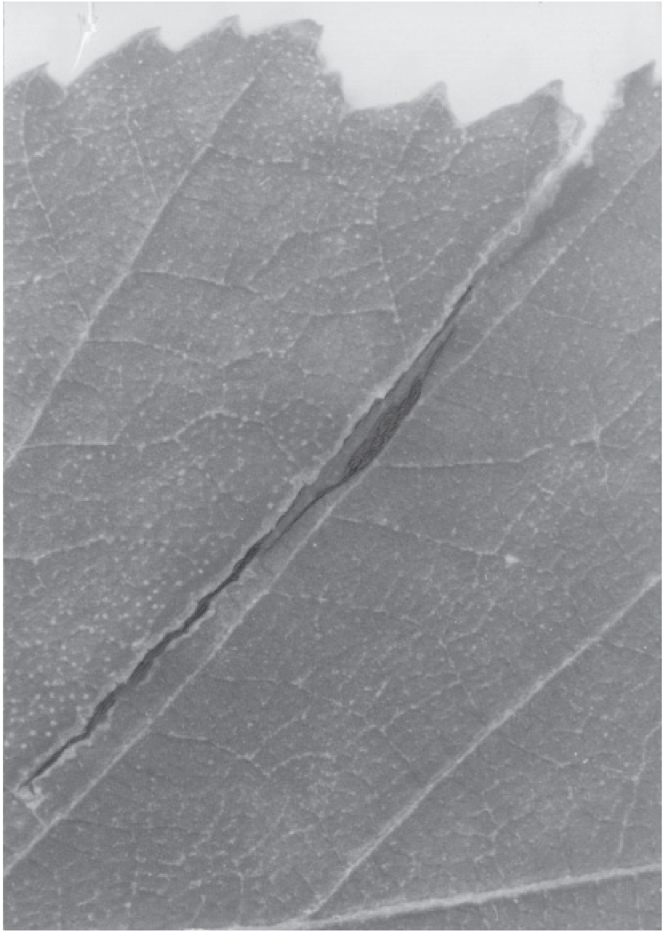
Embryos and young larvae of *C. latipes* are oriented (in egg envelopes) with their head to the apical ends



8: *The course of egg laying of C. latipes during particular days of life (including the proportion of unlaid eggs). Females lived on average three days and laid on average 112 eggs. In ovaries of died females, there were on average three unlaid eggs. Laboratory rearing, 2009–2011.*



9: *The leaf blade of birch incised by a female of C. latipes (look from below). The cut is led closely beside the main vein. Laboratory examination, 3 July 2010.*

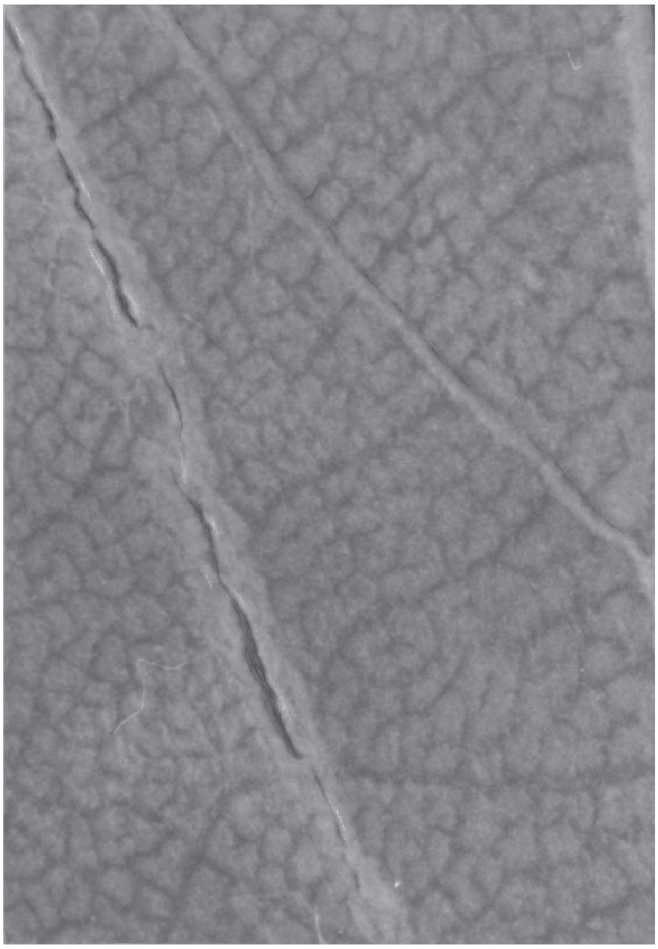


10: *The leaf blade of birch incised by a female of C. latipes (look from above). The cut is led closely beside a lateral vein. Laboratory examination, 12 July 2010.*

of veins. The egg larvae are much longer than eggs. Therefore, larvae in egg envelopes are ventrally folded (about in the body half) and both parts are placed ventrally to one another. Through the mouth system and ventral side of the body front part, they are oriented towards incisions in veins. The proximity of the larva enclosure is signalized by a marked head with black lateral ocelli and brown mandibles. The chorion splits longitudinally during hatching (nearly along the whole egg length) and young larvae gradually get away through originated fissures. Eggs in partial clutches are usually laid during a short time (about 20 minutes). Therefore, their hatching occurs more or less simultaneously. Abandoned egg envelopes persist in vein fissures after hatching the larvae. Incisions in veins gradually shut after the larvae enclosure (unlike fissures with died embryos and young larvae which open on the contrary) (Fig. 13).

Newly hatched larvae of the 1st instar rest in the place of hatching or in its immediate vicinity several hours (Fig. 14). Then, they begin to bite gradually increasing apertures into a leaf blade (Fig. 15). As soon as the little windows reach an area of about 20 mm^2, larvae climb to the window edges and continue in feeding. At the feeding, they "sit" astride on window edges. At any interruption, they shoot out (sigmoidally) their abdomen. In this caution position, they persist for a certain time or swing more or less co-ordinately by their abdomen up and down. After three (in the laboratory after two) days of ingestion, they exuviate in the place of feeding. Their cranium cracks in an epicranial suture and in frontal sutures and separates from a newly creating cranium. It shifts gradually to the ventral side and then it shifts to the abdominal body end together with an old cuticle. Ecdysis is a physiologically complicated several-hour process. However, the actual removal of an exoskeleton takes only about 30 to 40 minutes. During hatching in the laboratory (rarely also in nature), part of larvae often dies in fissures of the chorion or before its rupture.

Larvae of the 2nd instar climb to edges of the leaf blade. They settle down astride in rows with their head oriented toward the leaf tip. After three (in the laboratory after two) days of feeding ecdysis comes into being. Larvae of the 3rd instar browse leaves (including nervation), namely always only from leaf edges. After 3-day (in the laboratory after 2-day) feeding, the larvae pass through ecdysis. Larvae of the 4th instar (at the male line last but one) develop on average 3.5 days (in the laboratory 2.5 days). Male



11: *The leaf blade of birch incised by a female of C. latipes (look from below). The cut is led quite outside main and lateral veins. Laboratory examination, 12 July 2010.*

larvae of the 5th (last) instar live longest (about 5 days, in captivity 3 to 3.5 days). Male larvae develop on average three weeks from egg laying (in the laboratory on average 17 days) (Fig. 16). Grown-up larvae go out of trees and hide in surface layers of soil producing cocoons.

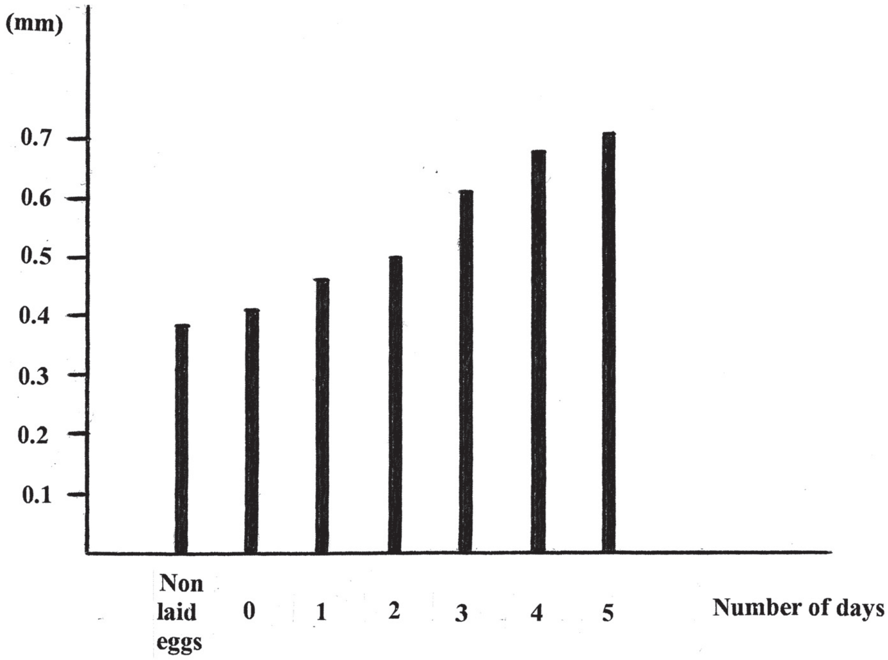
Female larvae of the 5th instar develop roughly for the same time as male larvae of this instar. After feeding, however, they moult once more on leaves. Larvae of the 6th instar (Fig. 17) consume intensively leaves for the period of eight to ten days (in the laboratory for the period of six days). They live gregariously, at the end of the period of feeding often also solitarily. The development of male larvae (from egg laying until the termination of feeding) takes on average four (in the laboratory three) weeks. After the termination of feeding, the larvae produce cocoons in soil. The width of crania of particular instars of male and female larvae is illustrated in Figs. 18 and 19.

No findings are available on the development of *C. latipes*. Larvae of a relative *C. septentrionalis* eat as many as four weeks (Ratzeburg, 1844). Its male larvae develop through five (female through six) instars (Boevé & Heilporn, 2009).

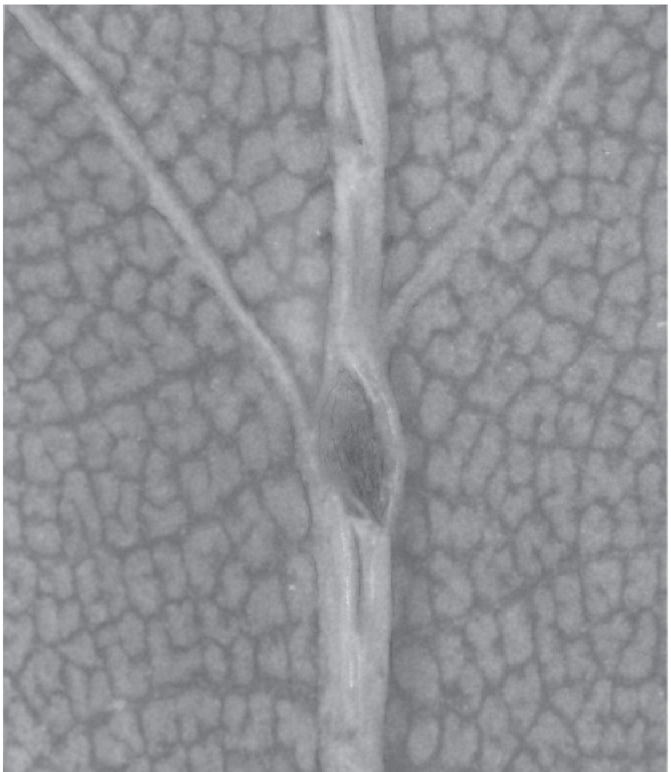
The size of damage and defecation

Based on the previous chapter, it is evident that male larvae of *C. latipes* ingest food on average two weeks and female larvae three weeks. Under laboratory conditions, male larvae eat on average 12 days and female larvae 16 days. Male larvae pass through their development by five instars, female larvae by six instars. Male larvae of all instars damaged in captivity on average 27.8 cm^2 leaves *B. pendula* (Tab. II). The transition of larvae to higher instars results in the increased consumption of food. Male larvae of the last (i.e. the 5th) instar damaged about 19.8 cm^2 leaves, i.e. 71.3% of the whole area damaged by larvae of all instars. It is of interest that the least leaf area was damaged (on average 26.9 cm^2) by larvae reared in most numerous (i.e. 15-member) groups.

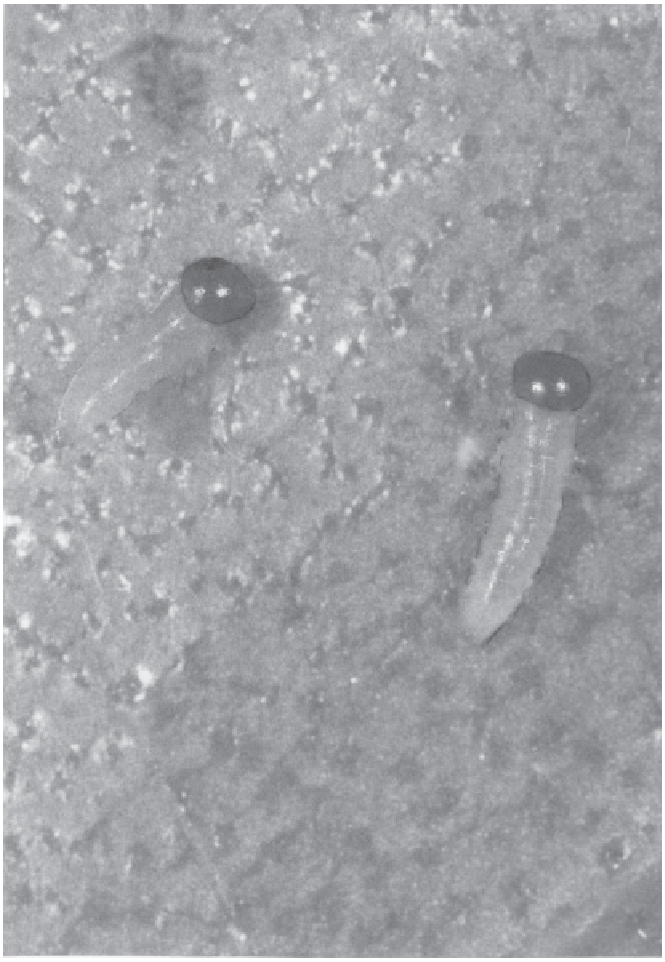
Larvae of the 1st instar are 2 to 4 mm long, larvae of the 2nd instar 3 to 6 mm, larvae of the 3rd instar 5 to 10 mm, larvae of the 4th instar 8 to 17 mm, larvae of the 5th instar 12 to 20 mm and larvae of the 6th instar 17 to 25 mm. Substantially larger damaged leaf area corresponds to substantially larger size of grown-up female larvae (as against grown-up male larvae).



12: *The width of eggs of C. latipes during their embryonal development. The length of eggs was virtually constant (1.6 mm). Laboratory examination, 15 to 20 August 2011.*

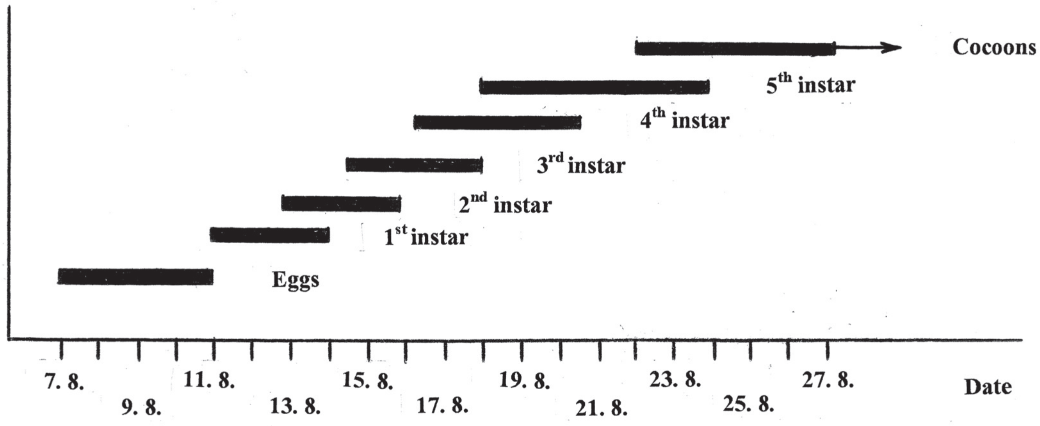


13: *Chorions after hatching the larvae of C. latipes. In the middle, an egg with a died (non-hatched) larva. Laboratory examination, 9 July 2010.*



14: *Newly hatched larvae of the 1st instar of C. latipes. Laboratory examination, 12 July 2010.*

15: *A detail of the birch leaf perforation by larvae of the 1st instar of C. latipes (look from below). 12 July 2010.*

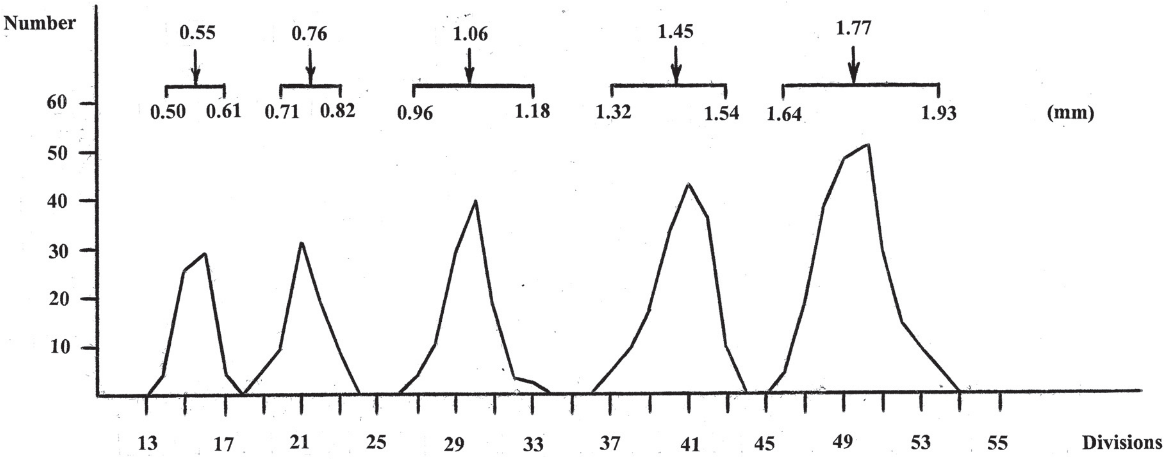


16: *The course of the development of male larvae of C. latipes from eggs laid in the laboratory on 7 August 2011. Group rearing 5, 10 and 15 larvae on birch leaves.*

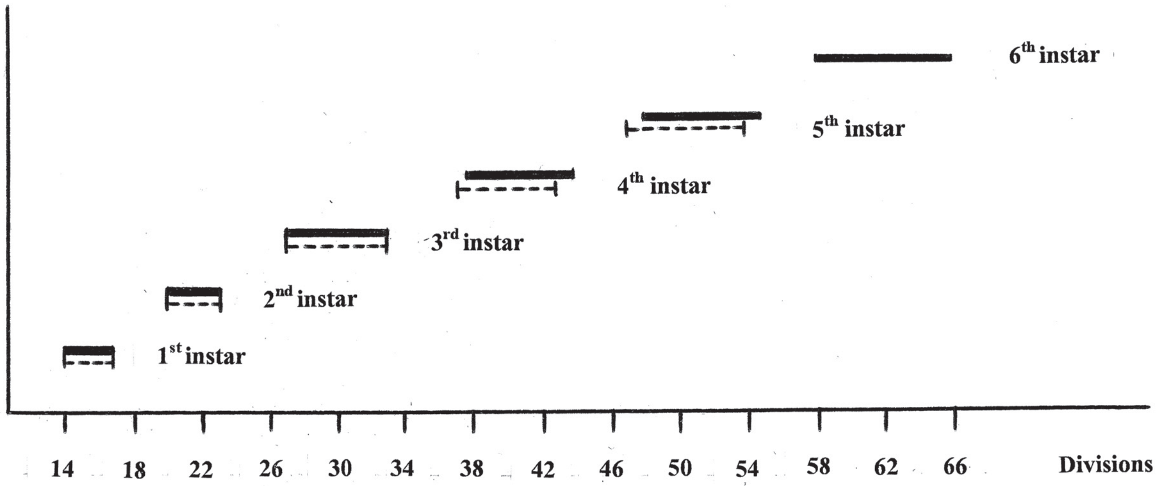
17: *Grown-up female larvae of the 6th instar of C. latipes at feeding on leaves of birch. Bílovice nad Svitavou, 26 August 2010 (photo D. Palovčíková).*

Female larvae damaged (in captivity) about 60 cm^2 leaves, i.e. about 2.2 times more than male larvae.

During feeding, larvae excrete great number of frass pellets. The frass pellets are cylindrical, sometimes rounded on one or both ends being rough on their surface. Initially, they are darkly green, later brown to black. Frass pellets of male larvae of the last instar are on average 1.4 mm long and 0.9 mm wide. Frass pellets of female larvae of the last instar are on average 1.8 mm long and 1.2 mm wide. The number, dimensions and volume of frass pellets were determined in detail only at male larvae (Tab. II, III and IV). Male larvae of all instars defecated on average 857 frass pellets of a total volume of 285.7 mm^3. From 1 cm^2 destroyed leaf area they defecated on average 10.3 mm^3 frass pellets. Larvae of the 1st to the 4th instar defecated 2 times to 3 times smaller volume of frass pellets from 1 cm^2 than larvae of the last (5th) instar. This fact is evidently related to the lower effectiveness of using



18: *The width of a cranium of male larvae of the 1st to the 5th instar of C. latipes in divisions (1 division = 0.0357 mm) and in mm. Laboratory examination, 2011.*



19: *The width of a cranium of larvae of C. latipes according to particular instars and according to sex (1 division = 0.0357 mm). Male larvae are marked by a dash line, female larvae by a solid line. Bílovice nad Svitavou, 2009–2011.*

food at growing up larvae. The average volume of produced frass pellets was also dependent on the number of larvae in groups. The smallest volume of frass pellets (236.7 mm³) was defecated by larvae reared in Drigalski dishes at 15 pieces and the largest volume of frass pellets (314.8 mm³) was defecated by larvae reared at 5 pieces (Tab. IV).

Cocoons

Cocoons of *C. latipes* (Fig. 20) are longitudinally oval, widely rounded at the front (head) end, in the rear of cocoons slightly tapered. They are drab (dun) to black and externally surrounded by earth particles. Their walls are rough, leathery and very tough (rather fragile under dry conditions). The walls are created by two layers (cocoons of *C. septentrionalis* allegedly only one layer /Pschorn-Walcher, 1982/). The inner layer is about 0.01 mm wide, membranous, from the inside smooth and glossy. In a moist cocoon, this layer is easily distinguishable and detachable. The external layer is much thicker its thickness being different in various parts of a cocoon (0.05 to 0.11 mm).

Male cocoons are 9 to 12 (on average 10.5) mm long and 4.5 to 5 (on average 4.7) mm wide. Female cocoons are 13 to 16 (on average 14.5) mm long and 5.5 to 7 (on average 6.2) mm wide. Larvae reared from eggs laid in the laboratory created usually smaller cocoons than larvae living in nature. Male cocoons were on average 9.5 mm long and 4 mm wide. Female cocoons were on average 13 mm long and 5.5 mm wide. Young imagoes leave the cocoons through oval holes 2.5 to 3.5 mm in diameter created on the wider (head) end of cocoons. They cut the cocoon and cut out a "plate cover" outwardly (similarly as imagoes of a family Diprionidae or Cimbicidae).

Generation conditions

According to Pschorn-Walcher & Altenhofer (2000), *C. latipes* shows two generations in the year the second generation being more numerous. According to the authors, larvae of the first generation occur in June and July and larvae of the second generation

20: *Cocoons of C. latipes (abandoned above, non-abandoned below).*

II: *The average area of leaves of B. pendula (cm^2) damaged by male larvae of C. latipes (according to particular instars and the number of larvae in groups) (numerator). The average number of frass pellets defecated by male larvae (denominator). Laboratory examinations, 2011.*

Instar	**Number of larvae in groups**				
	5	**10**	**15**	**Mean**	**(%)**
1st	0.25/249	0.23/250	0.24/235	0.24/244.7	0.9/28.5
2nd	0.75/128	0.67/126	0.70/110	0.71/121.3	2.5/14.2
3rd	2.2/142	1.8/132	2.0/115	2.00/129.7	7.2/15.1
4th	5.4/111	4.7/94	5.0/81	5.03/95.3	18.1/11.1
5th	19.7/292	20.8/288	19.0/219	19.83/266.3	71.3/31.1
Total	28.3/922	28.2/890	26.94/760	27.81/857.3	100.0/100.0

III: *Average dimensions and volume of frass pellets of larvae of C. latipes (according to particular instars and sex). Laboratory examinations, 2011.*

Instar	**Male larvae**		**Female larvae**	
	Average length/width (mm)	**Average volume (mm^3)**	**Average length/width (mm)**	**Average volume (mm^3)**
1st	0.29/0.17	0.0066	0.29/0.17	0.0066
2nd	0.46/0.27	0.0263	?	?
3rd	0.60/0.38	0.0680	?	?
4th	1.00/0.61	0.2921	?	?
5th	1.38/0.92	0.9169	1.10/0.76	0.4988
6th	-	-	1.80/1.20	2.0347

IV: *The average volume of frass pellets (mm³) defecated by male larvae of C. latipes (according to instars and the number of larvae in groups) (numerator). The average volume of frass pellets defecated by male larvae from 1 cm² damaged leaves (denominator). Laboratory examination, 2011.*

Instar	Number of larvae in groups				
	5	10	15	Mean	(%)
1st	1.64/6.56	1.65/7.17	1.55/6.46	1.61/6.71	0.6/65.3
2nd	3.37/4.49	3.31/4.94	2.89/4.13	3.19/4.49	1.1/43.7
3rd	9.66/4.39	8.98/4.99	7.82/3.91	8.82/4.41	3.1/42.9
4th	32.42/6.00	27.46/5.84	23.66/4.73	27.85/5.54	9.7/53.9
5th	267.73/13.59	264.07/12.70	200.80/10.57	244.20/12.31	85.5/119.9
Total	314.82/11.12	305.47/10.83	236.72/8.79	285.67/10.27	100.0/100.0

in August and September. At regions of higher altitudes, the developmental cycle of the sawfly is mostly univoltine with larvae in July to September. At a relative *C. septentrionalis*, tendencies to bivoltine generations were already known to Ratzeburg (1844). If young larvae occur even at the beginning of September then, according to Ratzeburg, it refers to the second generation. For example, Escherich (1942), Francke-Grosmann (1953), Chararas (1962), Iljinskij & Tropin (1965), Pschorn-Walcher (1982), Pschorn-Walcher & Altenhofer (2000) etc. mention one or two generations per year. Under optimum natural conditions of the Voronezh region (Russia), even three generations per year can develop at this sawfly (Stark *et al*., 1951).

Findings on the development of *C. latipes* in the Brno region and in the laboratory have indicated that generation conditions of the sawfly are different from the developmental scheme of Pschorn-Walcher & Altenhofer (2000). In the studied area, part of the sawfly population had bivoltine development and part of the population univoltine development. At the bivoltine development, larvae of the first generation occurred at the end of May and in June, larvae of the second generation on the second half of August and in the first half of September (sporadically later). In the part of cocoons, the development of larvae was delayed and imagoes flew out as late as in the second half of June and the first half of July. These imagoes founded a univoltine generation, the larvae of which occurred on trees from the second decade of June to the end of August. In the small part of cocoons, larvae diapaused for the second time and imagoes hatched from pronymphae as late as spring of the next year. Imagoes, eggs and eating larvae could by found in the Brno region nearly for the whole growing season (Fig. 2). For example, Stark *et al.* (1951) mention the similar course of emergence of imagoes of *C. septentrionalis* from cocoons in certain time-following waves.

Harmfulness

In the CR, *Craesus latipes* is virtually a rare species, larvae of which live gregariously on *Betula* spp. It occurs sparsely at various sites, mainly in open forests, on clear-felled areas, stand margins and along roads. In closed stands with full-grown trees, the species does not have optimum conditions for its development. It colonizes particularly young trees of the first age class (until ten years). Similarly as at other socially living species of the genus *Craesus* Leach, *Pristiphora* Latr. and *Nematus* Panz., larvae (including damage) can be only hardly neglected. On trees, it creates remarkable colonies causing fast local defoliation of particular branches or even whole trees. Feeding proceeds from subterminal leaves towards the shoot base. Larvae do not consume flushing and newly unfolded leaves.

Larvae of the first generation eat leaves at the end of May and in June, i.e. in the first half of the growing season. From the end of June until the end of August, larvae of a one-year generation cycle participate in the damage of trees. From mid-August to mid-September (or till the beginning of October), larvae of the second generation occur on trees. These larvae often eat leaves developed after spring and early summer damage.

Leaf area destroyed by larvae of *C. latipes* is rather large. Male larvae reared in captivity damaged on average 27.8 (female 60.0) cm² leaves of *B. pendula*. The longest development and the largest consumption of food show growing up larvae. Larvae of the last instar consume on average 75% of the whole amount of ingested food. Therefore, at standard inspections, only damaged branches with larvae of the 5th or the 6th instar are usually found. Defoliation becomes evident by the reduction of growth and the whole physiological weakening of trees. Forest management importance of *C. latipes* is nearly negligible.

SUMMARY

In the CR, *Craesus latipes* (Vill.) is one of four species of the genus *Craesus*. It is of Euro-Siberian distribution with the centre of occurrence in Central Europe. It is considered to be a non-abundant to rare phylophagous species. Its larvae live gregariously, namely almost solely on young *Betula* spp. up to 10 years. In 2009 to 2011, it was rather often found on *B. pendula* Roth in the Brno area. Through field and laboratory studies of its occurrence, bionomics and damage, these main findings were obtained:

1. In the studied area, part of the *C. latipes* population showed bivoltine development and part of the population univoltine development. At the double-generation cycle, imagoes occurred for the first time in the second half of May and at the beginning of June and for the second time in August. At the simple generation cycle, imagoes flew in the second half of June and in the first half of July.
2. Females lay eggs into longitudinal incisions in main (less in secondary) veins on the abaxial face of leaves. Particular clutches show the appearance of chains created by eggs placed in a row one after another. They lay on average 11 eggs into a partial clutch. The whole clutch (on average 112 eggs) is laid on seven to ten leaves. The females die after seven days of life.
3. Newly laid eggs are on average 1.55 mm long and 0.5 mm wide. During their embryonal development, which takes six to seven days (in the laboratory four to five days), their width increases to 0.7 mm.
4. At the beginning, larvae perforate leaves; from the second instar, they eat leaves together from their margins. Male larvae develop on average three weeks from laid eggs, in the laboratory 17 days. They pass through five instars reaching up to 20 mm in length. In captivity, they damage on average 19.8 cm^2 leaves *B. pendula*.
5. Female larvae develop on average four weeks from laid eggs, in the laboratory three weeks. The pass through six istars reaching up to 25 mm in length. In captivity, they damage on average 60.0 cm^2 leaves, i.e. 2.2 times more than male larvae.
6. In the studied area, larvae passing through the bivoltine development occurred on trees for the first time at the end of May and in June and for the second time in the second half of August and in the first half of September (rarely even later). Larvae of the univoltine subpopulation were found from the second decade of June till the end of August. It was possible to catch eating larvae locally and in small numbers almost during the whole growing season.
7. Grown-up larvae hide in surface layers of soil and crate cocoons. The cocoons are longitudinally oval and leathery. Their walls are created by two layers. The inner layer is only 0.01 mm wide, membranous. The external layer is 0.05 to 0.11 mm wide under moist conditions being detachable from the inner layer. Male cocoons are on average 10.5 mm long and 4.7 mm wide. Female cocoons are on average 14.5 mm long and 6.2 mm wide. Male and female cocoons created in the laboratory are on average smaller (9.5/4 mm and 13/5.5 mm). Imagoes leave cocoons through oval flight holes 2.5 to 3.5 mm in diameter. They make the hole similarly as, e.g. imagoes of the family Diprionidae.
8. From the aspect of forest management, *C. latipes* is an unimportant pest of birch and, therefore, it is not necessary to control it.

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