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Systematic position of *Eulachnus cembrae* Börner with description of hitherto unknown sexual morphs of *E. pumilae* Inouye (Hemiptera, Aphididae, Lachninae)

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Abstract

The identity of *Eulachnus cembrae* Börner, 1950, **stat. rev.** from Europe, treated as a synonym of *E. pumilae* Inouye, 1939 from East Asia is clarified based on characters of sexual morphs. The oviparous female and alate male forms of *E. pumilae* are described and figured in detail for the first time and the poorly known sexual forms of *E. cembrae* are redescribed and figured in detail as well. Sexual morphs of the two similar species are compared, and significant differences clearly distinguishing those species are presented. A key to the identification of oviparous females and males of *E. cembrae* and *E. pumilae* as well as notes on host plants and distribution of these species are provided. The status of *E. pumilae* in the European aphid-fauna is clarified. Morphological characters of the sexual generation that may be useful for species identification are discussed.

Introduction

The Palaearctic genus *Eulachnus* Del Guercio, 1909 comprises about 13–18 species of small, narrow-bodied aphids, of which about 12 are known from Europe. They live often singly or in small colonies on the needles of *Pinus* spp., are hidden while feeding and become very active when disturbed (Blackman and Eastop 1994; Kanturski and Wieczorek 2014). Taxa from the genus *Eulachnus* are good examples for species and species-groups of unclear identity (Blackman and Eastop 2014). Such an example is the species pair *E. pumilae* Inouye, 1939 and *E. cembrae* Börner, 1950, stat. rev. In comparison to the other *Eulachnus* species they are characterized by the absence of dorsal sclerites and scleroites on the abdomen.

E. pumilae was described by Inouye (1939) from Hokkaido (Japan) from *Pinus pumila*, whereas Börner (1950) described *E. cembrae* from the Eastern Alps from *P. cembra*. Many authors treated those two species as synonyms (Inouye 1970; Ghosh 1982; Blackman and Eastop 1994). However, Remaudière and Remaudière (1997) stated that *E. cembrae* should be treated as a separate species due to a difference in the number of accessory setae on the apical segment of the rostrum (2 setae in *E. pumilae*, no setae in *E. cembrae*), which is a difference also mentioned in Blackman and Eastop (2014). The problem of the identity of *E. cembrae* has not been resolved yet. The most recent papers of Mamontova (2011, 2012) still treat these two species as synonyms. Moreover, in the Fauna Europaea *E. pumilae* is recorded as European species (Nieto Nafría et al. 2014), known only from Slovakia (Goffova and Wojciechowski 2013).

The descriptions of *E. pumilae* and *E. cembrae* were based on characters of the viviparous generation, although there were also sexual morphs in the type material of Börner (1950). Pintera (1968) briefly described the sexual generation of *E. cembrae*. Oviparae were characterized by numerous pseudosensoria; males were winged with numerous rhinaria on the antennae. Similar information was reported by Szelegiewicz (1978). The life cycle and sexual forms of *E. pumilae* were not described.

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Ghosh (1982) gave a description of sexual forms under the name *E. pumilae*, but this was in reality a description of sexual forms of *E. cembrae*.

The aim of this paper is to define the taxonomic status of these two species by morphological and biometric examination of their sexual morphs, especially sexual forms of *E. cembrae* from the type material. On the basis of the material deposited in the Natural History Museum, London (UK), a description of sexual forms of *E. pumilae* is provided as well as a redescription of the sexual generation of *E. cembrae*. Moreover, the role of the characters of the sexual generation is highlighted, especially the underestimated and rather rarely used features of the male genitalia.

Material and methods

Material examined

E. pumilae. One oviparous female, one alate male, SOUTH KOREA, Seoul, 03.XI.1971, *Pinus koraiensis*, BM 1984-340, 688g, Paik leg. BMNH.

E. cembrae. One oviparous female, one alate male (from type material), AUSTRIA: East Alps, 21.VIII.1942, *Pinus cembra*, 1/22, Franz leg. DEIC; two oviparous females, POLAND: Tatra Mountains, Zbocze Żabiego, 07.IX.1977, *P. cembra*, R2046 4815, H. Szelegiewicz leg. ZMPA; one oviparous female, SWITZERLAND: Valais, Brüchen, 16.X.1985, *P. cembra*, 7042:10, Bergersen leg. MZLU; one alate male, two oviparous females, Les Plans sur Bex, 12.IX.1966, *P. cembra*, BM 1984-340 470, D. Hille Ris Lambers leg. BMNH; two oviparous females, one alate male, SLOVAKIA: High Tatra Mountains, Grúnik, 1.IX.1949, *P. cembra*, BM 1952-537, V. Pašek leg. BMNH; two oviparous females, FRANCE: Ravin de Molières, Mercantour A. M., X.1993, *P. cembra*, 22025, L. Dalstein leg., one alate male, *P. cembra*, 22026, L. Dalstein leg., three oviparous females, Risoul 1900 m, (Hautes Alpes), 16.X.1986, *P. cembra*, 22023, G. Remaudière leg., three oviparous females, *P. cembra*, 22024 G. Remaudière leg. all MNHN.

Methods

The specimens were examined using the light microscope Nikon Ni-U and were photographed with a Nikon DS-Fi2 camera. Drawings were made with a camera lucida. For each of the drawings a magnified view is provided. Measurements are given in mm (Table 1). The material studied is deposited in the Natural History Museum, London, UK (BMNH), Muséum national d'Histoire naturelle, Paris, France (MNHN), Deutsches Entomologisches Institut, Eberswalde, Germany (DEIC), Lund University, Lund Museum of Zoology, Lund, Sweden (MZLU), and Zoological Institute, Polish Academy of Sciences, Warsaw, Poland (ZMPA). Measurements and ratios of first segment of hind tarsus (HT I) were made after Szelegiewicz (1978) and Heie (1995) (Fig. 1f).

Table 1. Measurements (in mm) of oviparous female (n = 1), alate male (n = 1) of *Eulachnus pumilae* and oviparous females (n = 15) alate males (n = 3) of *E. cembrae*.

Character	Oviparous females		Alate males	
	E. pumilae	*E. cembrae*	*E. pumilae*	*E. cembrae*
Body length	3.50	2.62–3.25	2.95	2.7
Maximal width	1.37	0.90–1.32	0.90	0.75–0.92
Head width	0.52	0.46–0.68	0.54	0.52
Antennae length	1.32–1.38	1.48–1.67	0.69–0.70	2.11–2.20
Ant. segm. III	0.41–0.42	0.48–0.54	0.70–0.71	0.69–0.74
Ant. segm. IV	0.25	0.26–0.28	0.41–0.45	0.36–0.43
Ant. segm. V	0.26–0.27	0.30–0.34	0.41–0.42	0.45–0.49
Ant. segm. VI	0.24	0.26–0.28	0.27–0.29	0.33–0.35
Ant. segm. VIa	0.19–0.20	0.22–0.24	0.23–0.25	0.27–0.30
Ant. segm. VIb	0.04–0.05	0.04–0.05	0.04	0.05–0.06
Hind femora	1.15–1.20	1.10 –1.27	1.15–1.17	1.22–1.25
Hind tibiae	1.75–1.80	1.67–1.97	2.02–2.05	1.95–2.05
HT I basal length	0.03	0.03–0.04	0.02– 0.03	0.03
HT I dorsal length	0.08	0.10–0.12	0.10	0.11–0.12
HT I ventral length	0.12	0.14–0.16	0.13	0.14–0.15
HT I intersegmental length	0.05	0.04–0.05	0.04	0.04–0.05
HT II	0.20	0.24–0.28	0.23	0.25–0.28
ARS	0.09	0.09–0.10	0.10	0.09–0.10
Siphuncular sclerite	0.08–0.09	0.07–0.10	0.06	0.06–0.08
Siphuncular pore	0.03–0.04	0.03–0.04	0.03	0.03
Fore wings length	–	–	3.12–3.25	3.12–3.40
Subgenital plate length	0.25	0.13–0.15	–	–
Subgenital plate width	0.40	0.33–0.37	–	–

Results

Taxonomy

Eulachnus pumilae Inouye

Figs 1, 3a, c

Inouye 1939: 134, by original designation

Description. Oviparous female (Fig. 1; Table 1, 2). Colour in life unknown. Pigmentation of mounted specimens: several structures pigmented in a generally transparent body. Antennae brown, except segment I, which is pale at base and light-brown at apex. Fore and middle femora yellow with darker ends. Fore and middle tibiae light-brown. Hind legs brown, with only paler apices of femora. Tarsi brown. Siphuncular sclerites brown. Body elongated, oval (Fig. 1a). Head with big compound eyes, without triommatidia. Head width 0.36–0.37 times length of antennae. Head chaetotaxy: dorsal side with 11, ventral side with 12 fine and pointed setae, 0.08–0.11 mm long. Head setae arising from wart-like bases. Antennae (Fig. 1b, c) 6-segmented 0.39–0.40 times length of body. Ant. segm. III (Fig. 1b) shorter than segm. IV+V+VI with smooth proximal part and imbricated apex. Ant. segm. IV (Fig. 1b) only slightly shorter than ant. segm. V. Ant. segm. V (Fig. 1c) slightly longer than ant. segm. VI, with 1 rounded or oval primary rhinarium at apex. Rhinarium with little developed sclerotic rosette. Ant. segm. VI (Fig.

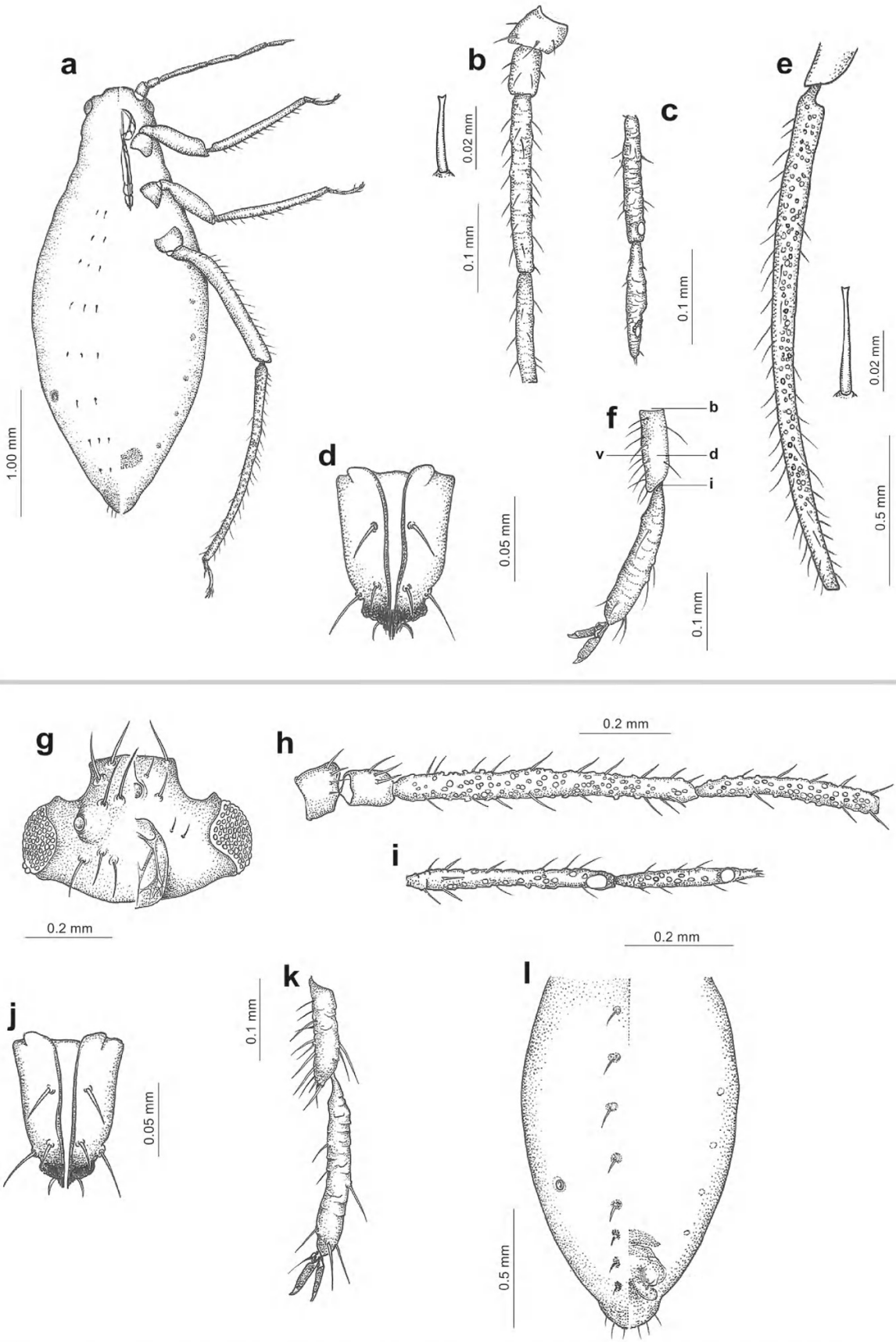

Figure 1. *Eulachnus pumilae* – oviparous female: **(a)** general view, **(b)** antennal segments I–IV, **(c)** antennal segments V and VI, **(d)** apical segment of rostrum, **(e)** hind tibia, **(f)** hind tarsus with HT I parts lengths: b – basal length, d – dorsal length, v –ventral length, i – intersegmental length. Alate male: **(g)** head, **(h)** antennal segments I–IV, **(i)** antennal segments V and VI, **(j)** apical segment of rostrum, **(k)** hind tarsus, **(l)** abdomen.

Table 2. Main morphological differences between oviparous females of *E. pumilae* and *E. cembrae* **AL**–antennae length, **BL**–body length, **ANT IV**–antennal segment IV length, **ANT III** – ant. segm. III length, **HT I bL**–first segment of hind tarsus basal length, **HT I dL**–HT I dorsal length, **HT I iL**–HT I intersegmental length, **HT I vL**–HT I ventral length **ARS**–apical segment of rostrum, **HT II**–second segment of hind tarsus length.

Character	*E. pumilae*	*E. cembrae*
AL/BL	0.39–0.40	0.49–0.57
ANT IV/ANT III	0.59–0.61	0.38–0.53
HT I bL/HT I dL	0.38–0.43	0.30–0.33
HT I dL/HT I iL	1.45–1.53	2.10–3.00
HT I bl/HT I vL	0.25–0.28	0.23–0.24
ARS/ANT III	0.21–0.22	0.18–0.20
ARS/HT II	0.42–0.45	0.35–0.41
Pseudosensoria	100–105	32–58
ARS accessory setae	2	0

1c) with very short terminal process (VIb), 0.20–0.26 times length of base (VIa) and with 1 rounded or oval primary rhinarium with little sclerotic rosette and 4 accessory rhinaria situated close to each other in about half of length of segment. Ant. segm. IV-VI imbricated on whole length. Other antennal ratios: VI:III 0.57–0.58, V:III 0.63–0.64, IV:III 0.59–0.61 Antennal chaetotaxy: segm. I with 4 setae, segm. II with 5 setae, segm. III with 20–23 setae, segm. IV with 7–9 setae, segm. V with 7–11 setae, segm. VI with 4–5 basal, 5–6 apical and 1 subapical setae. Ant. segm. III-IV with short and slightly forked setae (Fig. 1b), segm. V and VI with short and pointed setae, shorter, or as long as diameter of segments. Longest seta on ant. segm. III 1.00–1.05 times basal articular diameter of this segment (BD III). Rostrum short, reaching behind middle coxae. Apical segment of rostrum (ARS) blunt, with very short apical part (Fig. 1d), 0.21–0.22 times ant. segm. III, 0.37 times ant. segm. VI and 0.42–0.45 times second segment of hind tarsus (HT II), with 6 primary and 2 accessory setae. Dorsal side of thorax covered by short, 0.04–0.05 mm, and blunt setae. Hind legs long, covered by slightly blunt setae, which are as long as or slightly longer than width of tibiae. Distal, inner side of fore and middle tibiae with numerous short and pointed setae. Hind tibiae (Fig. 1e) slightly swollen, with 100–105 irregular pseudosensoria reaching about ¾ length of tibiae. Some setae of hind tibiae with slightly blunt apices (Fig. 1e), longest setae on distal part of tibiae pointed. First segment of hind tarsus (HT I) long, its basal length 0.38–0.43 times dorsal, 0.25–0.28 times ventral and 0.56–0.67 times intersegmental length, with 2 dorsal and 8–10 ventral, pointed setae (Fig. 1f). HT II 0.41–0.47 times length of ant. segm. III and 0.83 times ant. segm. VI. Dorsal side of abdomen membranous without sclerites and scleroites (Fig. 1a). Dorsal setae not numerous, very short, on abd. segm. I-VI 0.01–0.03 mm long and on segm. VII and VIII 0.05–0.08 mm long, pointed. Siphunculi very low, with narrow cone-shaped base. Subgenital plate in form of two sclerites. Cauda broadly rounded with many long, fine and pointed setae and very short spinules.

Description. Alate male (Figs 1, 3a, c; Table 1, 3). Colour in life unknown. Pigmentation of mounted specimens: several structures pigmented in a transparent body. Antennae dark brown with slightly lighter ant. segm. VI. Fore and middle femora light brown with darker ends. Hind femora dark brown with pale anterior parts. Tibiae and tarsi brown. Wings pale with light brown veins. Abdomen pale with light brown sclerites and scleroites. Siphuncular sclerites brown. Genitalia brown. Body elongated, oval. Head (Fig. 1g) with big and very well-developed compound eyes, without triommatidia and with 3 well-developed ocelli. Head width 0.25–0.26 times length of antennae. Head chaetotaxy: dorsal side with 14, ventral side with 10 long, fine and pointed setae, 0.11–0.13 mm long. Head setae arising from well-developed and brown, oval scleroites. Antennae (Fig. 1h, i) 6-segmented, 0.69–0.70 times length of body. Ant. segm. III (Fig. 1h) shorter than segm. IV+V+VI, with 125–136 secondary rhinaria. Almost all rhinaria small and rounded, situated on whole length and surface of segment. Ant. segm. IV (Fig. 1h) almost as long as ant. segm. V, with 55–64 secondary rhinaria. Ant. segm. V (Fig. 1i) longer than ant. segm. VI, with 1 rounded primary rhinarium at apex with little developed sclerotic rosette and 35–43 secondary rhinaria. Secondary rhinaria on ant. segm. IV and V small and rounded, situated on whole length and surface of segments. Ant. segm. VI (Fig. 1i) with very short VIb, 0.16–0.17 times VIa. VIa with 1 rounded or oval primary rhinarium with little sclerotic rosette, 4–5 accessory rhinaria situated close to each other in about half of length of segment and 11–14 secondary rhinaria, situated under the accessory rhinaria. Other antennal ratios: VI:III 0.38–0.41, V:III 0.57–0.60, IV:III 0.58–0.63. Antennae with pointed setae of various length. Longest seta on ant. segm. III 1.35–1.36 times BD III. Antennal chaetotaxy: segm. I with 4–7 setae, segm. II with 3–5 setae, segm. III with 18–19 setae, segm. IV with 7–9 setae, segm. V with 10–11 setae, segm. VI with 6–7 basal, 5–6 apical and 1 subapical setae. Rostrum short, reaching mesosternum. ARS blunt, with very short apical part (Fig.1j), 0.14 times ant. segm. III, 0.34–0.37 times ant. segm. VI and 0.43–0.45 times HT II, with 6 primary and 2 accessory setae. Dorsal side of thorax covered by long, fine and pointed setae, 0.09–0.10 mm long. Media with 1 fork. Hind legs long, covered by long and pointed setae, which are longer than width of tibiae. HT I long, its basal length 0.27–0.30 times dorsal, 0.20–0.22 times ventral and 0.61–0.75 times intersegmental length, with 2 dorsal and 12 ventral, pointed setae (Fig 1k). HT II 0.32 times length of ant. segm. III and 0.70–0.85 times ant segm. VI. Dorsal side of abdomen membranous, with long and pointed setae, on abd. segm. I-V 0.07–0.09 mm long, on segm. VI-VIII 0.09–0.12 mm long. Spinal setae arranged in two pairs on each segment, arising from oval scleroites (Fig. 1l). Siphunculi very low, with narrow cone-shaped base. Abdominal sternite VI and VII sclerotized on whole surface. Cauda broadly rounded with many long, fine and pointed setae and very short spinules. Parameres present, located above basal part of phallus, clearly visible, basally

Table 3. Main morphological differences between alate males of *E. pumilae* and *E. cembrae*. **AL**–antennae length, **BL**–body length, **Ant. segm. VIb**–antennal segment VI terminal process length, **Ant. segm. VIa**–ant. segm. VI base length, **Ant. segm VI**–ant. segm. VI length, **ANT III**–ant. segm. III length, **ARS**–apical segment of rostrum, **HT II**–second segment of hind tarsus length, **R III, IV, VI**–number of secondary rhinaria on ant. segm. III, IV and VI.

Character	*E. pumilae*	*E. cembrae*
AL/BL	0.69–0.70	0.78–0.81
Ant. segm. VIb/ant. segm. VIa	0.16–0.17	0.19–0.24
ANT VI/ANT III	0.38–0.41	0.45–0.51
ARS/HT II	0.43–0.45	0.32–0.40
ARS/ANT VI	0.34–0.37	0.27–0.29
HT II/ANT III	0.31–0.32	0.35–0.38
R III	125–136	80–120
R IV	55–64	29–42
R VI	11–14	4–10
ARS accessory setae	2	0

fused. Their lobate parts arise into distinct, finger-like projection toward base of phallus. Parameres dark pigmented, with numerous, long setae on entire surface. Basal part of phallus crescent-shaped, light brown, with numerous long setae. Sclerotized arms clearly visible, strongly sclerotized, dark pigmented. Proximal part robust, ends in triangular apex. Distal part also robust, strongly flattened with thorn-like process located in inner edge of arm. Sclerotized arms form upper half-circle-shaped structure that surrounds genital area (Fig. 3a, c).

Host plants. *Pinus koraiensis* (Inouye 1970; Lee et al. 1994; Pashchenko 1988; Szelegiewicz 1974), *P. parviflora* (Blackman and Eastop 1994), *P. pentaphylla* (Inouye 1970), *P. pumila* (Inouye 1939, 1970; Pashchenko 1988), *P. strobus* (Lee et al. 1994; Pashchenko 1988).

Distribution. India (Ghosh 1982), Japan (Inouye 1939, 1970), Korea (Lee et al. 1994; Szelegiewicz 1974), Russia-Far East (Pashchenko 1988).

Eulachnus cembrae Börner

Figs 2, 3b, d

Börner 1950: 2, by original designation

Redescription. Oviparous female (Fig. 2; Table 1, 2). Colour in life unknown. Pigmentation of mounted specimens: head, thorax and abdomen pale or yellowish. Antennae light-brown, except ant. segm. I, which is pale at base and light-brown at apex or antennae uniformly yellowish-brown. Fore and middle femora yellow with darker ends. Hind femora yellow or light brown with paler anterior part. Fore and middle tibiae yellow or light-brown. Hind tibiae brown. Tarsi brown. Siphuncular sclerite brown. Body elongated, oval (Fig. 2a). Head with big compound eyes, without triommatidia. Head width 0.29–0.40 times length of antennae. Head chaetotaxy: dorsal side with 9–10, ventral side with 12 blunt setae, 0.012–0.095 mm long. Head setae arising from wart-like bases. Antennae 6-segmented (Fig. 2b, c) 0.49–0.57 times length of body. Ant. segm. III (Fig. 2b) shorter than segm. IV+V+VI with smooth proximal part and imbricated apex. Ant. segm. IV (Fig. 2b) shorter than ant. segm. V. Ant. segm. V (Fig. 2c) longer than ant. segm. VI, with 1 rounded or oval primary rhinarium at apex with well-developed sclerotic rosette with smooth edge. Ant. segm. VI (Fig. 2c) with very short VIb, 0.16–0.22 times VIa. VIa with 1 rounded or oval primary rhinarium with little sclerotic rosette and 5–6 accessory rhinaria situated close to each other in about ¾ of length of segment. One of them much bigger, with very well-developed sclerotic rosette surrounded by 1 medium sized and 2–3 small other ones. Ant. segm. IV-VI imbricated on whole length. Other antennal ratios: VI:III 0.51–0.57, V:III 0.59–0.66, IV:III 0.38–0.53. Antennal chaetotaxy: segm. I with 4–6 setae, segm. II with 4–5 setae, segm. III with 17–23 setae, segm. IV with 6–9 setae, segm. V with 8–11 setae, segm. VI with 6–7 basal, 6 apical and without subapical setae. Ant. segm. III-IV with short, blunt or spatulate setae (Fig. 2b). Ant. segm. VI with short and pointed setae. Setae shorter than diameter of segments, longest seta on ant. segm. III 0.56–0.66 times BD III. Rostrum short, reaching behind hind coxae. ARS blunt, with very short apical part (Fig. 2d), 0.18–0.20 times ant. segm. III, 0.33–0.37 times ant. segm. VI and 0.35–0.41 times HT II, with 6 primary and without accessory setae. Dorsal side of thorax covered by short, 0.007–0.02 mm long blunt setae. Some setae on meso- and metanotum may arise from scleroites. Hind legs long, covered by slightly blunt setae, which are as long as or slightly longer than width of tibiae. Hind tibiae (Fig. 2e) slightly swollen, with 32–58 irregular pseudosensoria which are reaching mostly to half of length of tibiae. Basal length of HT I 0.30–0.33 times dorsal length, 0.23–0.24 times ventral length and 0.70–0.92 times intersegmental length, with 2 dorsal and 12 ventral, pointed setae (Fig. 2f). HT II 0.48–0.55 times length of ant. segm. III and 0.90–1.00 ant. segm. VI. Dorsal side of abdomen membranous. Abd. segm. I-VI without sclerites and scleroites (Fig. 2a). Abd. segm. I-VI with few, very short slightly blunt dorsal setae, 0.015–0.025 mm long. Abd. segm. VII and VIII with slightly longer and pointed dorsal setae, 0.035–0.062 mm. Setae on abd. segm. VII and VIII arising from oval scleroites. Siphunculi very low with a narrow cone-shaped base. Subgenital plate in the middle subdivided. Cauda broadly rounded with numerous long, fine and pointed setae and very short spinules.

Redescription. Alate male (Figs 2, 3b, d; Table 1, 3). Colour in life unknown. Pigmentation of mounted specimens: head and thorax sclerotized, yellow or brown. Antennae light brown with ant. segm. I, II and proximal part of segm. III pale. Legs yellow to light brown with darker apices of femora and sometimes darker tibiae. Tarsi dark. Wings pale with light brown veins and brownish pterostigma. Abdomen pale with light brown sclerites and scleroites. Siphuncular sclerites and genitalia brown. Body elongated, oval. Head (Fig. 2g) with big and very well-de-

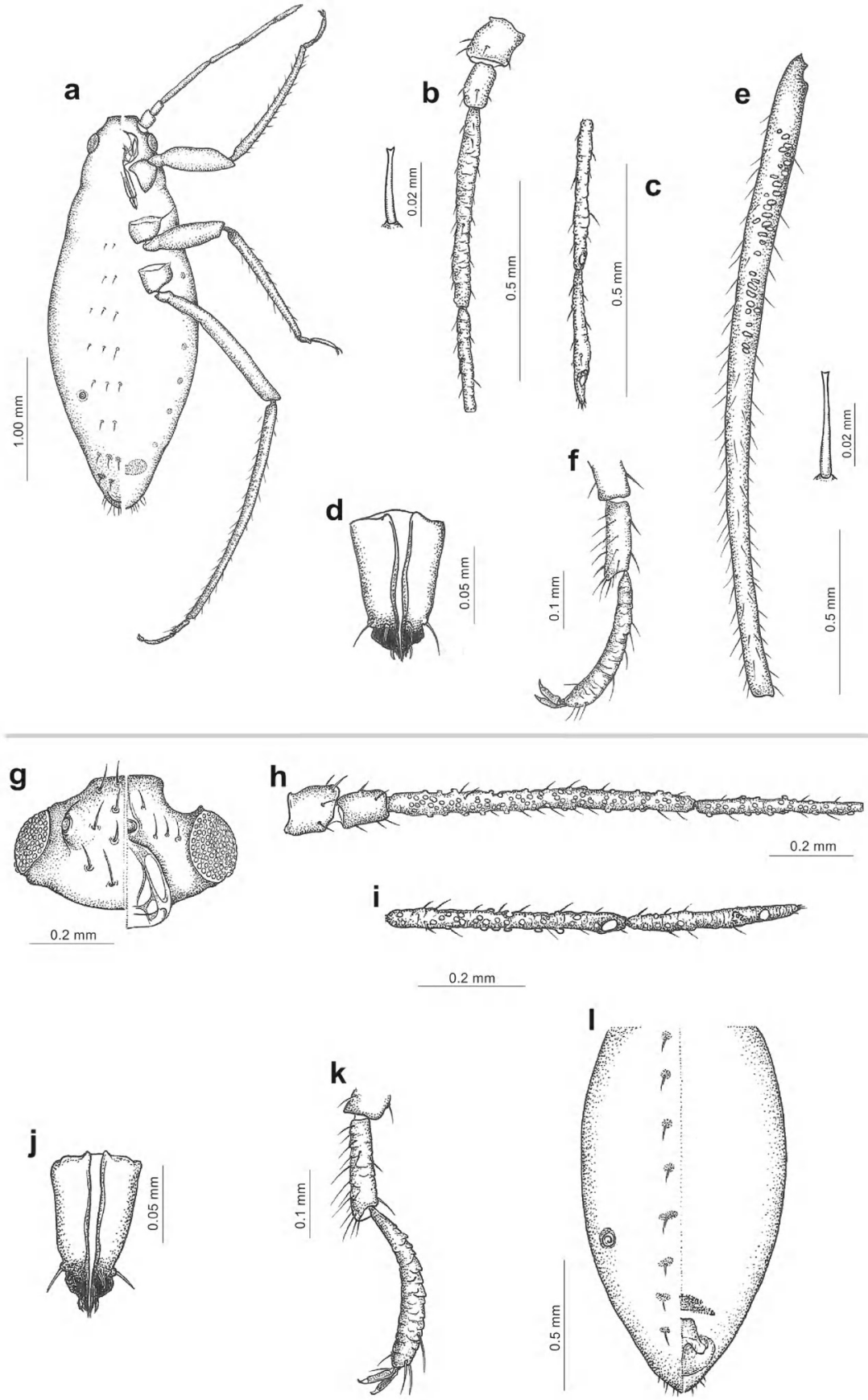

Figure 2. *Eulachnus cembrae* – oviparous female: **(a)** general view, **(b)** antennal segments I–IV, **(c)** antennal segments V and VI, **(d)** apical segment of rostrum, **(e)** hind tibia, **(f)** hind tarsus. Alate male: **(g)** head, **(h)** antennal segments I–IV, **(i)** antennal segments V and VI, **(j)** apical segment of rostrum, **(k)** hind tarsus, **(l)** abdomen.

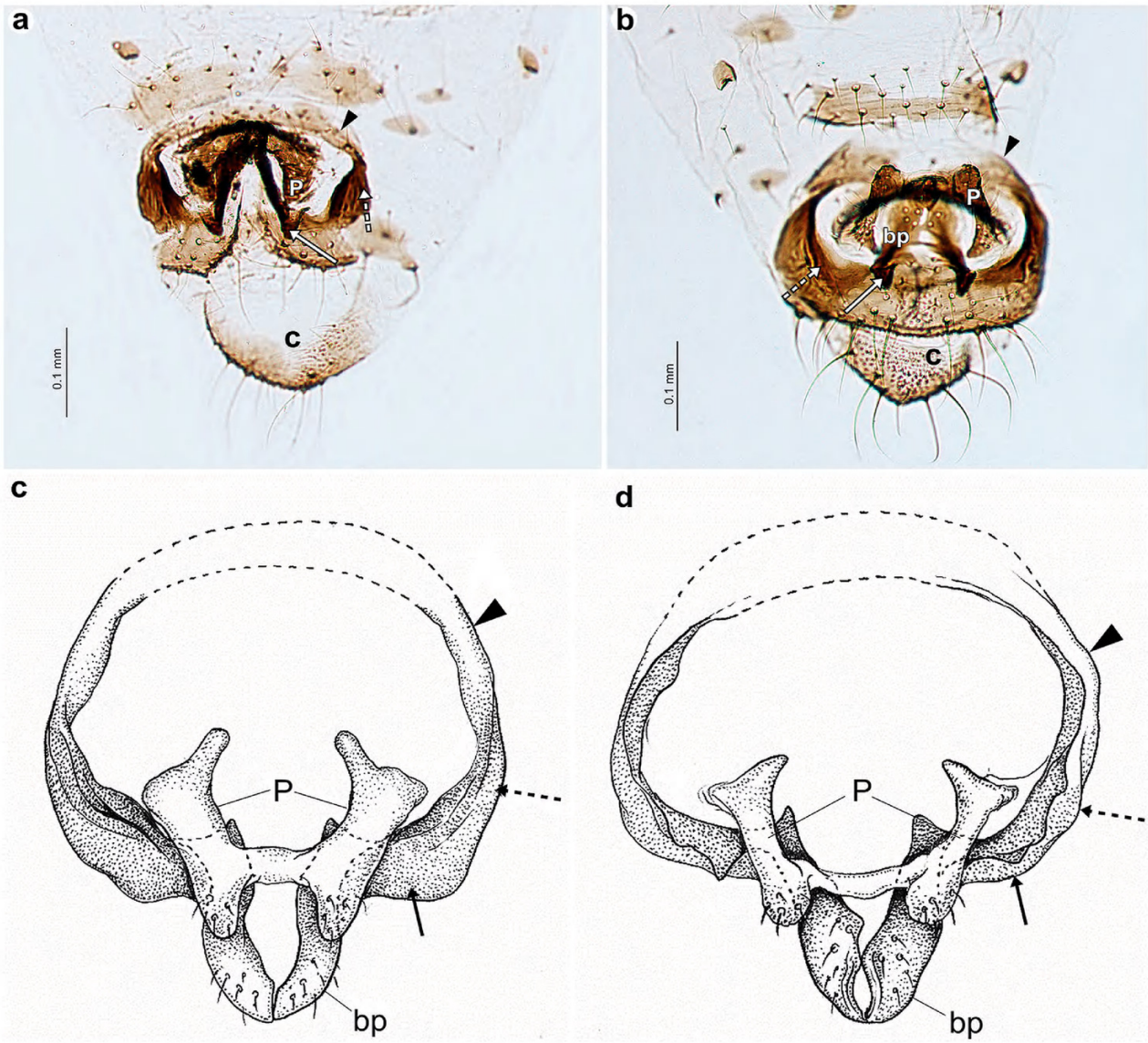

Figure 3. External male genitalia of *Eulachnus pumilae* **(a, c)** and *E. cembrae* **(b, d)**: bp –basal part of phallus with sclerotized arms consists of short proximal (solid arrow), long distal (dotted arrow) part and upper half-circle-shaped structure that surrounds the genital area (arrow-head), P – parameres, C – cauda.

veloped compound eyes, without triommatidia and with 3 well-developed ocelli. Head width 0.23–0.24 times length of antennae. Head chaetotaxy: dorsal side with 11, ventral side with 10 blunt setae, 0.045–0.075 mm long. Head setae arising from well-developed and light brown, oval scleroites. Antennae (Fig. 2h, i) 6-segmented, 0.78–0.81 times length of body. Ant. segm. III (Fig. 2h) shorter than segm. IV+V+VI, with 80–120 secondary rhinaria. Ant. segm. IV (Fig. 2h) shorter than ant. segm. V, with 29–42 secondary rhinaria. Ant. segm. V (Fig. 2i) longer than ant. segm. VI, with 1 rounded primary rhinarium at apex, with little developed sclerotic rosette and 23–38 secondary rhinaria. All secondary rhinaria on ant. segm. III-V small and rounded, situated on whole length and surface of segment. Ant. segm. VI (Fig. 2i) with short VIb, 0.19–0.24 times VIa, with 1 rounded or oval primary rhinarium with little sclerotic rosette, 4–5 accessory rhinaria situated close to each other in about ⅔ of length of segment and 4–10 small and rounded secondary rhinaria, situated behind VIa. Other antennal ratios: VI:III 0.45–0.51, V:III 0.60–0.71, IV:III 0.50–0.62. Antennal chaetotaxy: segm. I with 4–5 setae, segm. II with 5–6 setae, segm. III with 14–17 setae, segm. IV with 6–11 setae, segm. V with 12–15 setae, segm. VI with 6–7 basal, 5–6 apical and without subapical setae. Ant. segm. III-IV with short, blunt or spatulate setae. Ant. segm. VI with short and pointed setae. Longest seta on ant. segm. III 0.62–0.67 times BD III. Rostrum reaching meso- or metasternum. ARS blunt, with very short apical part (Fig. 2j), 0.12–0.14 times ant. segm. III, 0.27–0.29 times ant. segm. VI and 0.32–0.40 times HT II, with 6 primary and without accessory setae. Dorsal side of thorax covered by fine and pointed setae, 0.012–0.025 mm long. Media with 1 fork. Hind legs long, covered by blunt and pointed setae, not longer than width of tibiae. Basal length of HT I 0.26–0.31 times dorsal, 0.21–0.23 times ventral and 0.68–0.80 times intersegmental length, with 2 dorsal

and 14 ventral, pointed setae (Fig. 2k). HT II 0.35–0.38 times length of ant. segm. III and 0.72–0.83 ant. segm. VI. Dorsal side of abdomen membranous with pointed setae, on abd. segm. I–VI 0.017–0.025 mm long, on segm. VII–VIII 0.032–0.052 mm long. Spinal setae arranged in two pairs on each segment arising from oval scleroites (Fig. 2l). Siphunculi very low with narrow cone-shaped base. Abd. segm. VI and VII sclerotised on whole surface. Cauda broadly rounded with numerous long, fine and pointed setae and very short spinules. Parameres present, located above basal part of phallus, clearly visible, basally fused. Their lobate parts, capitate in shape, arise into distinct, forceps-like projection toward base of phallus. Parameres dark pigmented, with numerous long setae on entire surface. Basal part of phallus club-shaped, brown, with few short setae in middle part. Sclerotized arms clearly visible, strongly sclerotized, dark pigmented. Proximal part robust and ends in triangular apex, distal part thinner. Sclerotized arms form upper half-circle-shaped structure that surrounds genital area (Fig. 3b, d).

Host plants. *Pinus cembra* (Binazzi 1978, 1984; Börner 1950, 1952; Börner and Franz 1956; Barbagallo and Patti 1994; Chumak 2004; Heinze 1962; Kanturski and Wieczorek 2014; Pašek 1952, 1954; Pintera 1968; Roberti 1993; Szelegiewicz 1962a, 1962b, 1968, 1978; Tashev 1985), *P. peuce* (Tashev 1985), *P. strobus* (Chumak 2004).

Distribution. Austria (Börner 1950, 1952; Börner and Franz 1956; Heinze 1962; Pintera 1968), Bulgaria (Tashev 1985), Italy (Barbagallo and Patti 1994; Binazzi 1978, 1984; Roberti 1993), France (MNHN collection), Poland (Szelegiewicz 1962a, 1962b, 1968, 1978; Kanturski and Wieczorek 2014), Slovakia (Pašek 1952, 1954), Switzerland (BMNH collection, MZLU collection), Ukraine (Chumak 2004).

Discussion

Aphids are a group of hemipterans whose classification is still controversial, as evidenced by uncertainties about the identity of many species in this group of insects (Blackman and Eastop 1994; Heie 1995). Many of these uncertainties at species level in aphid taxonomy might be resolved by studying morphs other than apterous and alate viviparous females, especially the sexual generation (i.e. oviparous females and males), which have strictly-established species characters and are likely to vary much less than the parthenogenetic forms (Hille Ris Lambers 1966; Wieczorek et al. 2013b).

The genus *Eulachnus* as a whole is an example for a group of aphids which needs revision, because many of the characters that have been used in species discrimination are subject to environmental influences (Blackman and Eastop 2014). This also applies to *E. cembrae*, *E. pumilae* and *E. piniarmandifoliae* Zhang from China, which form a separate group within the genus *Eulachnus* characterized by the absence of dorsal scleroites at the base of thoracic and abdominal setae. The type species of the discussed genus, *E. agilis* (Kaltenbach), as well as other European and Asiatic species, are identified by the presence of numerous scleroites with setae of various lengths and shapes on the dorsal side of the abdomen. On the generic level, this specific character occurs also in sexual morphs: oviparous females of *E. pumilae* and *E. cembrae* (sexual forms of *E. piniarmandifoliae* are unknown) can be easily recognized by the absence of dorsal sclerites and scleroites on the abdomen whereas in males only spinal scleroites with short setae are present on the abdomen. Those two species are similar with respect to the absence of the dorsal sclerotization of the thorax and the abdomen, but otherwise they significantly differ with respect to both morphological and biometric characters. In particular, sexual forms of *E. pumilae* possess two accessory setae on the ARS, as mentioned by Remaudière and Remaudière (1997), but also longer setae on the head, antennae and the abdomen. Oviparous females of *E. pumilae* differ from those of *E. cembrae* with respect to the ratios of body length to antennal length, and also with respect to individual ratios of HT I basal, dorsal, ventral and intersegmental length; measuring those ratios is always a good method to distinguish closely related species, especially in the tribe Eulachnini (Szelegiewicz 1978; Heie 1995). The oviparous females also differ by the number of pseudosensoria on the hind tibiae (Table 2), which is one of the most easily recognizable characters of parthenogenetic and sexual aphid females. The alate males of *E. pumilae* and *E. cembrae* differ significantly with respect to the number of secondary rhinaria on antennal segments III, IV and VI and the ratios of the ARS to the antennal segments VI or HT II (Table 3). As males are the rarest morphs of aphids, appearing only for a short period of time, the taxonomic value of the characters of their genitalia has not been fully exploited as yet. However, a comparative, systematic study of the male genitalia of the Aphididae has revealed a number of characters that may potentially be useful in discussions on the phylogenetic relationships, species identity and identification of these insects (Wieczorek et al. 2011, 2012, 2013a). *E. pumilae* and *E. cembrae*, as most Lachninae, belong to a group of aphids with strongly modified genitalia, with parameres divided into lobate parts arising into projections, a well-developed basal part of the phallus and sclerotized arms forming the upper half-circle-shaped structure that surrounds the genital area (Wieczorek et al. 2012). On the species level, the shape of paramere projections (finger-like in *E. pumilae*, forceps-like in *E. cembrae*), the basal part of the phallus (crescent-shaped in *E. pumilae*, club-shaped in *E. cembrae*), and especially the structure of sclerotized arms (distal part robust, strongly flattened with a thorn-like process located on the inner edge in *E. pumilae* and thin in *E. cembrae*) are key characters in the identification of *E. pumilae* and *E. cembrae*.

According to Fauna Europaea (Nieto Nafría et al. 2014) *E. pumilae* is a European species, recorded from Slovakia. The checklist of Aphidomorpha from Slovakia (Goffova and Wojciechowski 2013) also reported this species. Goffova and Wojciechowski (2013) cited

the paper of Pašek (1952), whereas in this work on the genus *Eulachnus* (*Protolachnus* in the original) only *E. agilis*, *E. bluncki* (= *E. rileyi*), *E. nigricola* and *E. cembrae* were listed. The record of *E. pumilae* in Slovakia given by Fauna Europaea cites probably Holman and Pintera (1977), where the authors treated *E. cembrae* as a synonym of *E. pumilae*. The latter record from Ukraine presented by Mamontova (2012) should also be treated as *E. cembrae*. In the description as well as in the figure the author presents the apterous viviparous female with ARS without accessory setae, which is the key character to distinguish these two species. Moreover, the characters of sexual morphs overlap with features of *E. cembrae*. Thus all records of *E. pumilae* in Europe are in fact records of *E. cembrae*, and *E. pumilae* does not occur in Europe.

Separateness of these two similar species is also reflected by their biology: *E. cembrae* is a European species, recorded mostly from locations in central European mountain ranges (the Alps, the Carpathians) (Börner 1950; Heinze 1962; Pašek 1952; Szelegiewicz 1968; Chumak 2004). It may also occur in other, submontane regions (e.g. artificial plantings of *P. cembra* in Zakopane, Poland (Szelegiewicz 1978) or in the Botanical Garden in Cracow (Kanturski and Wieczorek 2014)). *E. pumilae*, on the other hand, should be treated as an East Palaearctic species, recorded from Japan, Korea, India and East Siberia (Inouye 1939, 1970; Szelegiewicz 1974; Ghosh 1982; Pashchenko 1988; Lee et al. 1994). Host plants of both species mostly belong to the subsection *Cembrae* of the *Pinus* section *Strobus*. *E. cembrae* is always associated with the Swiss stone pine *P. cembra* and occasionally with *P. strobus* (Holman 2009), whereas *E. pumilae* is associated with *P. koraiensis*, *P. parviflora*, *P. pentaphylla*, *P. pumila* and *P. strobus* (Blackman & Eastop, 2014). Recent molecular studies have shown that *P. cembra* is clearly separated from the closely related *P. koraiensis*, *P. parviflora* and *P. pumila* which form a distinct clade (Liston et al. 1999; Wang et al. 1999; Gugerli et al. 2001).

Detailed morphological and biometric analysis of the sexual morphs of the studied species, including type material of *E. cembrae* designated by Börner, supported by biological data, definitely distinguish the studied species as separate taxa.

Key to oviparous females of *E. cembrae* and *E. pumilae*.

1. Ant. segm. VI/ant. segm. III 0.38–0.53. ARS without accessory setae. Hind tibiae with 32-58 pseudosensoria ..... *E. cembrae* Börner
– Ant. segm. VI/ant. segm. III 0.58–0.61. ARS with two accessory setae. Hind tibiae with 100-105 pseudosensoria ..... *E. pumilae* Inouye

Key to alate males of *E. cembrae* and *E. pumilae*.

1. Antennae length/body length 0.78–0.81. ARS without accessory setae. Ant. segm. IV with 29-42 accessory rhinaria .... *E. cembrae* Börner
– Antennae length/body length 0.69–0.71. ARS with two accessory setae. Ant. segm. IV with 55-64 accessory rhinaria... *E. pumilae* Inouye

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