

Diagnostics of bark beetles of the genus *Pityokteines* Fuchs important in forestry

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ABSTRACT: The paper deals with problems of determination of imagoes (mainly females) in bark beetles of the genus *Pityokteines* Fuchs. *P. curvidens* (Germ.) is on average only slightly longer than *P. spinidens* (Reitt.) and distinctly longer than *P. vorontzowi* (Jak.). Males are (without lower hooked teeth) equally long as females. The shield of *P. curvidens* is on average 8% (*P. spinidens* 12% and *P. vorontzowi* 13%) longer than wider. Males of *P. curvidens* have wing cases at shoulders equally wide as their shield, females on average 3.3% wider than their shield. Males of *P. spinidens* have wing cases on average 1.0% narrower (females 2.1% wider) than their shield. Males of *P. vorontzowi* have wing cases on average 1.3% narrower than their shield, females have wing cases equally wide as their shield. The longest tail-like hair of the shield front edge (about 0.38 mm) occurs in females of *P. spinidens*, much more shorter (about 0.26 mm) in *P. curvidens* and shortest (about 0.23 mm) in *P. vorontzowi*. In females of *P. curvidens*, the hair of forehead as against the hair of shield is shorter on average by 8.3, in *P. spinidens* by 5.6 and in *P. vorontzowi* by 9.5%. Based on the length of the shield hair it is possible to distinguish reliably females of *P. spinidens* and according to short (0.12 mm) bristles on the rear of wing cases females of *P. vorontzowi*. A longitudinal central keel occurs on the forehead of 80% males of all three species and 72% females of *P. vorontzowi*. A figure defined by the teeth of the 2nd and the 5th pair in females of *P. curvidens* on the rear of wing cases is an isosceles trapezoid that approaches (or is almost equal) to a rectangle. In *P. spinidens*, it is quite a well-marked (in *P. vorontzowi* well-marked) trapezoid. It has been found that the shape and size of these figures are the main characteristics for species determination of females of the genus *Pityokteines*.

Keywords: *Pityokteines curvidens*; *P. spinidens*; *P. vorontzowi*; diagnostic characteristics; sexual dimorphism

In Europe, 3 species of bark beetles of the genus *Pityokteines* Fuchs occur, viz. *P. curvidens* (Germ.), *P. spinidens* (Reitt.) and *P. vorontzowi* (Jak.). As for their appearance, they are very similar and as for their size, they are either the same or very similar (SCHAUFUSS 1916; ESCHERICH 1923; NÜSSLIN, RHUMBLER 1927; FLEISCHER 1927–1930; KARPIŃSKI 1932; ROUBAL 1937–1941; NUNBERG 1948; PFEFFER et al. 1954; PFEFFER 1955, 1989; GEORGIJEVIĆ 1966; POSTNER 1974; MARTIN, COBOS 1986; BRUTOVSKÝ 1994, etc.). Together with *Cryphalus piceae* (Ratz.), *Crypturgus pusillus* (Gyll.), *Pityophthorus pityographus* (Ratz.) and *Xyloterus lineatus* (Oliv.) they rank among the important members of the community of Scolytidae on silver fir (*Abies alba* Mill.). *Crypturgus cinereus* (Hbst.), *Cryphalus abietis* (Ratz.), *Pityogenes chalcographus* (L.), *Orthotomicus laricis* (F.), *Ips typographus* (L.), *Hylurgops palliatus* (Gyll.), *Dryocoetes autographus* (Ratz.), *D. hectographus* Reitt. etc. occur rather sporadically in the synusia of Scolytidae on silver

fir. In comparison with bark beetles on spruce important in forestry the species living on silver fir are less known (NIERHAUS-WUNDERWALD 1995).

All 3 *Pityokteines* species mentioned above live as polygamous species particularly in weakened and dying or recently died silver fir trees damaged for example by gale, snow, air pollution, frost (especially late frost), insect pests (e.g. *Choristoneura murinana* /Hbn./, *Epinotia nigricana* /Her.-Sch./, *Zeiraphera rufimitrana* /Her.-Sch./ and *Pissodes piceae* /Ill./) and particularly by drought. On these trees, they show often mass outbreak and under the shortage of suitable propagating material they attack even healthy trees. Marked activation of these bark beetles occurs in the stage of decreased height increment, viz. in oak/ beech and beech/oak forest vegetation zones (STOLINA et al. 1985) or generally at lower locations (VASILJEV et al. 1975; SZUJECKI 1983). The process of damage to silver fir and subsequent dieback can occur to a smaller extent even in fir/ beech and spruce/fir/ beech vegetation zones,

The paper was prepared at the Faculty of Forestry and Wood Technology, Mendel University of Agriculture and Forestry, Brno, within the MSM No. 434100005 Research plan.

i.e. at localities optimum for silver fir from the viewpoint of ecology. The course of gradations of bark beetles in particular groups of forest types (in terms of Prof. Zlatník) is rather fixed. For example, *P. spinidens* shows long gradations of large amplitude in the *Querceto-Fagetum* forest type group and short gradations of small amplitude in the *Fagetum pauper* group (PFEFFER et al. 1961).

Heavy damage to silver fir by extreme drought accompanied by high temperatures occurred in the Czech Republic for the last time in the first half of the 90s of the 20th century (URBAN 1994). Based on reports on the occurrence of harmful factors, about 9,000 m³ wood infested by bark beetles were felled in 1993 to 1995 from the total standing volume of 10 million m³ (timber to the top of 7 cm o.b.). A considerable increase in damage to silver fir by bark beetles of the genus *Pityokteines* was found for example in the area of Regional Inspectorates Rožnov pod Radhoštěm, Zlín, Olomouc, Brno, Šumperk, Hořice v Podkrkonoší, Křivoklát, Český Krumlov, Training Forest Enterprise (TFE) Křtiny near Brno, etc. In 1996 to 2000, numerical stocks of bark beetles substantially decreased which was reflected in a reduction of wood infested by bark beetles to 1,000 m³ only. Minimum damage (less than 100 m³) was also reported in 2001.

In 1994 to 1997, the species representation of bark beetles of the genus *Pityokteines* was investigated in 62 stands of 22 forest districts in Bohemia and in 102 stands of 32 forest districts (including VLS Plumlov na Moravě, Lipník nad Bečvou and TFE Křtiny near Brno) in Moravia and Silesia. Silver fir dieback was particularly caused by *P. spinidens*, which was found at more than 2/3 of localities. *P. curvidens* was found roughly at 1/3 of localities in the Carpathian region (e.g. in the Moravian-Silesian Beskids, Vizovice Hills, White Carpathians and Hostýn-Vsetín Upland) and surprisingly only sporadically in the Hercynian-Sudeten region (the Hrubý Jeseník Mts. only). The preliminary species determination according to gallery systems was verified by the determination of imagoes. In contrast to mostly easily determinable males, however, the species determination of females encountered difficulties and in some cases it was not possible at all according to the existing keys for bark beetle determination. Therefore the author tried to specify the diagnostic features known so far (and to find new ones) on the basis of which it would be possible to determine reliably adults (particularly females) of *P. curvidens*, *P. spinidens* and *P. vorontzowi*. Original findings concerning particularly morphological characteristics of the bark beetle species can also be used in forest practice for specifying and increasing the effectiveness of inspection, protective and control measures.

MATERIAL AND METHODS

The total length of a body (including the length and width of prothorax and the length and width of wing cases at shoulders) was measured using micrometry in 168 males and 150 females of *P. curvidens*, 130 males and

135 females of *P. spinidens* and 96 males and 128 females of *P. vorontzowi*. The length of males was measured including the 5th pair of teeth and without it. In females, the length of the tail-like hair of the shield front part was not included in the body length. In a representative number of adults of each of the species the length of hair of the shield front edge, forehead and rear was measured using micrometry and in females also the distance between the teeth of the 2nd pair, the 5th pair and the 2nd and 5th pairs situated at the edge of the deepened part of wing cases. The surface structure of the forehead of 400 males and females in particular species of the genus *Pityokteines* was examined in detail.

The partial objective of the study was to test the reliability of determination of particular species of bark beetles according to insect galleries and larvae. For this purpose, the width of 100 mother galleries, 100 emergence holes and 100 entrance holes in bark was measured in each of the species. In 410 larvae of the 1st to the 3rd instar of *P. spinidens* and in 261 larvae of the 1st to the 3rd instar of *P. vorontzowi* the width of the head case was measured.

RESULTS AND DISCUSSION

BASIC MORPHOLOGICAL CHARACTERISTICS OF THE GENUS *PITYOKTEINES*

The beetles are 1.8 (1.6) to 3.2 (3.5) mm in length, cylindrical and black-brown. Their body is glossy, long and hairs sparsely stick out. Little hairs are yellowish, in the rear somewhat denser and longer. The forehead is lightly convex, in males with sparse gold hair, centrally mostly with the fine longitudinal keel. The forehead of females has dense and long hair whereas hairs in the upper part of the forehead are longest. Antennas are yellowish. A 5-segment flagellum and a 4-segment (seemingly 3-segment) circular-oval clavus sit on the basic antenna segment (scapus). The shield is 5 to 15% longer than wider, shortly cylindrical. In front, it is circularly rounded and rather roughly concentrically tubercle-like, at the back along the sides densely (from above at the shield sparsely) spotted. In females, the front edge of the shield is provided with a well-marked tail of long gold hairs that continue the forehead hair viewed laterally (Fig. 1).

Wing cases are roughly cylindrical, slightly enlarged backwards, in males equally wide or 1.3% narrower than the shield at shoulders, in females equally wide or as much as 3.3% wider than the shield. Their length is 1.51 to 1.90 times (according to PFEFFER [1955] 1.65 to 1.70) longer than their width at shoulders. Wing cases are glossy, densely and markedly spotted in rows. Depressions gradually and markedly (as much as 6 times) increase and mutually close backwards. Lateral marginal lines are much more slight. The area between the lines is smooth or very finely spotted in rows. The back part of wing cases is distinctly deepened, spotted and dentate along the depression periphery in both sexes. Males show a pair of tiny pointed ('sutural') teeth at the upper edge

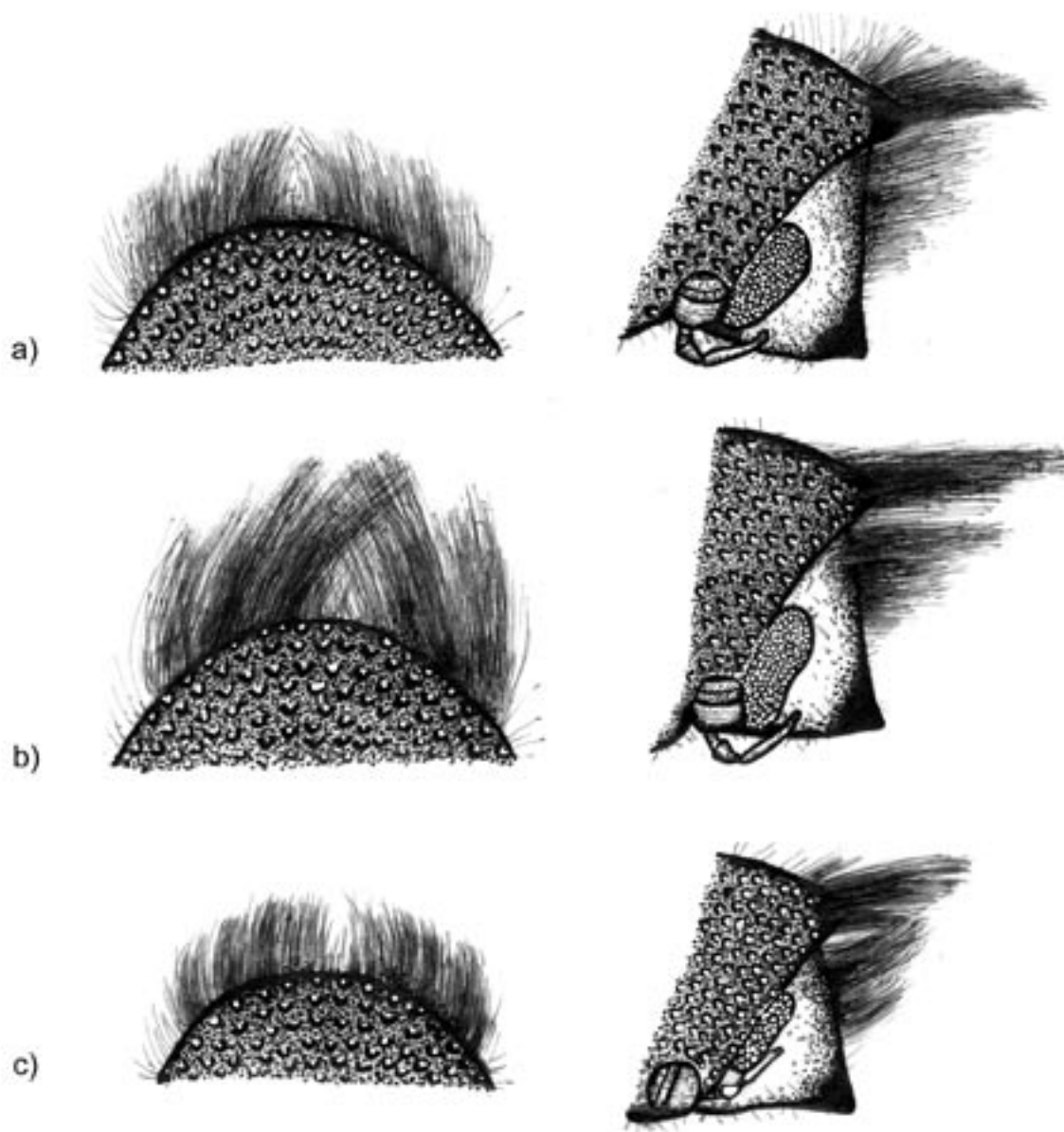


Fig. 1. Left is hair of the front margin of the shield of females: a) *P. curvidens*, b) *P. spinidens*, c) *P. vorontzowi* – view from above. Right is hair of the front margin of the shield and forehead of females – side view

of the depression (near the wing case commissure) that are typically oriented either upright or obliquely or almost horizontally backwards in particular species. Under them in males there is a diagnostically important upper pair of strong main teeth that are hooked towards the centre of the depression. Two pairs of smaller lateral (with blunt ends) conical teeth follow behind them. At the bottom edge of the depression, there is a lower pair of hooked teeth that is similar to the upper pair of hooked teeth. These teeth are, however, always somewhat more slender and slightly hooked towards the centre of the depression. Under the lower hooked teeth, there are (towards the commissure) another 2 pairs of tiny tubercle-like teeth. In females, the upper and lower hooked teeth (and partly also sutural teeth) are converted into sharply conical teeth that are markedly larger than the other teeth (Fig. 2).

The size of imagoes

There are numerous, but often inaccurate data on the body length of particular species of the genus *Pityokteines* in literature. *P. curvidens* is usually considered to be the largest species. The majority of authors (e.g. ECKSTEIN 1897; Klapálek 1903; Schaufuss 1916; Javorek 1947; Pfeffer et al. 1954; Pfeffer 1955; Postner 1974 and Bratovský 1994) report that the species is 2.5 to 3.0 mm long. According to Escherich (1923), Pfeffer (1989), Nierhaus-Wunderwald (1995), etc. the beetles are 2.5 to 3.2 mm long, according to Schwerdtfeger (1970) 2.8 to 3.3 mm. All these data refer to adults irrespective of their sex. According to our measurements, imagoes of *P. curvidens* are 2.2 to 3.2 mm long. Males are (without lower hooked teeth) 2.2 to

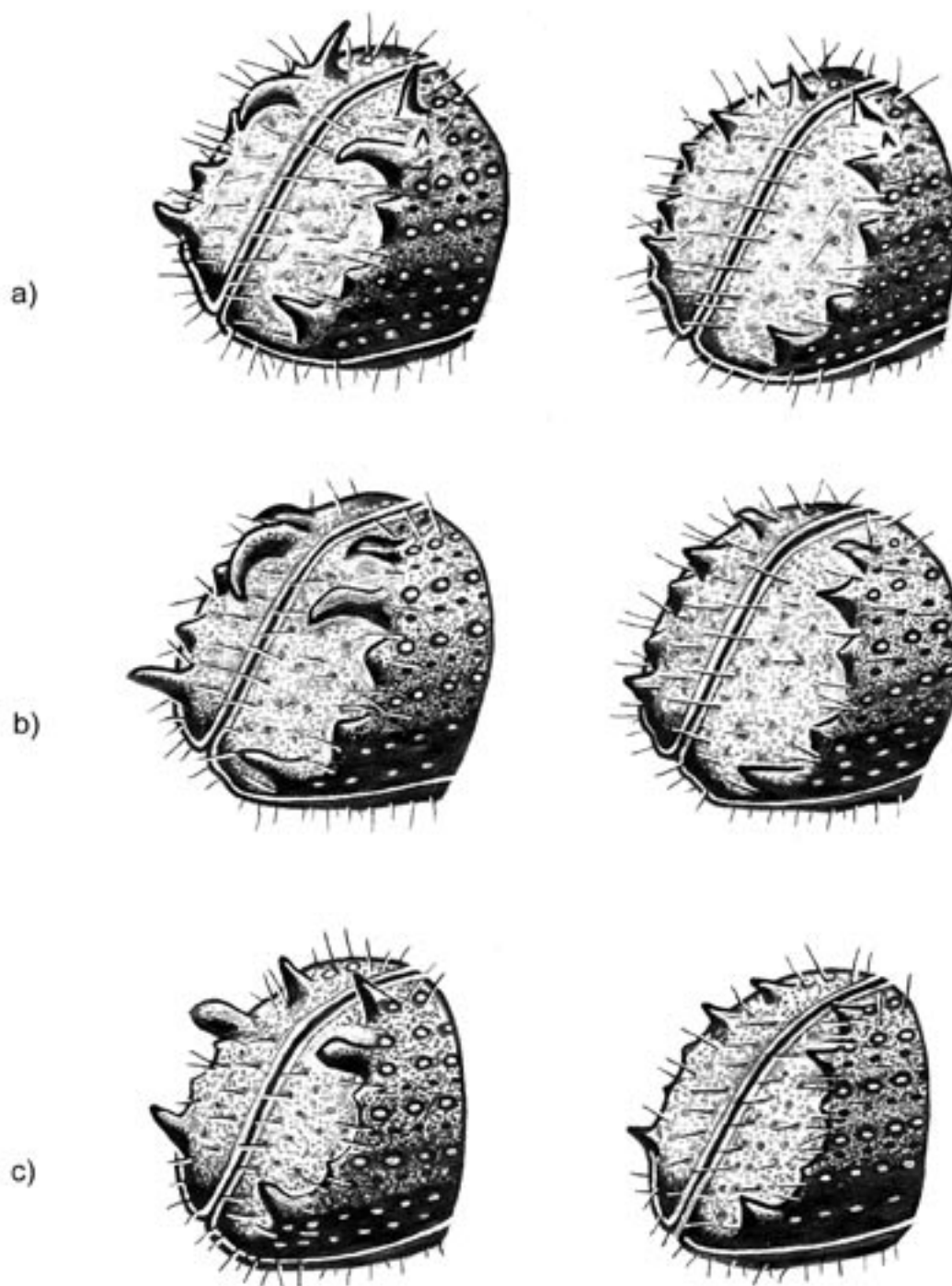


Fig. 2. Left is a hollowed rear of wing cases of males: a) *P. curvidens*, b) *P. spinidens*, c) *P. vorontzowi*. Right is a hollowed rear of wing cases of females of the same species

3.1 (on average 2.65) mm long, including lower hooked teeth 2.3 to 3.2 (on average 2.75) mm and females 2.2 to 3.0 (on average 2.62) mm (Table 1).

According to the existing literature, as compared with *P. curvidens* adults of *P. spinidens* are generally distinctly smaller. For example, according to PFEFFER (1955), NOVÁK et al. (1974), POSTNER (1974) and NIERHAUS-WUNDERWALD (1995), they are 2.0 to 2.8 mm long, according to SCHAUFUSS (1916) 2.0 to 3.0 mm and according to PFEFFER

(1989) 1.9 to 2.8 mm. Nevertheless, for example ESCHERICH (1923) gives a markedly different length (2.3 to 3.5 mm). According to our micrometric measurements, imagoes of *P. spinidens* are 2.1 to 3.1 mm long. Males are (without lower hooked teeth) 2.1 to 3.0 mm long (on average 2.6 mm), including lower hooked teeth 2.2 to 3.1 (on average 2.7) mm and females 2.1 to 2.9 (on average 2.6) mm (Table 1).

As compared with *P. curvidens* and *P. spinidens* of about the same size *P. vorontzowi* is considerably small-

Table 1. The length of the body of males and females of *Pityokteines curvidens*, *P. spinidens* and *P. vorontzowi*. The length of the body of males in last two lines is given without lower hooked teeth (in parentheses including the hooked teeth)

Body length (mm)	<i>P. curvidens</i>		<i>P. spinidens</i>		<i>P. vorontzowi</i>	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
1.80–1.97	–	–	–	–	–	2 (1.6)
1.98–2.15	–	–	1 (0.8)	1 (0.8)	12 (12.5)	27 (21.1)
2.16–2.33	2 (1.2)	5 (3.3)	4 (3.1)	4 (3.0)	55 (57.3)	59 (46.1)
2.34–2.51	31 (18.4)	30 (20.0)	38 (29.2)	38 (28.1)	28 (29.2)	38 (29.7)
2.52–2.69	63 (37.5)	78 (52.0)	50 (38.5)	66 (48.9)	1 (1.0)	2 (1.5)
2.70–2.87	61 (36.3)	34 (22.7)	34 (26.1)	23 (17.0)	–	–
2.88–3.05	10 (6.0)	3 (2.0)	3 (2.3)	3 (2.2)	–	–
3.06–3.23	1 (0.6)	–	–	–	–	–
Total (pc) (%)	168 (100.0)	150 (100.0)	130 (100.0)	135 (100.0)	96 (100.0)	128 (100.0)
Body length (from – to) (mm)	2.21–3.07 (2.31–3.17)	2.21–3.03	2.14–3.03 (2.24–3.13)	2.14–2.92	2.00–2.53 (2.07–2.61)	1.93–2.53
Mean length of the body (mm)	2.65 (2.75)	2.62	2.60 (2.70)	2.59	2.29 (2.37)	2.27

er. According to SCHAUFUSS (1916), its length is 1.8 to 2.5 mm, according to ESCHERICH (1923) 2.0 to 2.3 (2.5) mm, according to POSTNER (1974) 1.7 to 2.5 mm, according to BRUTOVSKÝ (1994) 1.7 to 2.4 mm, according to PFEFFER (1989) and NIERHAUS-WUNDERWALD (1995) 1.6 to 2.4 mm. The length of *P. vorontzowi* adults determined by micrometry amounted to 1.9 to 2.6 mm. Males (without lower hooked teeth) reached 2.0 to 2.5 (on average 2.3) mm, including lower hooked teeth 2.1 to 2.6 (on average 2.4) mm and females 1.9 to 2.5 (on average 2.3) mm (Table 1).

The measurements have positively demonstrated that there are no differences in the length of body in males and females. The range of the length of body in adults of *P. curvidens*, *P. spinidens* and *P. vorontzowi* overlaps either fully or to a greater extent. Therefore the length of body cannot be considered to be an additional diagnostic criterion in females which are differentiated and determined with difficulties only.

The length of the body of an imago is related to the size of prothorax. The width of the prothorax of species under comparison is given in Table 2. The length of the shield of males and females in *P. curvidens* is on average 8% larger than its width (in *P. spinidens* by 12% and in *P. vorontzowi* by 13%). Thus, the shield of adults of both sexes in *P. vorontzowi* and *P. spinidens* as compared with *P. curvidens* is always a little more elongated.

In males of *P. curvidens*, wing cases at shoulders are equally wide as the shield, in males of *P. spinidens* they

are on average 1.0% narrower than the shield (in males of *P. vorontzowi* by 1.3%). In females of *P. curvidens*, wing cases at shoulders are 3.3% (in females of *P. spinidens* by 2.1%) wider than the shield. Females of *P. vorontzowi* show wing cases at shoulders equally wide as the shield. These data prove the existence of a slight sexual dimorphism in the form of the body of *P. vorontzowi* imagoes. Generally, it is possible to state that the wing cases of males of all three species of the genus *Pityokteines* are equally wide at shoulders or slightly narrower than the shield while the wing cases of females are equally wide at shoulders or slightly wider than the shield.

A relationship between the length of wing cases and their width at shoulders is also interesting. The length of wing cases in males of *P. curvidens* (including the lower hooked teeth) is on average 1.69 times (females 1.65 times) larger than the width of wing cases at shoulders. The length of wing cases in males of *P. spinidens* is on average 1.67 times (females 1.62 times) larger than the width of wing cases at shoulders. Wing cases in *P. vorontzowi* are slenderest. Males have wing cases that are on average 1.74 times (females 1.75 times) longer than their width at shoulders.

Hair in adults

The forehead, shield and wing cases in males of the genus *Pityokteines* are yellow-hairy. In the front part of the shield of males (particularly at its front margin) the hair is denser and longer. The hair reaches a length of 0.15 and

Table 2. The width of the prothorax of males and females of *P. curvidens*, *P. spinidens* and *P. vorontzowi*

Prothorax width (mm)	<i>P. curvidens</i>		<i>P. spinidens</i>		<i>P. vorontzowi</i>	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
0.680	—	—	—	—	—	1 (0.8)
0.715	—	—	—	—	1 (1.0)	10 (7.8)
0.750	—	—	—	—	2 (2.1)	17 (13.3)
0.785	—	—	—	—	11 (11.5)	39 (30.4)
0.820	—	2 (1.3)	1 (0.8)	2 (1.5)	25 (26.0)	33 (25.8)
0.855	1 (0.6)	5 (3.3)	3 (2.3)	12 (8.9)	30 (31.3)	21 (16.4)
0.890	17 (10.1)	16 (10.7)	13 (10.0)	33 (24.4)	22 (22.9)	7 (5.5)
0.925	19 (11.3)	31 (20.7)	21 (16.2)	39 (28.9)	5 (5.2)	—
0.960	30 (17.9)	55 (36.7)	34 (26.1)	30 (22.2)	—	—
0.995	33 (19.6)	29 (19.3)	32 (24.6)	10 (7.4)	—	—
1.030	42 (25.0)	6 (4.0)	19 (14.6)	9 (6.7)	—	—
1.065	21 (12.5)	4 (2.7)	7 (5.4)	—	—	—
1.100	5 (3.0)	2 (1.3)	—	—	—	—
Total (pc) (%)	168 (100.0)	150 (100.0)	130 (100.0)	135 (100.0)	96 (100.0)	128 (100.0)
Prothorax width (from – to) (mm)	0.86–1.11	0.82–1.10	0.82–1.07	0.82–1.04	0.71–0.93	0.68–0.90
Prothorax mean width (mm)	0.99	0.95	0.97	0.93	0.85	0.80

0.12 mm in *P. curvidens* and *P. spinidens*, respectively. Backwards, the density and length of hair decreases and in the rear third of the shield the hair is missing or is considerably thin and short. The hair of the front part of wing cases of males in all three species under evaluation is thin, towards the rear and towards margins of the wing cases being denser and longer. At the rear of wing cases the hair changes into yellow (sometimes rusty) small bristles. The longest bristles (about 0.26 mm) are on the rear of wing cases of males of *P. curvidens*, somewhat shorter bristles (about 0.23 mm) are on the rear of wing cases of *P. spinidens* and the shortest bristles (about 0.19 mm) are on the rear of wing cases of *P. vorontzowi*. The ventral side of the body of males is glossy, thin and partly densely hairy.

Females of the genus *Pityokteines* are also yellow-hairy. Their front part of the shield and forehead show, however, conspicuously dense and long tail-like hair (Fig. 1). According to scarce literature data, hairs at the front margin

of the shield in females of *P. curvidens* are equally long as on the forehead and in females of *P. spinidens* by 50% longer than on the forehead. According to SCHAUFUSS (1916) etc., hairs on the front margin of the shield in females of *P. vorontzowi* are much longer than on the forehead, according to POSTNER (1974) they are equally long as on the forehead.

Particular data on the length of hair in the front part of the shield and the forehead of females are given in Table 3. It is evident from the table that females of *P. spinidens* show the longest hair on the front margin of the shield (about 0.38 mm). Substantially shorter hairs on the front margin of the shield (about 0.26 mm) were observed in females of *P. curvidens* and the shortest hair (about 0.23 mm) in females of *P. vorontzowi*. The hair on the front margin of the shield of females in *P. curvidens* is thus on average 31.6% shorter than in *P. spinidens* and in *P. vorontzowi* it is even shorter by 11.5% than in *P. curvidens*. Table 3 shows that a small brush of hairs

Table 3. Mean length of the tail-like hair of the front margin of a shield and forehead of females. Some 101, 117 and 98 of females of *P. curvidens*, *P. spinidens* and *P. vorontzowi*, respectively were measured

Length of hairs (mm)	<i>P. curvidens</i>	<i>P. spinidens</i>	<i>P. vorontzowi</i>
Front margin of the shield	0.26	0.38	0.23
Forehead	0.24	0.36	0.21

on the forehead is always somewhat shorter (in *P. curvidens* on average by 8.3%, in *P. spinidens* by 5.6% and in *P. vorontzowi* by 9.5%) than on the front margin of the shield. Based on the length of tail-like hair on the front margin of the shield and forehead it is possible to differentiate quite reliably females of *P. spinidens* from females of the other two species. However, this criterion cannot be used to distinguish females of *P. curvidens* from those of *P. vorontzowi*.

The hair of wing cases in females is very similar to that of males. In the front part of wing cases it is thin and short. Towards the rear of the abdomen (or towards the margin of wing cases) it increases its density and becomes longer. At the rear of wing cases it changes into yellow (sometimes rusty) small bristles that are longest (about 0.19 mm) in females of *P. curvidens*. Bristles on the rear of females of *P. spinidens* are of medium length (about 0.17 mm) and the shortest bristles (about 0.12 mm) are on the rear of females of *P. vorontzowi*. According to the length of these bristles it is possible to distinguish reliably females of *P. vorontzowi* from females of the other two species. The ventral side of the body of females is glossy (similarly like in males), thinly, finely and partly densely hairy.

Formation of the forehead of adults

The forehead of males and females of the genus *Pityokteines* is slightly convex, glossy, finely grainy on the surface. According to literature data, there is a fine longitudinal keel on the forehead of males of all three species under investigation whereas the forehead of females is formed variously (in *P. curvidens* the forehead is provided with a protuberance or bulge, in *P. spinidens* it is smooth and glossy and in *P. vorontzowi* it is decorated with a fine longitudinal central keel).

It has been found by the detailed examination of the structure of the forehead in males and females of particular species of the genus *Pityokteines* that the description mentioned above cannot be generalised. In contrast to conspicuous sexual dimorphism in the length of the forehead hair differences in the surface structure of the forehead of individuals in both sexes are less marked or negligible. The fine longitudinal keel in the centre of the forehead occurred in examined specimens in 80% males of *P. curvidens*, *P. spinidens* and *P. vorontzowi* only. The remaining 20% males had their forehead more or less evenly grainy or with a fine glossy bulge. The forehead of 50% females of *P. curvidens* was provided with a glossy bulge in the lower part (above the upper labium) and in the upper part, 33% females have their forehead more or less evenly grainy and 17% with a fine longitudinal keel. The forehead of 72% females of *P. spinidens*

was more or less evenly grainy, 17% females showed the forehead with a smooth longitudinal central line and 11% with a central bulge. The forehead of 72% females of *P. vorontzowi* was decorated with a fine longitudinal keel in the upper part and 28% with a smaller bulge in the lower part and with a larger bulge in the upper part (or with both these bulges).

It follows that relatively the most marked sexual dimorphism in the formation of the surface structure of forehead occurs in *P. spinidens* and distinctly smaller in *P. curvidens*. In the majority of males and females of *P. vorontzowi*, there is a fine longitudinal keel in the centre of the forehead and the surface structure of the forehead of individuals of both sexes is (with the exception of quite different hair) in principle the same.

Formation of the rear part of wing cases

In addition to the hair of the forehead and the front part of the shield (in *P. spinidens* and *P. vorontzowi* to a certain extent except the forehead structure) the sexual dimorphism shows mostly in the dentation of the depressed rear part of wing cases. Along the margin of the depression, dentation in males is characteristic to such an extent that it is possible to determine reliably particular species according to it. But in the form and size of teeth on the rear of females there are no substantial differences between the species under assessment and, therefore it is necessary to take into account always several traits for their species determination (particularly the size and form of a figure delimited by the 2nd and 5th pairs of teeth and the length of hair of the front part of the shield or forehead and the rear of wing cases).

Males of all three species have the large, towards the centre of the depression hooked 2nd pair of teeth and the somewhat smaller slightly upwards and towards the centre of the depression hooked 5th pair of teeth. Between the 2nd and the 5th pair of teeth, there are 2 smaller lateral bluntly conical teeth. The 1st ('sutural') pair of teeth and in the case of need also the 2nd pair of teeth serve for the species determination of males.

Males of *P. curvidens* can be easily determined according to upright and slightly converging sutural little teeth. These teeth evenly narrow towards a point being slightly hooked ahead by their rear part. Upper hooked teeth (i.e. teeth of the 2nd pair) are aimed somewhat obliquely upwards at the beginning, later they turn aiming at the centre of the depression. From the tooth root to the tip they gradually narrow (at first less, later more). Above (or before) the hooked teeth, there are several small conical teeth that do not occur in any other evaluated species of the genus *Pityokteines* (Fig. 2a – left).

Table 4. Mean distance between the teeth of the 2nd and the 5th pair and the 2nd and the 5th pair on the margin of the hollowed part of wing cases of females. Some 113, 124 and 115 females of *P. curvidens*, *P. spinidens* and *P. vorontzowi*, respectively, were measured

Mean distance (mm)	<i>P. curvidens</i>	<i>P. spinidens</i>	<i>P. vorontzowi</i>
Teeth of the 2 nd pair	0.40	0.33	0.23
Teeth of the 5 th pair	0.42	0.41	0.36
Teeth of the 2 nd and the 5 th pair	0.33	0.32	0.23

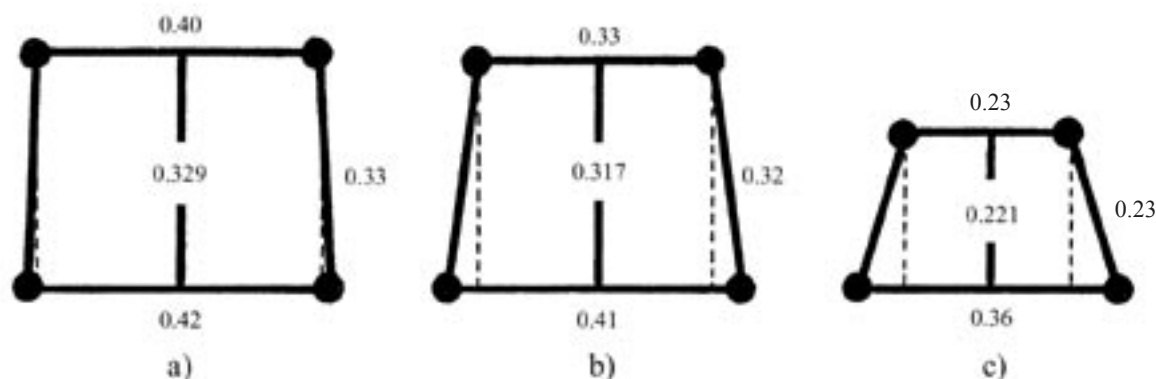


Fig. 3. An area defined by the joins of the 2nd and the 5th pair of teeth of females of a) *P. curvidens*, b) *P. spinidens*, c) *P. vorontzowi*. Numbers mean average distances of teeth and the height of figures in mm

Females of *P. curvidens* have pointed conical sutural teeth aiming obliquely upwards. The 2nd pair of teeth is a little larger than the 1st pair (sutural) being sharply conical. Above (or before) the 2nd pair of teeth (similarly like in males), there is a pair of small conical teeth. The 3rd and the 4th pair of teeth is small, bulge-like and the 5th pair is roughly of the same size as the 2nd pair being similarly sharply conical (Fig. 2a – right). According to

SCHAUFUSS (1916), PFEFFER (1955, 1989), etc. a figure defined by the joins of teeth of the 2nd and the 5th pair is rectangular, distinctly wider than longer. According to our findings, however, the area delimited by these teeth is an isosceles trapezoid that markedly approaches (or is nearly equal) to a rectangle (Table 4, Fig. 3a).

Sutural teeth of males of *P. spinidens* are aimed slightly obliquely upwards with their point aimed nearly horizon-

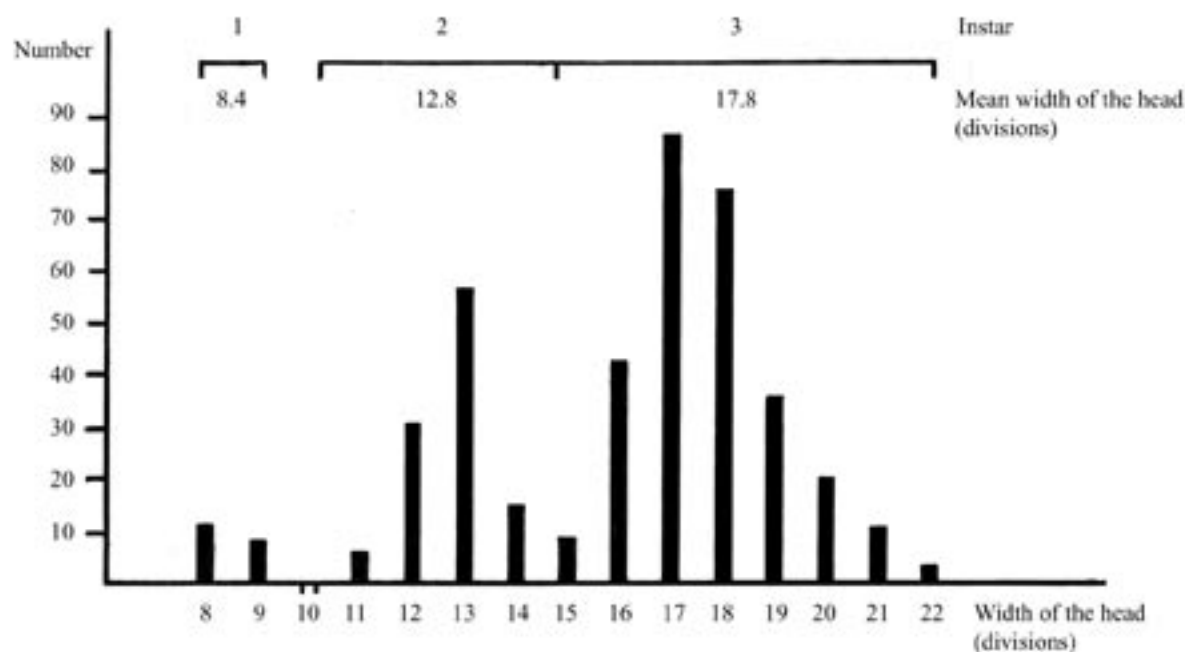


Fig. 4. The width of the head of larvae of the 1st to the 3rd of instar *P. spinidens* (1 divisions = 0.0357 mm)

Table 5. The width of the prothorax of females and the width of mother galleries of *P. curvidens*, *P. spinidens* and *P. vorontzowi*

Species	The width of the prothorax of females (mm)			The width of mother galleries (mm)		
	minimum	mean	maximum	minimum	mean	maximum
<i>P. curvidens</i>	0.82	0.95	1.10	1.07	1.30	1.43
<i>P. spinidens</i>	0.82	0.93	1.04	1.00	1.23	1.36
<i>P. vorontzowi</i>	0.68	0.80	0.90	0.78	0.91	1.07

Table 6. The width of the prothorax and the size of emergence holes of males and females of *P. curvidens*, *P. spinidens* and *P. vorontzowi* under conditions of the 1:1 sexual ratio. The mean size of entrance holes of bark beetles in case of an invasion on silver fir trees amounted to 1.30, 1.23 and 1.04 mm in *P. curvidens*, *P. spinidens* and *P. vorontzowi*, respectively

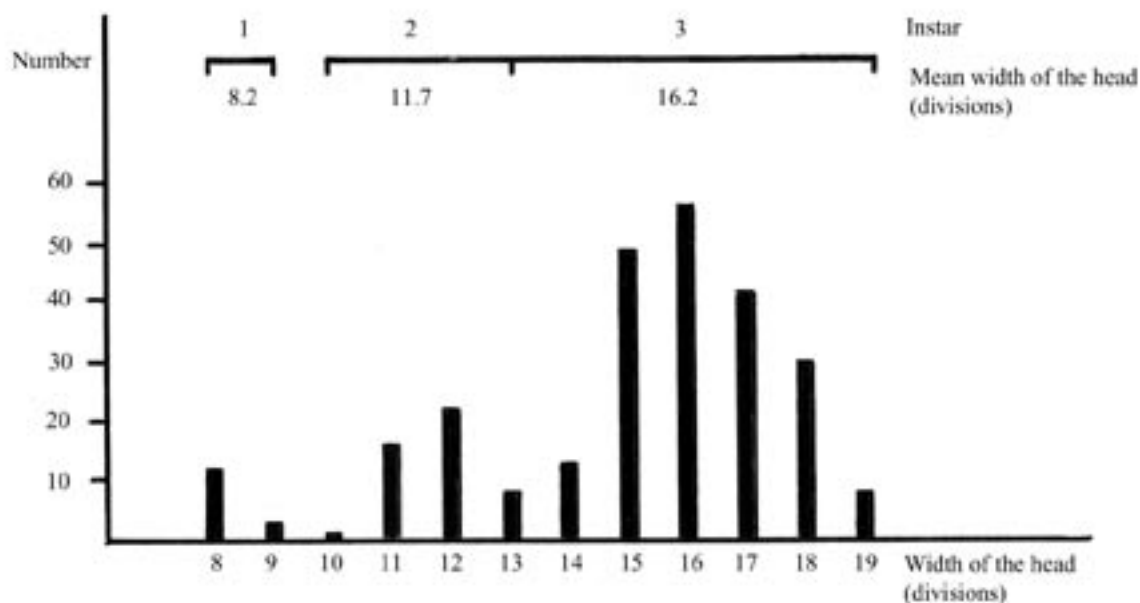
Species	The width of the prothorax of males and females (mm)			The size of emergence holes (mm)		
	minimum	mean	maximum	minimum	mean	maximum
<i>P. curvidens</i>	0.82	0.97	1.11	0.95	1.12	1.32
<i>P. spinidens</i>	0.82	0.95	1.07	0.93	1.08	1.25
<i>P. vorontzowi</i>	0.68	0.82	0.93	0.75	0.92	1.07

tally backwards. Upper hooked teeth are very long, slender and aimed at the centre of the depression. As against the teeth of males of *P. curvidens* they are longer and evenly tapered (Fig. 2b – left).

Sutural teeth of females of *P. spinidens* are aimed (similarly like in males) slightly obliquely upwards with their point aimed nearly horizontally backwards. The 2nd pair of teeth is larger than the 1st pair being sharply conical. Teeth of the 3rd, 4th and 5th pairs are very similar to teeth of females of *P. curvidens* (Fig. 2b – right). A figure defined by the joins of teeth of the 2nd and the 5th pair is a square according to SCHAUFUSS (1916), PFEFFER (1955, 1989) etc. According to our own measurements, however, it is a well-marked isosceles trapezoid with distinctly shorter upper base-line that resembles a square very distantly only (Table 3, Fig. 3b).

Males of *P. vorontzowi* have sutural teeth aimed roughly obliquely upwards at 45°. Upper hooked teeth are thickened in the basal and central parts and before the end only they are suddenly narrowed. They are slightly obliquely directed upwards being somewhat hooked at their end towards the centre of the depression (Fig. 2c – left).

Sutural teeth of females of *P. vorontzowi* are directed slightly obliquely upwards with their point nearly horizontally backwards. The 2nd pair of teeth is sharply conical being somewhat larger than the 1st pair. Teeth of the 3rd and 4th pairs are small, bulge-like, teeth of the 5th pair are sharply conical and equally large as teeth of the 2nd pair (Fig. 2c – right). A figure defined by the joins of teeth of the 2nd and the 5th pair is a rectangle according to SCHAUFUSS (1916), PFEFFER (1955, 1989), etc. According to our

Fig. 5. The width of the head of larvae of the 1st to the 3rd of instar *P. vorontzowi* (1 division = 0.0357 mm)

own measurements, however, it is a well-marked trapezoid with distinctly shorter upper base-line. As against *P. spinidens* and particularly *P. curvidens*, the size of the trapezoid is substantially smaller (Table 4, Fig. 3c).

Supplement

The width of the body of adults reflects in the size of entrance holes, in the width of mother galleries and in the size of emergence holes. Results of our measurements of the width of mother galleries and the size of emergence holes (in mm) are given in Tabs. 5 and 6. The values of both these quantities markedly overlap in *P. curvidens* and *P. spinidens* and, therefore, they cannot be used for the species determination of gallery system originators. According to the width of mother galleries it is, however, possible to differentiate very reliably feeding marks of *P. vorontzowi* from *P. curvidens* and usually also from *P. spinidens*.

The width of the head case of larvae of all 3 instars of *P. spinidens* and *P. vorontzowi* (in divisions) is given in Figs. 4 and 5. The width of the head of larvae of *P. curvidens* does not virtually differ from that of *P. spinidens*. The figures indicate that the species of the genus *Pityokteines* cannot be differentiated in most cases on the basis of the head width of larvae.

SUMMARY

In 1994 to 1997, the species representation was investigated of bark beetles of the genus *Pityokteines* Fuchs at 164 localities in Bohemia, Moravia and Silesia. The bark beetles were tentatively determined. As compared with relatively easily determinable males the species determination of females according to the existing keys for bark beetle determination was difficult and in some cases rather unreliable. The author tried to specify diagnostic characters known so far (and to find new ones) on the basis of which it could be possible to determine reliably imagoes (especially females) of particular species of this genus. In adults of both sexes of *P. curvidens* (Germ.), *P. spinidens* (Reitt.) and *P. vorontzowi* (Jak.) the following parameters were determined using micrometry: length of body, length and width of the shield and wing cases at shoulders, length of hair of the front margin of the shield, forehead and the rear of wing cases. Formation of the forehead of adults and the rear of wing cases in females was studied in detail. A possibility was also tested to determine particular species according to the width of mother galleries, the size of entrance and emergence holes and the width of the head of larvae. The following main findings were obtained:

1. Adults of *P. curvidens* are only slightly longer than *P. spinidens* and distinctly longer than *P. vorontzowi*. No sexual dimorphism can be found in the length of the body. The length of the body cannot be used as an additional diagnostic criterion. Males of *P. curvidens* without lower hooked teeth are 2.2 to 3.1 (on average 2.65) mm long, including teeth 2.3 to 3.2 (on average 2.75) mm, females 2.2 to 3.0 (on average 2.62) mm.

Males of *P. spinidens* are without these teeth 2.1 to 3.0 (on average 2.6) mm long, including teeth 2.2 to 3.1 (on average 2.7) mm, females 2.1 to 2.9 (on average 2.6) mm. Males of *P. vorontzowi* are without the teeth 2.0 to 2.5 (on average 2.3) mm long, including the teeth 2.1 to 2.6 (on average 2.4) mm, females 1.9 to 2.5 (on average 2.3) mm.

2. The shield of males and females in *P. curvidens* is on average by 8% (*P. spinidens* by 12% and *P. vorontzowi* by 13%) longer than wider. The shield of *P. curvidens* as against that of *P. spinidens* and *P. vorontzowi* is thus less elongated. A sexual dimorphism in the form of the body is not marked. While males of *P. curvidens* have wing cases at shoulders of the same width as their shield, wing cases of females are on average 3.3% wider than their shield. Males of *P. spinidens* have wing cases on average by 1.0% narrower (females by 2.1% wider) than their shield. Males of *P. vorontzowi* have wing cases on average 1.3% narrower than their shield, females show wing cases equally wide as their shield. Wing cases of males of *P. curvidens* (including lower hooked teeth) are at shoulders on average 1.69 (females 1.65) times longer than wider. Wing cases of males of *P. spinidens* are on average 1.67 (females 1.62) times longer than wider. Wing cases of males of *P. vorontzowi* are slenderer (on average 1.74 [females 1.75] times longer than wider).
3. Females of the genus *Pityokteines* show markedly tail-like hair of the front margin of their shield and forehead. The longest hair of the front margin of the shield is in *P. spinidens* (about 0.38 mm), substantially shorter (about 0.26 mm) in *P. curvidens* and shortest (about 0.23 mm) in *P. vorontzowi*. Hairs on the forehead are 8.3, 5.6 and 9.5% shorter in *P. curvidens*, *P. spinidens* and *P. vorontzowi*, respectively than on the front margin of the shield. According to the length of hair of the shield (or the forehead) we can quite reliably differentiate the females of *P. spinidens*, however, not of *P. curvidens* from those of *P. vorontzowi*.
4. Small bristles on the rear of wing cases of females are about 0.19 mm long in *P. curvidens*, in *P. spinidens* about 0.17 mm and in *P. vorontzowi* about 0.12 mm. Based on the length of the bristles it is possible to identify reliably the females of *P. vorontzowi*, however, not those of *P. curvidens* and *P. spinidens*.
5. On the forehead of 80% males of all three species under comparison, there is a fine longitudinal central keel. The forehead of 20% males is more or less evenly grainy or with glossy bulge. The surface structure of the forehead of females is various (in *P. curvidens* in 50% with one or two bulges, in 33% more or less grainy, in 17% with a fine longitudinal keel, in *P. spinidens* in 72% grainy, in 17% with a smooth central line, in 11% with a bulge, in *P. vorontzowi* in 72% with a fine longitudinal keel and in 28% with a bulge in the lower or upper parts or in both parts of the forehead). Thus, unlike *P. curvidens* and *P. spinidens*, no sexual dimorphism occurs in principle (naturally with the excep-

tion of hair) in the surface structure of the forehead of *P. vorontzowi*.

6. The shape and size of figures that are defined by the 2nd and the 5th pair of teeth on the lowered part of wing cases rank among the most important diagnostic features of females of particular species of the genus *Pityokteines*. In *P. curvidens*, the figure corresponds to a isosceles trapezoid (lower base-line about 0.42 mm, upper base-line 0.40 mm, height 0.329 mm) that markedly approaches (or is almost equal) to a rectangle. In *P. spinidens*, it is however a rather distinct isosceles trapezoid (lower base-line about 0.41 mm, upper base-line 0.33 mm and height 0.33 mm) that considerably differs from a square. In *P. vorontzowi*, the area delimited by teeth of the 2nd and 5th pairs corresponds to a well-marked isosceles trapezoid the size of which is substantially smaller as compared with *P. spinidens* and particularly *P. curvidens* (lower base-line about 0.36 mm, upper base-line 0.23 mm and height 0.221 mm).
7. According to the width of mother galleries, it is possible to differentiate rather reliably feeding marks of *P. vorontzowi* from those of *P. curvidens* and usually also from *P. spinidens*. Mother galleries of *P. vorontzowi* are max. 1.07 mm in width whereas galleries of *P. curvidens* are min. 1.07 mm wide and those of *P. spinidens* are min. 1.00 mm wide. According to the size of emergence holes (or entrance holes) and the width of the head case of larvae it is not usually possible to differentiate particular species of the genus *Pityokteines*.

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Received 16 May 2002

K diagnostice lesnický významných kůrovců rodu *Pityokteines* Fuchs

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ABSTRAKT: Práce se zabývá především problematikou determinace dospělců (a hlavně samiček) kůrovců rodu *Pityokteines* Fuchs. *P. curvidens* (Germ.) je v průměru jen nepatrně delší než *P. spinidens* (Reitt.) a zřetelně delší než *P. vorontzowi* (Jak.).

Samečci jsou (bez spodních hákovitých zubů) stejně dlouzí jako samičky. Štít *P. curvidens* je průměrně o 8 % (*P. spinidens* o 12 % a *P. vorontzowi* o 13 %) delší než širší. Samečci *P. curvidens* mají krovky v ramenou stejně široké jako štít, samičky průměrně o 3,3 % širší než štít. Samečci *P. spinidens* mají krovky průměrně o 1,0 % užší (samičky o 2,1 % širší) než štít. Samečci *P. vorontzowi* mají krovky průměrně o 1,3 % užší než štít, samičky stejně široké jako štít. Nejdelší chvostkovité ochlupení předního okraje štítu (kolem 0,38 mm) je u samiček *P. spinidens*, daleko kratší (kolem 0,26 mm) u *P. curvidens* a nejkratší (kolem 0,23 mm) u *P. vorontzowi*. U samiček *P. curvidens* je ochlupení čela oproti ochlupení štítu kratší průměrně o 8,3 %, u *P. spinidens* o 5,6 % a u *P. vorontzowi* o 9,5 %. Podle délky ochlupení štítu lze spolehlivě odlišit samičky *P. spinidens* a podle krátkých (0,12 mm) štětin na zádi krovek samičky *P. vorontzowi*. Podélný středový kýl je na čele 80 % samečků všech tří druhů a 72 % samiček *P. vorontzowi*. Obrazec na zádi krovek vymezený zoubky 2. a 5. páru samiček *P. curvidens* je rovnoramenný lichoběžník, který se blíží (až téměř rovná) na šířku postavenému obdélníku. U *P. spinidens* je to dosti výrazný (u *P. vorontzowi* výrazný) lichoběžník. Byl zjištěn tvar a velikost těchto obrazců, které jsou hlavními znaky pro druhovou determinaci samiček rodu *Pityokteines*.

Klíčová slova: *Pityokteines curvidens*; *P. spinidens*; *P. vorontzowi*; diagnostické znaky; pohlavní dimorfismus

V letech 1994–1997 bylo zjišťováno druhové zastoupení kůrovců rodu *Pityokteines* Fuchs na 164 lokalitách v Čechách, na Moravě a ve Slezsku. Kůrovci byli především determinováni podle požerků a determinace byla ověřována podle dospělců. Na rozdíl od celkem snadno určitelných samečků byla druhová determinace samiček podle stávajících určovacích klíčů obtížná a v některých případech nespolehlivá. Autor práce se pokusil zpřesnit dosud známé (a nalézt nové) diagnostické znaky, podle nichž by bylo možné dospělé (a zvláště samičky) jednotlivých druhů tohoto rodu bezpečně determinovat. U dospělců obou pohlaví *P. curvidens* (Germ.), *P. spinidens* (Reitt.) a *P. vorontzowi* (Jak.) byla mikrometricky zjišťována délka těla, délka a šířka štítu a krovek v ramenou, délka ochlupení předního okraje štítu, čela a zádi krovek. Podrobně bylo prozkoumáno utváření čela dospělců a zádi krovek samiček. Byla ověřována také možnost determinace jednotlivých druhů podle šířky matečných chodeb, velikosti závrtočných a výletových otvorů a šířky hlavy larev. Byly získány tyto hlavní poznatky:

1. Dospělci *P. curvidens* jsou jen nepatrně delší než *P. spinidens* a značně delší než *P. vorontzowi*. V délce těla se neprojevuje žádný pohlavní dimorfismus. Délku těla také nelze použít jako doplňkové diagnostické kritérium. Samečci *P. curvidens* jsou bez spodních hákovitých zubů dlouzí 2,2 až 3,1 (průměrně 2,65) mm, včetně zubů 2,3 až 3,2 (průměrně 2,75) mm, samičky 2,2 až 3,0 (průměrně 2,62) mm. Samečci *P. spinidens* jsou bez těchto zubů dlouzí 2,1 až 3,0 (průměrně 2,6) mm, včetně zubů 2,2 až 3,1 (průměrně 2,7) mm, samičky 2,1 až 2,9 (průměrně 2,6) mm. Samečci *P. vorontzowi* jsou bez zubů dlouzí 2,0 až 2,5 (průměrně 2,3) mm, včetně zubů 2,1 až 2,6 (průměrně 2,4) mm, samičky 1,9 až 2,5 (průměrně 2,3) mm.

2. Štít samečků i samiček *P. curvidens* je průměrně o 8 % (*P. spinidens* o 12 % a *P. vorontzowi* o 13 %) delší než širší. Štít *P. curvidens* je tedy oproti *P. spinidens* a *P. vorontzowi* méně protáhlý. Nevýrazný je pohlavní dimorfismus ve tvaru těla. Zatímco samečci *P. curvidens* mají krovky v ramenou stejně široké jako štít, samičky je mají průměrně o 3,3 % širší než štít. Samečci *P. spinidens* mají krovky průměrně o 1,0 % užší (samičky o 2,1 % šir-

ší) než štít. Samečci *P. vorontzowi* mají krovky průměrně o 1,3 % užší než štít, samičky stejně široké jako štít. Krovky samečků *P. curvidens* (včetně spodních hákovitých zubů) jsou v ramenou průměrně 1,69krát (samiček 1,65krát) delší než širší. Krovky samečků *P. spinidens* jsou průměrně 1,67krát (samiček 1,62krát) delší než širší. Krovky samečků *P. vorontzowi* jsou štíhlejší (průměrně 1,74krát [samiček 1,75krát] delší než širší).

3. Samičky rodu *Pityokteines* mají nápadně chvostkovitě ochlupený přední okraj štítu a čelo. Nejdelší ochlupení předního okraje štítu je u *P. spinidens* (kolem 0,38 mm), podstatně kratší (kolem 0,26 mm) u *P. curvidens* a nejkratší (kolem 0,23 mm) u *P. vorontzowi*. Chloupky na čele jsou u *P. curvidens* o 8,3 % (u *P. spinidens* o 5,6 % a u *P. vorontzowi* o 9,5 %) kratší než na předním okraji štítu. Podle délky ochlupení štítu (resp. čela) můžeme zcela spolehlivě odlišit samičky *P. spinidens*, nikoliv *P. curvidens* od *P. vorontzowi*.

4. Štětiny na zádi krovek samiček jsou u *P. curvidens* dlouhé kolem 0,19 mm, u *P. spinidens* kolem 0,17 mm a u *P. vorontzowi* kolem 0,12 mm. Podle délky těchto štětin lze s jistotou identifikovat samičky *P. vorontzowi*, nikoliv *P. curvidens* a *P. spinidens*.

5. Na čele 80 % samečků všech tří srovnávaných druhů je jemný podélný středový kýl. Čelo 20 % samečků je víceméně stejnoměrně zrnité nebo s lesklým hrbolkem. Povrchová struktura čela samiček je různá (u *P. curvidens* v 50 % s jedním nebo dvěma hrbolky, ve 33 % víceméně stejnoměrně zrnitá, v 17 % s jemným podélným kýlem, u *P. spinidens* v 72 % zrnitá, v 17 % s hladší středovou linií, v 11 % s hrbolkem, u *P. vorontzowi* v 72 % s jemným podélným kýlem a ve 28 % s hrbolkem ve spodní nebo horní části, případně v obou částech čela). Na rozdíl od *P. curvidens* a *P. spinidens* se tedy v povrchové struktuře čela *P. vorontzowi* v podstatě nevyskytuje (samozřejmě kromě ochlupení) žádný pohlavní dimorfismus.

6. K nejvýznamnějším diagnostickým znakům samiček jednotlivých druhů rodu *Pityokteines* patří tvar a velikost obrazců, které jsou na vyhloubené části krovek ohraničeny 2. a 5. párem zoubků. U *P. curvidens* se tento obrazec rovná rovnoramennému lichoběžníku (o spodní

základně kolem 0,42 mm, horní základně 0,40 mm a výšce 0,329 mm), který se výrazně blíží (nebo až téměř rovná) na šířku postavenému obdélníku. U *P. spinidens* je to však dosti výrazný rovnoramenný lichoběžník (o spodní základně kolem 0,41 mm, horní základně 0,33 mm a výšce 0,33 mm), který se jen velmi vzdáleně podobá čtverci. U *P. vorontzowi* se pole vymezené zoubky 2. a 5. páru rovná výraznému rovnoramennému lichoběžníku, jehož velikost je oproti *P. spinidens* a zvláště *P. curvidens* pod-

statně menší (spodní základna je kolem 0,36 mm, horní základna 0,23 mm a výška 0,221 mm).

7. Podle šířky matečných chodeb lze celkem spolehlivě odlišit požerky *P. vorontzowi* od *P. curvidens* a zpravidla i od *P. spinidens*. Matečné chodby *P. vorontzowi* jsou široké maximálně 1,07 mm, kdežto chodby *P. curvidens* minimálně 1,07 mm a chodby *P. spinidens* minimálně 1,00 mm. Podle velikosti výletových (resp. závrtových) otvorů a šířky hlavové schránky nelze jednotlivé druhy rodu *Pityokteines* od sebe většinou vůbec odlišit.

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