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# Species concepts in the psyllid genus *Camarotoscena* (Hemiptera, Psylloidea) associated with *Populus* (Salicaceae)

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## Abstract

The temperate Palaearctic genus *Camarotoscena* (Liviidae, Liviinae) is revised to contain 10 species confirming previous morphology-based species concepts. The results of the molecular analyses were only partly conclusive, as the barcoding genes used (*COI* and *cytb*) did not provide sufficient resolution to recognise all species. Both markers showed no differences between the taxa in two species pairs: *C. fulgidipennis* – *C. hoberlandti* and *C. speciosa* – *C. subrubescens*, while *cytb* also failed to distinguish *C. trjapitzini* from *C. fulgidipennis* – *C. hoberlandti*. Morphological characters of fifth instar immatures, available for half of the species, supported the species diagnosed by adult characters. Five new synonymies are proposed: *Camarotoscena subrubescens* (Flor 1861b) = *C. ujenci* Klimaszewski (1982), **syn. nov.**; *Camarotoscena bianchii* Loginova (1975b) = *C. pamirica* Baeva (1983a), **syn. nov.**, = *C. wulingshanica* Li (2011), **syn. nov.**, = *C. wutaishanica* Li (2011), **syn. nov.**, = *C. xinjiangica* Li (2011), **syn. nov.** The previously unknown female of *C. lauta* is diagnosed and its terminalia are illustrated. Illustrated identification keys are provided for the adults and, where known, for the fifth instar immatures. New country records are provided for *C. fulgidipennis* (India: Ladakh), *C. hoberlandti* (India: Ladakh), *C. lauta* (Turkey: Ankara) and *C. trjapitzini* (Iran: Tehran, Yazd; Spain). The record of *C. hoberlandti* from Jordan is a misidentification of *C. trjapitzini*. All species are, as far as known, narrowly oligophagous on *Populus* spp. (Salicaceae), and the immatures induce leaf roll galls.

## Key Words

DNA barcodes, jumping plant lice, Liviidae, new country records, poplar, Sternorrhyncha, taxonomy

## Introduction

*Populus* constitutes a predominantly temperate and, to a lesser extent, subtropical and tropical genus of Salicaceae with some 60 recognised species, in addition to many hybrids (POWO 2025). Some species or hybrids of these deciduous, broad-leaved trees are widely planted for timber, fuel, wind breaks or animal fodder (Isebrands and Richardson 2014; Mi et al. 2025). In some mountain areas of India, such as Ladakh, poplars are among the principal cultivated tree species (Mallon and Prodon 1995). Unsurprisingly, several insect species, mostly Coleoptera and Lepidoptera, inflict major damage to poplar plantations (Charles et al. 2014). Among the sap-sucking Sternorrhyncha developing on *Populus* are also psyllids, namely the species of the genera *Camarotoscena* Haupt, 1935 (Liviidae, Liviinae) (Fig. 1A–D) and *Egeirotrioza* Boselli, 1931 (Triozidae), as well as one species of *Anomoterga* Klyver, 1932, viz. *A. unicolor* (Loginova, 1958) (Liviidae, Liviinae) (Ouvrard 2020; Burckhardt et al. 2024). These taxa are Palaearctic while no psyllids are known to develop on poplars in North America or sub-Saharan Africa (Ouvrard 2020).

For the study and control of any pest, a sound taxonomic base is crucial. This base is available for *Egeirotrioza* and *A. unicolor* (Loginova 1976; Burckhardt and Lauterer 1993), but the identification of *Camarotoscena* species remains problematic. *Camarotoscena* species occur in the southern latitudes of the temperate deciduous forest belt from the Mediterranean Basin to the Far East. The genus is most species-rich in the arid mountain regions of Asia (Loginova 1975b; Gegechkori and Loginova 1990; Hodkinson 2009; Burckhardt et al. 2024). Information on the distribution and biology is sketchy and sometimes inaccurate. Loginova (1975b) reviewed the genus based on adult morphological characters and provided a key for the identification of adults. She concluded that the genus is morphologically ‘monolithic’ with minor differences between species. In particular, the male and female terminalia, providing usually reliable diagnostic characters, are unusually homogeneous.

Loginova (1975b) recognised 13 species, three of which were transferred to *Diclidophlebia* Crawford, 1920 (*Camarotoscena* sp. = *D. xuani* Messi, in Messi et al., 1998) (Messi et al. 1998) or *Anomoterga* Klyver (*C. africana* Loginova, 1975 and *C. unicolor*) (Burckhardt et al. 2024). Li and Yang (1989) described *Camarotoscena huashana* Li & Yang, 1989, which was synonymised with *C. personata* Loginova, 1975 (Burckhardt and Mifsud 2003). *Camarotoscena ujenci* Klimaszewski, 1982 was erected for two males from Mongolia (Klimaszewski 1982). Baeva (1983a) added a species from Tadzhikistan (*Camarotoscena pamirica* Baeva, 1983) and Li (2011) three species from China (*Camarotoscena wulingshanica* Li, 2011, *C. wutaishanica* Li, 2011, *C. xinjiangica* Li, 2011), all four based on one or two females only. The three species from China were synonymised with *C. bianchii* Loginova, 1975 by Luo (2016) in his Ph. D. thesis, a nomenclatural act which is not valid according to the ICZN (1999: Article 8). The 12 currently recognised species are probably oligophagous on *Populus* and possibly induce roll galls on the poplar leaves (Conci et al. 1993) (Fig. 1E–H). The fifth instar immature has been described only for *C. speciosa* (Flor, 1861) (Ossiannilsson 1992; Luo 2016). It is not uncommon that closely related psyllid species develop on the same plant species and often on the same plant individual (Burckhardt and Queiroz 2020; Burckhardt 2021). In *Camarotoscena*, the two species pairs *C. speciosa* and *C. subrubescens* (Flor, 1861) (Flor 1861a, b; present paper) as well as *C. fulgidipennis* Loginova, 1975 and *C. hoberlandti* Vondráček, 1952 (present paper) have been collected together, some possibly on the same plants.

For psyllids, as for other insects, DNA barcoding is a useful and relatively quick and inexpensive tool broadly used for species identification (Cho et al. 2020; Chen et al. 2023; Choi et al. 2025), especially when morphological and ecological data provide insufficient diagnostic characters. A 3% cytochrome c oxidase subunit I (*COI*) threshold is commonly applied for species delimitation (Martoni et al. 2018; Cho et al. 2020; Pramatarova et al. 2024), although divergence levels can vary between and even within genera. This marker has been successfully used to delimit species of several genera from all seven currently recognised psyllid families, although with some exceptions. For example, the genetic difference in *COI* was <1% between the morphologically similar *Aphalara avicularis* Ossiannilsson, 1981 and *A. freji* Burckhardt & Lauterer, 1997 (Aphalaridae) (Pramatarova et al. 2024), while the intraspecific difference reached up to 14% between specimens from the same or different populations in several *Melanastera* species (Liviidae) (Serbina et al. 2025). Similar patterns were encountered with the cytochrom b (*cytb*) marker, which is often more variable and less frequently used for delimitating thresholds, but which generally supports the same species-level clusters as *COI* (Percy 2018). Although species of *Camarotoscena* have never been compared using DNA barcodes, sequences of three species are already available (Burckhardt et al. 2024).

In the current study, we review *Camarotoscena* by comparing the results from morphological and molecular analyses. As species in this genus are morphologically homogeneous, we examine whether DNA barcodes provide more reliable means of identification and whether their genetic divergences show congruence with morphological boundaries. We provide identification keys to adults and, where known, to fifth instar immatures. Illustrations are provided for selected species.

## Material and methods

### Depositories of studied material

Material from the following institutions was examined: **BFUS**—Zoological Collection of the University of Sofia, Sofia, Bulgaria; **CAU**—China Agricultural University, Beijing, China; **MHNG**—Muséum d’histoire naturelle, Geneva, Switzerland; **MMBC**—Moravian Museum, Brno, Czechia; **NHMB**—Naturhistorisches Museum, Basel, Switzerland.

**Figure 1.** *Camarotoscena* spp. **A–D.** Living adults on *Populus*; **E–H.** Galls on *Populus nigra*. **A, B, G.** *C. speciosa*; **C, H.** *C. subrubescens*; **D.** *Camarotoscena* sp. with colour pattern intermediate between *C. speciosa* and *C. subrubescens*; **E, F.** *C. fulgidipennis* and *C. hoberlandti*. Photos **A, D** by M. Pramatarova; **B, C, G, H** by S. Grimaud; **E, F** by C. Haseen.

## Terminology and conventions

The morphological terminology accords with Bastin et al. (2023a). The surface spinules on the forewings were examined with a dissecting microscope at 50–100 times magnification. The total body length corresponds to the distance measured between the fore margin of head and the tip of forewings when folded over body taken from dry mounted or ethanol preserved specimens; the other measurements were taken from slide mounted specimens. In the fifth instar immature, the caudal plate bears three transverse rows of irregularly spaced and unevenly long normal setae as well as pointed sectasetae. They are named basal, medial and apical row of setae (Fig. 7A, B: brs, mrs and ars. Their relative length in longitudinal body direction as well as the corresponding intervals named interval I (proximal) and interval II (distal) is measured from the most basal to the most apical setal insertion in the middle of the caudal plate (Fig. 7A, B: inv I and inv II). The measurements and ratios are given as range. The psyllid nomenclature follows Ouvrard (2020) and the classification Burckhardt et al. (2021) and Burckhardt et al. (2024). Under "Distribution", only papers with primary information are cited, except for the countries of the former Soviet Union where we refer to the very thoroughly compiled catalogue of Gegechkori and Loginova (1990). The plant nomenclature accords with POWO (2025).

## Molecular analyses

DNA was extracted from specimens of *Camarotoscena fulgidipennis* (India), *C. hoberlandti* (India), *C. speciosa* (China, Czechia) and *C. subrubescens* (Bulgaria) using kits Qiagen DNeasy Blood and Tissue Kit, and Invitrogen PureLink® Genomic DNA Kit. The *COI* fragment was amplified using primer sets from Folmer et al. (1994), Bastin et al. (2023b), Simon et al. (1994) and Percy et al. (2018): LCOP-F (5'-AGAACWAAYCATAAAAYWATTGG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3'), mtd6-F (5'-GGAGGATTTGGAAATTGATTAGTTCC-3') and mtd9-R (5'-CCCGGTAAAATTAAAATATAAACTTC-3'). Amplification followed standard cycling conditions: 94 °C for 3 min; 40 cycles of 92 °C for 30 s, 55 °C for 30 s and 72 °C for 1 min, producing amplicons of 492–658 bp. Sequencing was performed either on an AML-part Prism 3130 Genetic Analyzer (Applied Biosystems), or in-house with Oxford Nanopore Technologies (ONT) Flongle R10.4.1 Flow Cell on a GridION using the SQK-LSK114 Ligation Kit. ONT sequences were processed with ONTBarcoder, following procedures developed by Srivathsan et al. (2021). The *cytb* fragment was amplified using the primer set from Timmermans et al. (2010) and Percy et al. (2018): cytBf (5'-TGAGGNCAAATATCHTTYTGA-3') and cytBr (5'-GCAAATARRAARTATCATTCDG-3'), producing a 385 bp amplicon. PCR conditions were as follows: 94 °C for 3 min; 40 cycles of 92 °C for 30 s, 53 °C for 30 s and 72 °C for 1 min. DNA extraction, amplification and sequencing of the *COI* fragment from Bulgarian specimens of *C. speciosa* were performed at the Canadian Centre for DNA Barcoding (CCDB).

The *COI* and *cytb* sequences of both *C. fulgidipennis* and *C. trjapitzini* from Jordan, and *C. speciosa* from Czechia, published by Burckhardt et al. (2024), were downloaded from GenBank.

The sequences were aligned and trimmed manually using MEGA v11 (Tamura et al. 2021). The genetic distances between the *COI* and *cytb* gene fragments of the *Camarotoscena* species were compared using the Kimura 2-parameter (K2P) model. The tree was inferred using Maximum Likelihood (ML) method implemented in IQ-TREE v3.0.1, with 1000 bootstrap replicants (Trifinopoulos et al. 2016). *Aphalara avicularis* (Aphalaridae) was used as the outgroup, with its sequences retrieved from GenBank under the following accession numbers: *COI* (PQ109737) and *cytb* (PQ100054). The resulting tree was visualized using iTOL v7 (Letunic and Bork 2024). Numbers at nodes indicate bootstrap support (BS) values.

The accession numbers for the *COI* and *cytb* gene fragments of the analysed *Camarotoscena* species are presented in Table 1.

# Results

## Taxonomy based on morphology

### *Camarotoscena* Haupt

*Camarotoscena* Haupt (1935): 228; Type species: *Rhinocola speciosa* Flor, 1861, by original designation.

**Diagnosis.** Adult and fifth instar immature by Burckhardt et al. (2024).

**Table 1.** GenBank numbers with information on locality, date, plant species, collector and depository of voucher for the *Camarotoscena* specimens used for the molecular analysis. Accession numbers in bold indicate specimens sequenced in the current study (others were published by Burckhardt et al. 2024). The specimen listed as *C. hoberlandti* in table S1 in Burckhardt et al. (2024) was re-examined in the current study and is identified here as *C. trjapitzini*.

| Species | GenBank numbers | | Locality | Date | Plant species | Collector | Depository |
|---|---|---|---|---|---|---|---|
| | *COI* | *cytb* | | | | | |
| *C. fulgidipennis* | **PX236524** | **PX238426** | India, Ladakh, Leh | 26.vii.2024 | *Populus nigra* | C. Haseen | NHMB |
| *C. fulgidipennis* | MW119582 | MW119611 | Jordan, Mafraq, Mafraq | 23.x.1995 | *Populus* sp. | M. Al-Khawaldeh | NHMB |
| *C. hoberlandti* | **PX236523** | **PX238427** | India, Ladakh, Leh | 26.vii.2024 | *P. nigra* | C. Haseen | NHMB |
| *C. trjapitzini* | MW119583 | MW119612 | Jordan, Balqa, Baqa | 3.ix.1995 | *Populus* sp. | M. Al-Khawaldeh | NHMB |
| *C. speciosa* | MW119577 | MW119607 | Czechia, South Moravia, Brno-Královo Pole | 4.x.2017 | *P. × canadensis* | I. Malenovský | MMBC |
| *C. speciosa* | **PX249571** | **PX262424** | China, Xinjiang | 12.vii.2025 | *P. alba* | Z. He | CAU |
| *C. speciosa* | **PX367177** | – | Bulgaria, Maleshevska Planina Mt., Peyo Yavorov train station | 8.v.2022 | *Populus* sp. | M. Pramatarova | BFUS |
| *C. subrubescens* | **PX236522** | **PX238425** | Bulgaria, Goce Delchev (towards Ognyanovo) | 13.viii.1972 | - | P. Lauterer | MMBC |
| *Camarotoscena* sp. | **PX367178** | **–** | Bulgaria, Western Stara Planina Mt., Dragoman marsh | 28.vii.2023 | *Populus* sp. | M. Pramatarova | BFUS |

**Character assessment.** *Camarotoscena* is morphologically very homogeneous (Loginova 1975b), both in the adult and immature stages. **Adults**. Body colour in most species ochreous or light brown with irregularly spaced small brown to dark brown dots (Fig. 2A, D, J, M, P) and whitish or yellowish forewings with sparser or denser small brown dots (Fig. 2B, E, K, N, Q); according to Loginova (1975b), the dark pattern is reduced in young specimens, an observations we could not confirm; the dark colour in young specimens is lighter but not reduced. In *C. subrubescens* Flor, 1861 and *C. trjapitzini* Loginova, 1968, the colour of the body (Fig. 2G, S) and forewings (Fig. 2H, T) can be yellow or bright orange to ochreous without or with sparse dark dots (Fig. 1C). In some specimens, that we cannot assign to a particular species with certainty, the forewing pattern is intermediate between *C. speciosa* and *C. subrubescens* (Fig. 1D). In *C. trjapitzini* Loginova, 1968, the dark colour on body and forewings can be quite extensive. The forewing membrane is whitish in most species but yellow or light brown, at least in some areas, in *C. badia* Loginova, 1965, *C. fulgidipennis*, *C. hoberlandti*, *C. subrubescens* and *C. trjapitzini*. The body length ranges usually between 2.0–2.5 mm with some specimens smaller or larger. Only *C. lauta* Loginova, 1975 is distinctly larger with 2.8–3.2 mm body length. The integument of the head and thorax is irregularly reticulate (in *C. lauta*, *C. personata*, *C. speciosa*). Sometimes the reticulation on the vertex is slightly reduced (in *C. fulgidipennis*, *C. subrubescens*) or completely absent (in *C. hoberlandti*). The forewing membrane is semi-transparent in *C. badia*, *C. fulgidipennis* and *C. trjapitzini* but subopaque in the other species. The surface spinules on the forewing are mostly very dense (Fig. 2L, O, R, U) and can be coarser as in *C. speciosa* (Fig. 2R) or finer as in *C. subrubescens* (Fig. 2U). The surface spinules are sparser in *C. hoberlandti* and *C. trjapitzini* where they form sometimes transverse rows (Fig. 2F, I) and in *C. fulgidipennis* were they form small groups of two to four spinules (Fig. 2C). In most species the male proctiger is tubular and widest in basal third; only in *C. lauta* (Fig. 4A) and *C. personata* (Fig. 4D) the male proctiger has posterior lobes and is, in lateral view, widest in the middle. The male subgenital plate is subspherical in most species (Figs 3A, F, K, 4D, G, J) but elongate in *C. lauta* (Fig. 3A). In most species, the paramere, in lateral view, is digitiform with a bend in the middle (Figs 3B, D, G, I, L, 4H, K) but it is lamellar in *C. lauta* and *C. personata* (Fig. 4B, E). The female proctiger is usually cuneate with the dorsal outline almost straight and the apex subacute; the apical third is covered with moderately long setae (Fig. 5A–D, G, H). In *C. lauta*, the dorsal margin of the proctiger, in lateral view, is concave and the apical third covered with short bristles, distinctly shorter than those in basal third laterally (Fig. 5F). The female subgenital plate, in lateral view, is in most species irregularly cuneate with a short apical process (Fig. 5A–C, G, H). In *C. personata* the apical process is long (Fig. 5D). In *C. bianchii* and *C. lauta* the subgenital plate is, in lateral view, square (Fig. 5E) or subtrapezoidal (Fig. 5F), respectively. **Fifth instar immature**. Immatures are known only of five species: *C. fulgidipennis*, *C. hoberlandti*, *C. speciosa*, *C. subrubescens* and *C. trjapitzini* (Fig. 6A–E). The dorsal sclerites on the head, thorax and abdomen are brown to dark brown in most species (Fig. 6A, C–E) but light in *C. hoberlandti* (Fig. 6B). In *C. fulgidipennis*, *C. hoberlandti* and *C. trjapitzini*, the setae on the dorsal surface of the forewing pads are sparser and slightly shorter and sectasetae are almost completely absent (Fig. 6F); in *C. speciosa* and *C. subrubescens* the dorsal setae are more numerous, denser and slightly longer with more sectasetae (Fig. 6G–I). The caudal plate consists of three transverse rows of irregularly spaced setae and sectasetae (Fig. 7A–E). Their relative length in longitudinal body direction and that of their intervals varies between species. The ventrite bearing the circumanal ring is strongly sclerotised and well-delimited anteriorly in *C. speciosa* and *C. subrubescens* (Fig. 7F) but unsclerotised and not clearly delimited anteriorly in the other species (Fig. 8A–C).

## Key to adults

1 Surface spinules of forewing in cell $r_2$ at the level of bifurcation of vein M irregularly or sparsely spaced (Fig. 2C, F, I) ...... 2

– Surface spinules of forewing in cell $r_2$ at the level of bifurcation of vein M evenly, densely spaced (Fig. 2L, O, R, U) .... 4

2 Surface spinules of forewing in cell $r_2$ at the level of bifurcation of vein M coarse, irregularly spaced, forming groups of two to four (Fig. 2C). Paramere, in lateral view, rather curved along fore margin (Fig. 3B, D, arrow) ......... *C. fulgidipennis*

– Surface spinules of forewing in cell $r_2$ at the level of bifurcation of vein M fine and sparsely spaced, not forming groups (Fig. 2F, I). Paramere, in lateral view, relatively angular along fore margin (Fig. 3G, I, L, arrow) .................................. 3

3 Body and forewings densely covered in brown or dark brown dots; forewing with cells $r_1$ and $r_2$ mostly dark (Fig. 2D, E) ........................................................................................................................................ *C. hoberlandti*

– Body and forewings often lacking brown or dark brown dots, at most sparsely, irregularly covered in dark dots; forewing with cells $r_1$ and $r_2$ mostly light (Fig. 2G, H) .......................................................................................... *C. trjapitzini*

4 Male ........................................................................................................................................................ 5

– Female ...................................................................................................................................................... 11

5 Proctiger bearing large posterior lobe which is widest in basal third (Fig. 4A, D). Paramere, in lateral view, narrowly lamellar, wide in apical third, with margins subparallel, not distinctly tapering to apex (Fig. 4B, E) ............................ 6

– Proctiger weakly produced posteriorly widest in basal fifth (Fig. 4G, J). Paramere, in lateral view, digitiform, narrow in apical third, irregularly tapering to apex (Fig. 4H, K) .................................................................................... 7

6 Large; body length > 2.7 mm. Subgenital plate elongate (Fig. 4A). Paramere, in lateral view, straight with large, well visible apical hook (Fig. 4B)........ *C. lauta*

– Small; body length < 2.2 mm. Subgenital plate subglobular (Fig. 4D). Paramere, in lateral view, weakly sinuate with small apical hook which is partly hidden by apex of paramere (Fig. 4E) ........ *C. personata*

7 Body bright orange, forewing yellowish; both without or with only sparse brown to dark brown dots (Figs 1C, 2S, T)........ *C. subrubescens*

– Body yellowish to ochreous, forewing whitish; both more or less densely covered in brown to dark brown dots (Figs 1A, B, 2P, Q)........ 8

8 Body length < 1.9 mm. Forewing with densely spaced dots, often fused ........ *C. badia*

– Body length > 2.0 mm (except for *C. speciosa*: 1.8–2.4 mm). Dots on forewing more sparsely spaced, rarely fused in the middle of wing (Fig. 1Q)........ 9

9 Vertex with, at most, few dark dots........ *C. bianchii*

– Vertex densely covered in dark dots........ 10

10 Forewing lacking broad transverse white band subapically; dark dots covering most of apical part of the wing........ *C. libera* Loginova, 1975

– Forewing with broad transverse subapical white band lacking dark dots (Fig. 2Q)........ *C. speciosa*

11 Subgenital plate truncate apically (Fig. 5E, F)........ 12

– Subgenital plate pointed apically or with apical process (Fig. 5D, G, H)........ 13

12 Dorsal margin of proctiger, in lateral view, almost straight; apical third covered with setae about as long as those in basal third laterally; subgenital plate, in lateral view, square (Fig. 5E)........ *C. bianchii*

– Dorsal margin of proctiger, in lateral view, concave; apical third covered with short bristles, distinctly shorter than those in basal third laterally; subgenital plate, in lateral view, subtrapezoidal (Fig. 5F)........ *C. lauta*

13 Subgenital plate with long apical process (Fig. 5D) ........ *C. personata*

– Subgenital plate pointed apically or with, at most, short apical process (Fig. 5G, H)........ 14

14 Body bright orange, forewing yellowish; both without or with only sparse brown to dark brown dots (Figs 1C, 2S, T)........ *C. subrubescens*

– Body yellowish to ochreous; forewing whitish, both more or less densely covered in brown to dark brown dots (Figs 1A, B, 2P, Q)........ 15

15 Body length < 1.9 mm. Forewing with densely spaced dots, often fused ........ *C. badia*

– Body length > 2.0 mm (except for *C. speciosa*: 1.8–2.4 mm). Dots on forewing sparsely spaced, rarely fused in the middle of wing (Fig. 2Q)........ 16

16 Forewing lacking broad transverse white band subapically; dark dots covering most of apical part of the wing........ *C. libera*

– Forewing with broad transverse subapical white band lacking dark dots (Fig. 2Q)........ *C. speciosa*

## Key to immatures

### (of *C. fulgidipennis*, *C. hoberlandti*, *C. speciosa*, *C. subrubescens* and *C. trjapitzini*)

1 Setae on the dorsal surface of the forewing pads relatively dense, numerous and long (Fig. 6G, H) and with several sectasetae (Fig. 6I, arrows). Ventrite bearing circumanal ring strongly sclerotised and well-delimited anteriorly (Fig. 7F, arrows); bearing a row of setae along anterior margin; venter with four transverse rows of setae between abdominal base and anterior margin of terminal ventrite (Fig. 8B)........ 2

– Setae on the dorsal surface of the forewing pads relatively sparse and short and with almost no sectasetae (Fig. 6F). Ventrite bearing circumanal ring not sclerotised and not clearly delimited anteriorly; venter, therefore, with five transverse rows of setae between abdominal base and circumanal ring (Fig. 8A) ........ 3

2 Transverse row IV of setae on abdominal venter consisting of two uneven rows of variously long setae (Fig. 8B). Antennal segment VII dark distal to third rhinarium ........ *C. speciosa*

– Transverse row IV of setae on abdominal venter consisting of one uneven row of variously long setae (Fig. 8C). Antennal segment VII light brown distal to apical rhinarium ........ *C. subrubescens*

3 Dorsal sclerites ochreous to light brown (Fig. 6B). Caudal plate with interval II longer than medial or apical row of setae (Fig. 7B)........ *C. hoberlandti*

– Dorsal sclerites brown to dark brown (Fig. 6A, E). Caudal plate with interval II as long as or shorter than medial or apical row of setae (Fig. 7A, E)........ 4

4 Caudal plate with interval II as long as medial row of setae (Fig. 7A)........ *C. fulgidipennis*

– Caudal plate with interval II shorter than medial row of setae (Fig. 7E) ........ *C. trjapitzini*

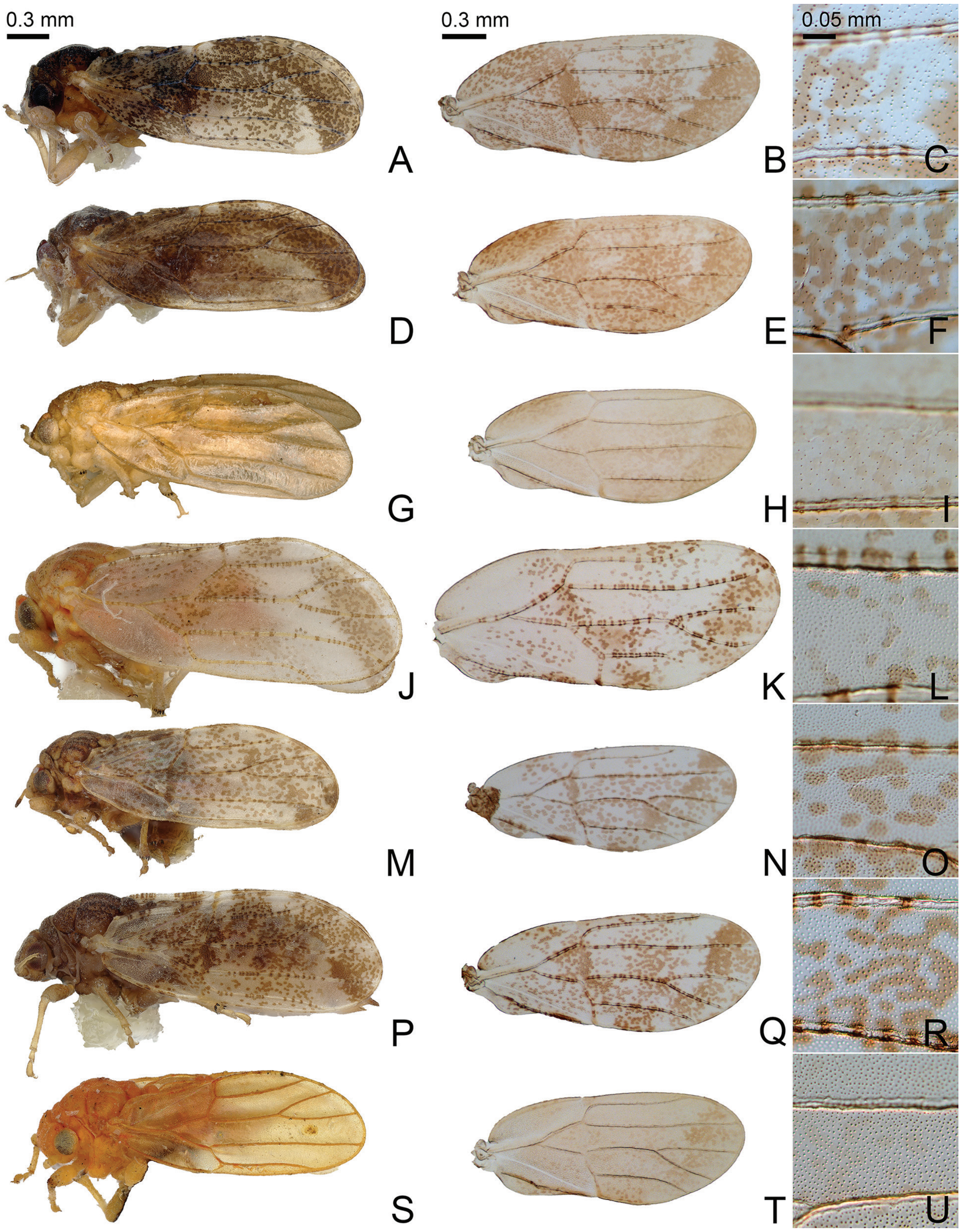

**Figure 2.** *Camarotoscena* spp. **A, D, G, J, M, P, S.** Habitus, in lateral view (scale = 0.3 mm); **B, E, H, K, N, Q, T.** Forewing (scale = 0.3 mm); **C, F, I, L, O, R, U.** Surface spinules in cell $r_2$ above the bifurcation of vein M (scale = 0.05 mm). **A–C.** *C. fulgidipennis*; **D–F.** *C. hoberlandti*; **G–I.** *C. trjapitzini*, the forewing in H is anomalous in that it lacks cell $m_1$; **J–L.** *C. lauta*; **M–O.** *C. personata*; **P–R.** *C. speciosa*; **S–U.** *C. subrubescens*.

### *Camarotoscena badia* Loginova

*Camarotoscena badia* Loginova (1965): 198.

**Description.** Adult by Loginova (1965) and Baeva (1985). Fifth instar immature unknown.

**Distribution.** Tadzhikistan (Loginova 1965; Baeva 1985; Gegechkori and Loginova 1990).

**Host plant.** *Populus usbekistanica* Kom. (Gegechkori and Loginova 1990) (Salicaceae), not confirmed by the presence of immatures.

**Biology.** Two generations per year (Gegechkori and Loginova 1990).

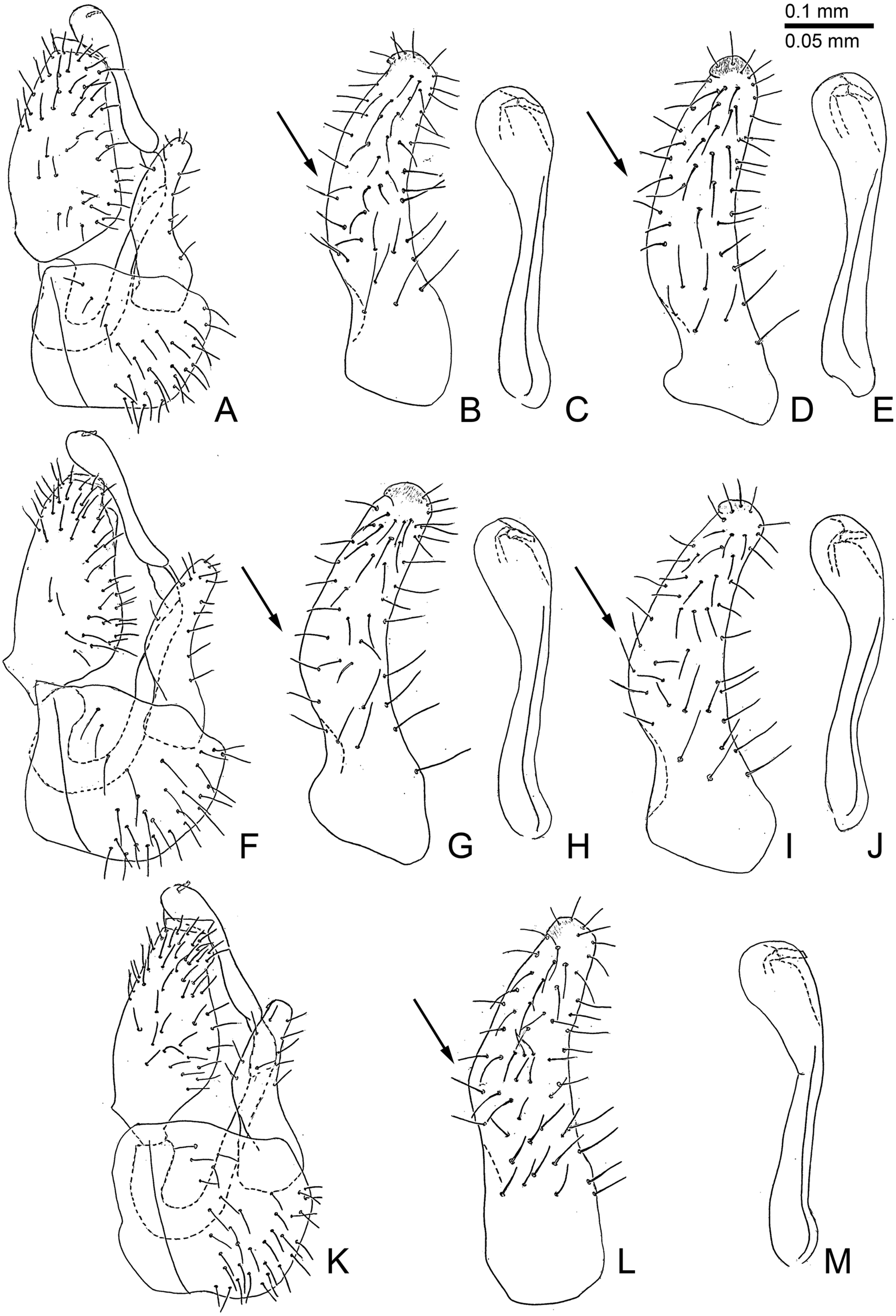

**Figure 3.** *Camarotoscena* spp., male terminalia. **A, F, F.** Male terminalia, in lateral view (scale = 0.1 mm); **B, D, G, I, L.** Paramere, inner face in lateral view (scale = 0.05 mm); **C, E, H, J, M.** Distal segment of aedeagus (scale = 0.05 mm). **A–E.** *C. fulgidipennis*, from Iran (**A–C**), from India, Ladakh (**D, E**); **F–J.** *C. hoberlandti*, from India, Ladakh (**F–H**), from Iran (**I, J**); **K–M.** *C. trjapitzini*.

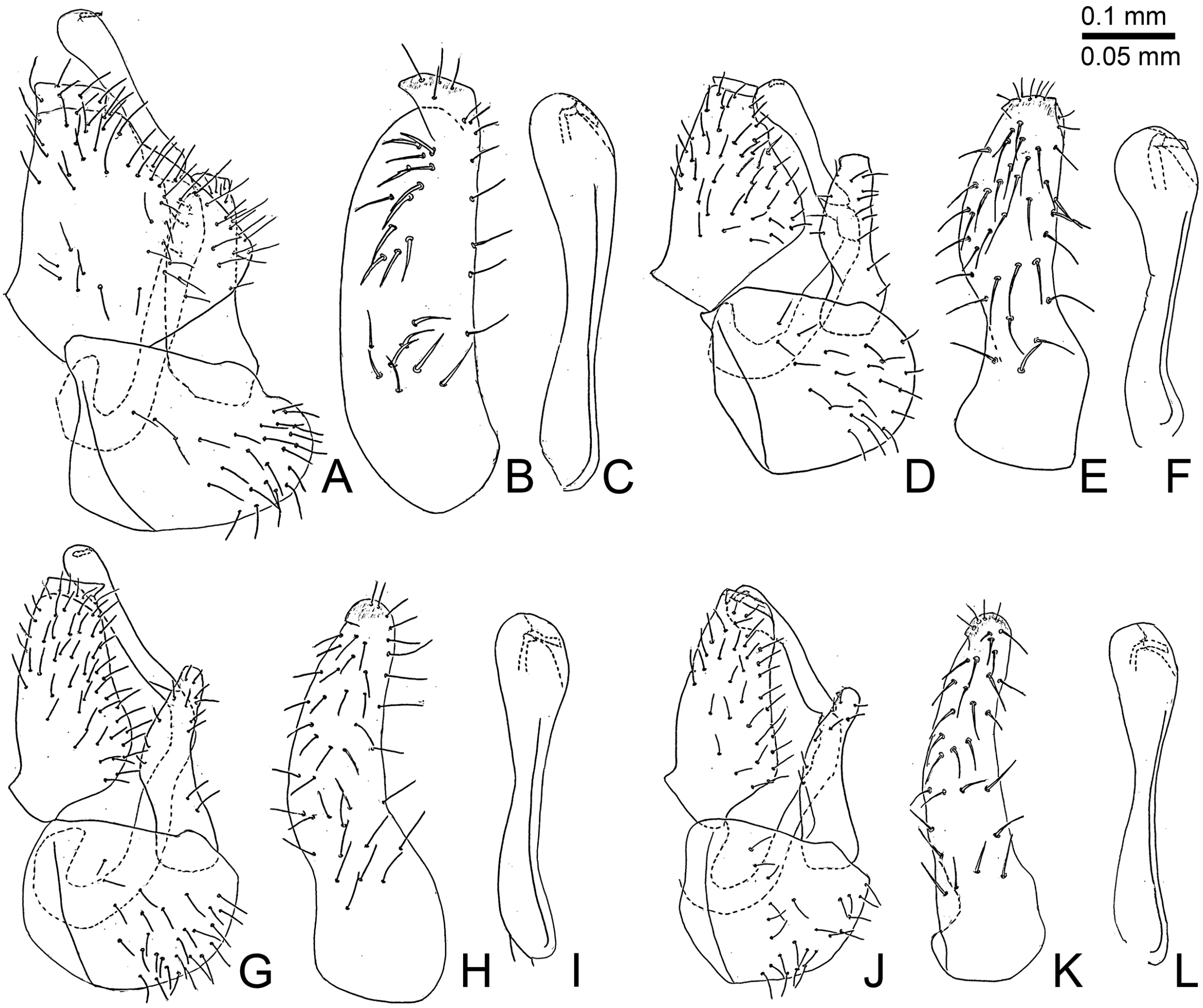

**Figure 4.** *Camarotoscena* spp. **A, D, G, J.** Male terminalia, in lateral view (scale = 0.1 mm); **B, E, H, K.** Paramere, inner face in lateral view (scale = 0.05 mm); **C, F, I, L.** Distal segment of aedeagus (scale = 0.05 mm). **A–C.** *C. lauta*; **D–F.** *C. personata*; **G–I.** *C. speciosa*; **J–L.** *C. subrubescens*.

### ***Camarotoscena bianchii*** **Loginova**

Fig. 5E

*Camarotoscena bianchii* Loginova (1975b): 56.
*Camarotoscena pamirica* Baeva (1983a): 256; syn. nov.
*Camarotoscena wulingshanica* Li (2011): 383; syn. nov.
*Camarotoscena wutaishanica* Li (2011): 384; syn. nov.
*Camarotoscena xinjiangica* Li (2011): 381; syn. nov.

**Material examined.** CHINA • ♀ holotype of *C. xinjiangica*; Xinjiang, Wulumuqi, Nanshan; 1400–2000 m a.s.l.; 19.ix.1979, leg. F. Li; CAU • ♀ holotype and 1 ♀ paratype of *C. wulingshanica*; Hebei, Xinglong, Wulingshan; 1750 m a.s.l.; leg. J. Yang; CAU • ♀ holotype of *C. wutaishanica*; Shanxi, Wutaishan, Nanshansi; 1880 m a.s.l.; 23.vii.1981; leg. F. Li; CAU.

**Description.** Description of adult by Loginova (1975b) and Luo (2016). Fifth instar immature unknown.

**Distribution.** China (Hebei, Shanxi, Xinjiang; as *Camarotoscena wulingshanica*, *C. wutaishanica*, *C. xinjiangica* (Li 2011)), Kyrgyzstan, Mongolia, Russia (Siberia, Tuva), Tadzhikistan, Uzbekistan (Loginova 1972, 1975b; Baeva 1985; Gegechkori and Loginova 1990), Tadzhikistan (as *Camarotoscena pamirica* (Baeva 1983b)).

**Host plant.** *Populus laurifolia* Ledeb., *P. usbekistanica* Kom. (Salicaceae) (Gegechkori and Loginova 1990), not confirmed by the presence of immatures.

**Comment.** *Camarotoscena bianchii* is characterised by the female subgenital plate which is square in lateral view (Fig. 5E). According to the original description by Baeva (1983a) this is also the case in *C. pamirica*. We consider the two conspecific and formally synonymise the two. The square subgenital plate is found also in *C. wulingshanica*, *C. wutaishanica* and *C. xinjiangica* which were synonymised by Luo (2016) with *C. bianchii*, synonymies which are not valid according to Article 8 of the ICZN (1999). For this reason we formally propose the synonymies here. The record of *C. speciosa* from Mongolia by Klimaszewski (1973) refers to *C. bianchii* (Gegechkori and Loginova 1990).

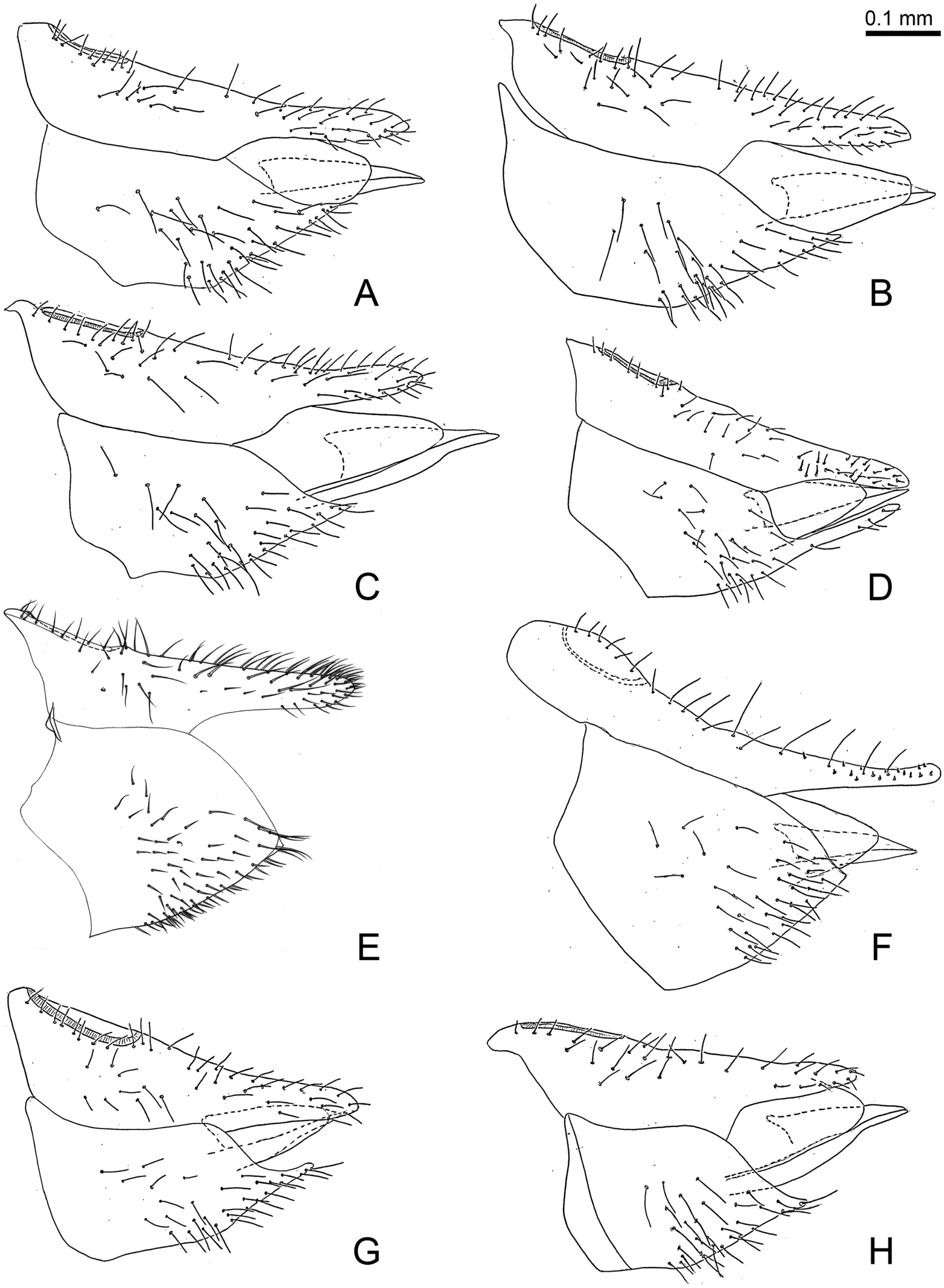

**Figure 5.** *Camarotoscena* spp., female terminalia, in lateral view (scale = 0.1 mm). **A.** *C. fulgidipennis*; **B.** *C. hoberlandti*; **C.** *C. trjapitzini*; **D.** *C. personata*; **E.** *C. badia* (del. X. Luo); **F.** *C. lauta*; **G.** *C. speciosa*; **H.** *C. subrubescens*.

### ***Camarotoscena fulgidipennis*** **Loginova**

Figs 1E, F, 2A–C, 3A–E, 5A, 6A, F, 7A, 8A

*Camarotoscena fulgidipennis* Loginova (1975b): 57

**Material examined.** INDIA • 12 ♂, 18 ♀, 4 immatures; Ladakh, Leh; 34.2167°N, 77.9500°E; 3500 m a.s.l.; 26.vii.2024; arid, cold desert; on *Populus nigra*, Salicaceae, leg. C. Haseen; dry and slide mounted, in 70% ethanol; NHMB. Additional material from Iran and Jordan; dry and slide mounted, in 70% ethanol; MHNG, NHMB.

**Description.** Description of adult by Loginova (1975b). Fifth instar immature (Fig. 6A). Dorsal sclerites on the head, thorax and abdomen brown to dark

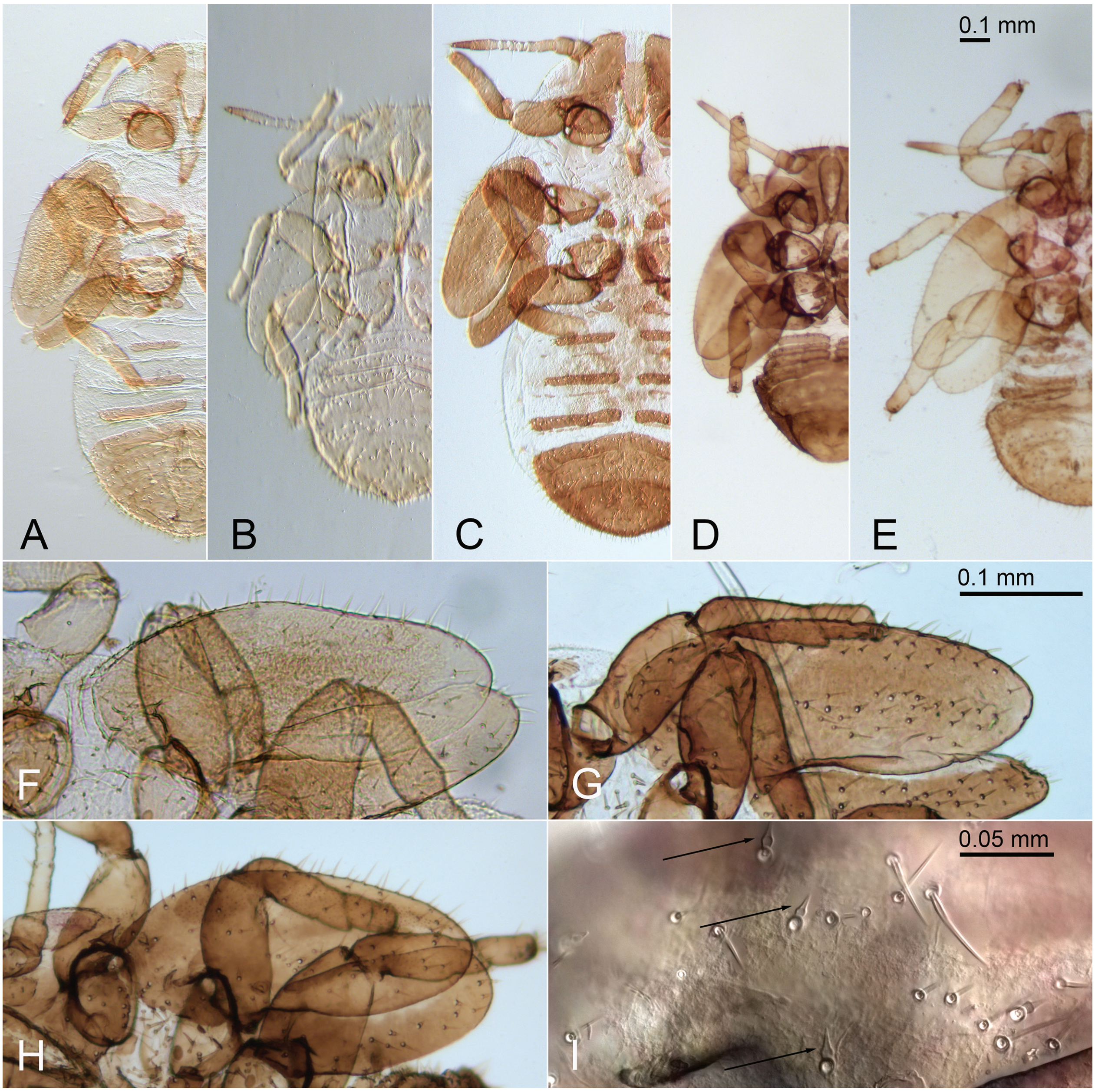

**Figure 6.** *Camarotoscena* spp., fifth instar immature. **A–E.** Dorsal view, left side (scale = 0.1 mm); **F–H.** Left forewing pad, dorsal view (scale = 0.1 mm); **I.** Detail of dorsal face of forewing pad with sectasetae (arrows) (scale = 0.05 mm). **A, F.** *C. fulgidipennis*; **B.** *C. hoberlandti*; **C, G, I.** *C. speciosa*; **D, H.** *C. subrubescens*; **E.** *C. trjapitzini*.

brown (Fig. 6A). Setae on the dorsal surface of the forewing pads relatively sparse and short and with almost no sectasetae (Fig. 6F). Caudal plate with interval II as long as medial and longer than apical row of setae (Fig. 7A). Ventrite bearing the circumanal ring unsclerotised and not clearly delimited anteriorly; venter, therefore, with five transverse rows between abdominal base circumanal ring; transverse row IV of setae on abdominal venter consisting of two uneven rows of variously long setae (Fig. 8A).

**Distribution.** Armenia, Azerbaijan, Iran, Jordan, Turkey (Loginova 1975b; Baeva 1985; Gegechkori and Loginova 1990; Burckhardt and Lauterer 1993; Al-Khawaldeh et al. 1997); new for India (Ladakh).

**Host plant.** *Populus alba* L., *P. nigra* L. (Salicaceae) (Burckhardt and Lauterer 1993), confirmed with immatures.

**Biology.** Immatures induce leaf roll galls (Fig. 1E, F). Immatures of both *C. fulgidipennis* and *C. hoberlandti* can sometimes inhabit the same gall.

### *Camarotoscena hoberlandti* Vondráček

Figs 1E, F, 2D–F, 3F–J, 5B, 6B, 7B

*Camarotoscena hoberlandti* Vondráček (1952): 445.

**Material examined.** INDIA • 6 ♂, 8 ♀, 4 immatures; Ladakh, Leh; 34.2167°N, 77.9500°E; 3500 m a.s.l.; 26.vii.2024;

arid, cold desert; on *Populus nigra*, Salicaceae, leg. C. Haseen; dry and slide mounted, in 70% ethanol; NHMB. Additional material from Iraq; dry mounted; MHNG.

**Description.** Adult by (Loginova 1975b). Adults resemble dark specimens of *C. trjapitzini*. In *C. hoberlandti*, the cells $r_1$ and $r_2$ of the forewing are mostly dark, with pigment covering more than half of the cells. In *C. trjapitzini* cells $r_1$ and $r_2$ are mostly light. Immature mentioned by Tarasi et al. (2006) but not described. Fifth instar immatures (Fig. 6B). Dorsal sclerites on the head, thorax and abdomen light (Fig. 6B). Setae on the dorsal surface of the forewing pads are relatively sparse and short and with almost no sectasetae. Caudal plate with interval II longer than medial and apical row of setae (Fig. 7B). Ventrite bearing the circumanal ring unsclerotised and not clearly delimited anteriorly; venter, therefore, with five transverse rows between abdominal base circumanal ring; transverse row IV of setae on abdominal venter consisting of two uneven rows of variously long setae.

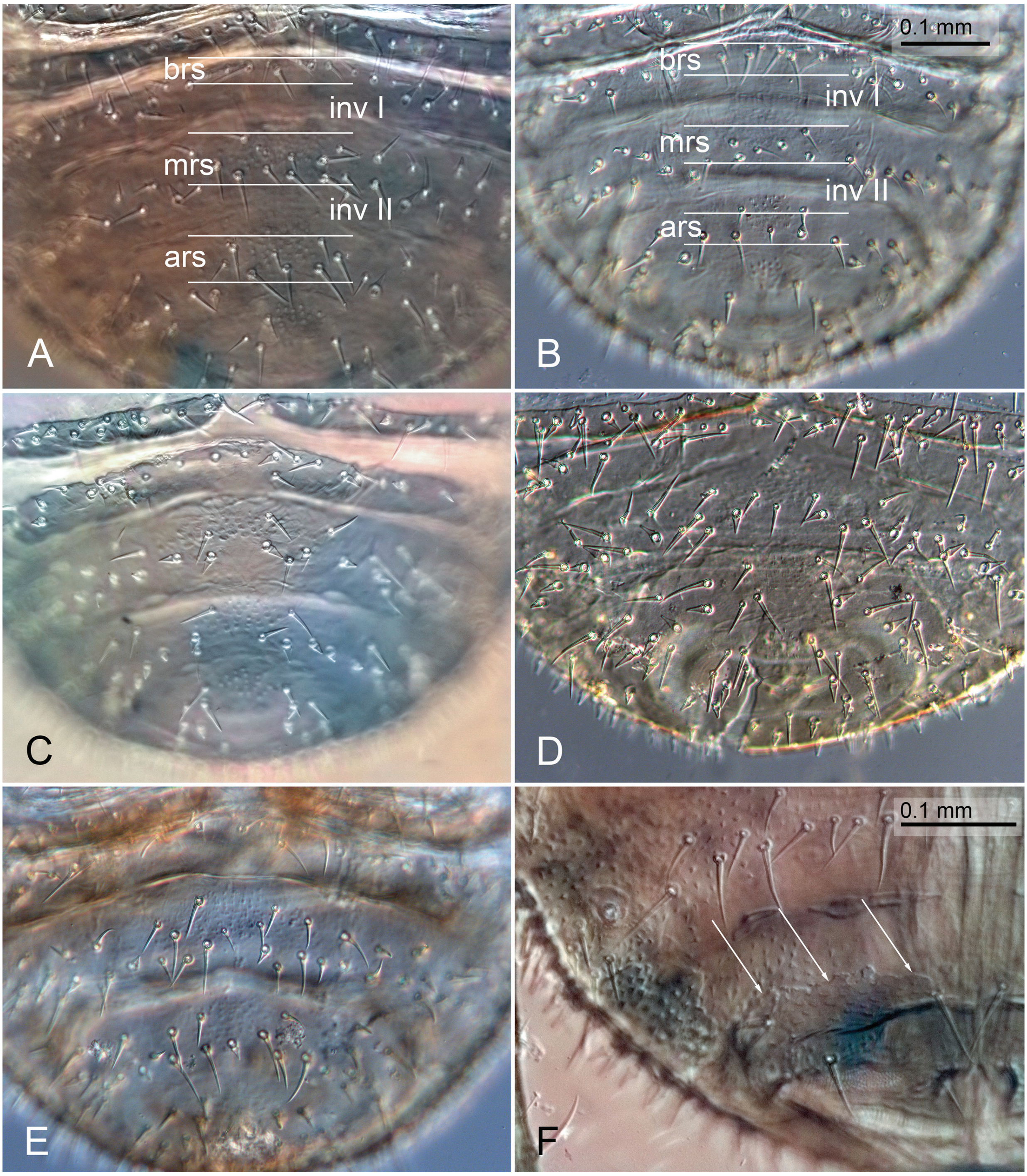

**Figure 7.** *Camarotoscena* spp., fifth instar immature. **A–E.** Caudal plate (scale = 0.1 mm); **F.** Apex of abdominal venter, anterior margin of sclerotised plate indicated by arrows (scale = 0.1 mm). **A.** *C. fulgidipennis*; **B.** *C. hoberlandti*; **C, F.** *C. speciosa*; **D.** *C. subrubescens*; **E.** *C. trjapitzini*. Abbreviations: brs, mrs and ars = basal, medial and apical row of setae.

**Distribution.** Iran, Iraq, Turkey, Turkmenistan (Vondráček 1952; Loginova 1975b; Gegechkori and Loginova 1990; Burckhardt and Lauterer 1993; Tarasi et al. 2006); new for India (Ladakh).

**Host plant.** *Populus nigra* L. (Salicaceae) (Tarasi et al. 2006), confirmed with immatures.

**Biology.** Immatures induce leaf roll galls and are considered a pest (Tarasi et al. 2006) (Fig. 1E, F). See also comment on biology under *C. fulgidipennis*.

**Comment.** The records from Jordan (Al-Khawaldeh et al. 1997; Burckhardt et al. 2024) concerns *C. trjapitzini*.

### *Camarotoscena lauta* Loginova

Figs 2J–L, 4A–C, 5F

*Camarotoscena lauta* Loginova (1975): 56.

**Material examined.** TURKEY • 4 ♂, 4 ♀; Ankara, Ankara; 29.x.2001; *Populus alba*, Salicaceae; leg. N. M. Gençer; dry and slide mounted; NHMB.

**Description.** Male by Loginova (1975b). Male terminalia see Fig. 4A–C. Female terminalia with dorsal margin of proctiger, in lateral view, concave; apical third covered with short bristles, distinctly shorter than those in basal third laterally; subgenital plate, in lateral view, subtrapezoidal (Fig. 5F). Immatures unknown.

**Distribution.** Azerbaijan (Nakhichevan Autonomous Republik) (Loginova 1975b; Gegechkori and Loginova 1990); new for Turkey.

**Host plant.** *Populus* sp. (Salicaceae), not verified by immatures.

**Comment.** Loginova (1975b) reported the male holotype from Azerbaijan, Nakhichevan Autonomous Republik (Даста Ордубадского района: Ordubad district, Dasta). This was incorrectly translated in Loginova (1975a) to "Dasta in the Orenburg district".

### *Camarotoscena libera* Loginova

*Camarotoscena libera* Loginova (1975): 59.

**Description.** Description of adult by (Loginova 1975b). Fifth instar immature unknown.

**Distribution.** Azerbaijan (Loginova 1975b; Gegechkori and Loginova 1990).

**Host plant.** *Populus* sp. (Salicaceae) (Loginova 1975b), not verified with immatures.

### *Camarotoscena personata* Loginova

Figs 2M–O, 4D–F, 5D

*Camarotoscena personata* Loginova (1975): 58.

*Camarotoscena huashana* Li and Yang (1989): 74, 77, synonymised by Burckhardt and Mifsud (2003): 12.

**Material examined.** From China; dry and slide mounted; MHNG, NHMB.

**Description.** Adult by Loginova (1975b) and Li (2011) (as *Camarotoscena huashana*). Male and female terminalia as in Figs 4D–F, 5D. Immature unknown.

**Distribution.** China (Shaanxi) (Li 2011), Russia (Amur, Primorye, Siberia) (Loginova 1975b; Gegechkori and Loginova 1990).

**Host plant.** *Populus* sp. (Salicaceae) (Loginova 1975b), not verified with immatures.

### *Camarotoscena speciosa* (Flor)

Figs 1A, B, G, 2P–R, 4G–I, 5G, 6C, G, I, 7C, F, 8B

*Rhinocola speciosa* Flor (1861a): 525.

*Camarotoscena speciosa*, Haupt (1935): 228.

*Paurocephala* (*Camarotoscena*) *speciosa*, Vondráček (1957): 126.

**Material examined.** From Bulgaria, China (Xinjiang), Czechia, France, Germany, Hungary, Italy, Switzerland and Turkey; dry and slide mounted, preserved in 70% ethanol; BFUS, CAU, MHNG, MMBC, NHMB.

**Description.** Adult and immature by Ossiannilsson (1992). Fifth instar immature (Fig. 6C). Dorsal sclerites on the head, thorax and abdomen brown to dark brown (Fig. 6C). Setae on the dorsal surface of the forewing pads relatively dense, numerous and long and with several sectasetae (Fig. 6G, I). Caudal plate with interval II longer than medial and apical row of setae (Fig. 7C). Ventrite bearing the circumanal ring strongly sclerotised and well-delimited anteriorly (Fig. 7F); bearing a row of setae along anterior margin; venter with four transverse rows between abdominal base and anterior margin of terminal ventrite; transverse row IV of setae on abdominal venter consisting of two uneven rows of variously long setae (Fig. 8B).

**Distribution.** Armenia, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, China, Czechia, Denmark, Estonia, Finland, France, Germany, Georgia, Greece, Hungary, Italy, Kazakhstan, Kyrgyzstan, Latvia, Moldova, Netherlands, Poland, Romania, Russia (European part), Slovakia, Slovenia, Spain, Switzerland, Tadzhikistan, Turkey, Turkmenistan, UK, Ukraine, Uzbekistan (Flor 1861a; Schaefer 1949; Ramírez Gómez 1960; Wagner and Franz 1961; Dobreanu and Manolache 1962; Klimaszewski 1975; Lauterer 1977; Hodkinson and White 1979; Burckhardt 1988; Gegechkori and Loginova 1990; Ossiannilsson 1992; Burckhardt and Önuçar 1993; Conci et al. 1993; Lauterer 1993; Nokkala 1995; Baugnée et al. 2002; Burckhardt and Lauterer 2003; Ripka 2008; Serbina et al. 2015; Luo 2016; Bieman et al. 2019; Seljak 2020; Pramatarova et al. 2025); galls were reported from Luxemburg (Rapisarda et al. 2022).

**Host plant.** *Populus alba* L., *P. nigra* L., *P. tremula* L., (Salicaceae), *P.* × *generosa* A.Henry (Hodkinson and White 1979; Nokkala 1995), confirmed with the presence of immatures. Galls were reported from *P.* × *berolinensis* K.Koch and *P.* × *canadensis* Moench (Ambrus 1958).

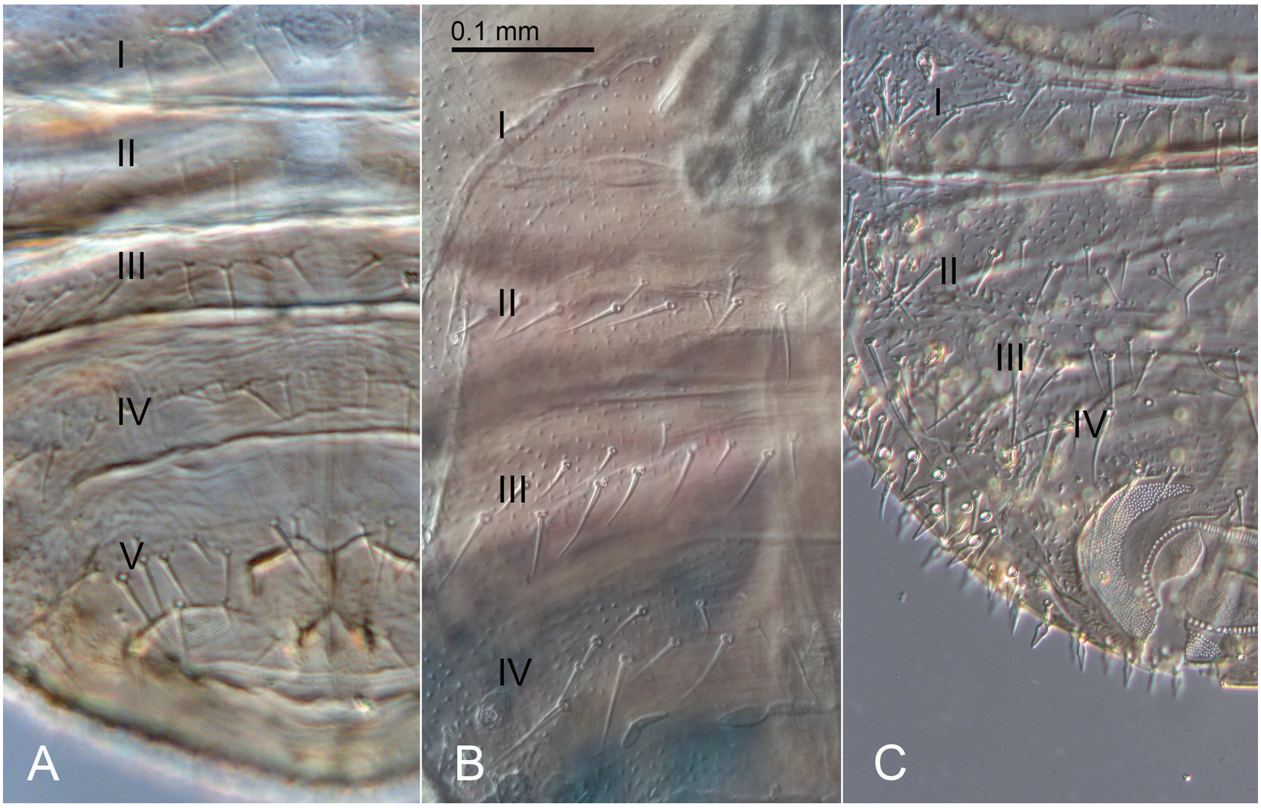

**Figure 8.** *Camarotoscena* spp., fifth instar immature, abdominal venter with transverse rows of setae indicated by numbers (scale = 0.1 mm). **A.** *C. fulgidipennis*; **B.** *C. speciosa*; **C.** *C. subrubescens*.

On an internet site (https://bladmineerders.nl/parasites/animalia/arthropoda/insecta/hemiptera/sternorrhyncha/psylloidea/psyllidae/paurocephalinae/camarotoscena/camarotoscena-speciosa/) also following non-European species are cited though it is not stated where this information comes from and if the records are based on the presence of immatures: North American species: *P. balsamifera* L., *P. deltoides* W.Bartram ex Marshall; Asian species: *P. lasiocarpa* Oliv., *P. simonii* Carrière.

**Biology.** Immatures in leaf roll galls. Probably bivoltine (Conci et al. 1993). In the south of France, adults are common in August (S. Grimaud, pers. obs.). The species occurs sometimes together with *C. subrubescens* (Flor 1861b) (S. Grimaud, pers. obs.).

**Comment.** The record from Mongolia (Klimaszewski 1973) refers to *C. bianchii* (Gegechkori and Loginova 1990). The registers from Iraq (Al-Maroof 1990; Mustafa et al. 2014) are doubtful and may concern other species.

### *Camarotoscena subrubescens* (Flor)

Figs 1C, H, 2S–U, 4J–L, 5H, 6D, H, 7D, 8C

*Rhinocola subrubescens* Flor (1861b): 411
*Camarotoscena subrubescens*, Vondráček (1951): 124
*Camarotoscena ujenci* Klimaszewski (1982): 3; syn. nov.

**Material examined.** From Bulgaria, France, Turkey; dry and slide mounted; BFUS, MHNG, MMBC, NHMB.

**Description.** Adult by Loginova (1975b). Fifth instar immature (Fig. 6D). Dorsal sclerites on the head, thorax and abdomen brown to dark brown (Fig. 6D). Setae on the dorsal surface of the forewing pads relatively dense, numerous and long and with several sectasetae (Fig. 6H). Caudal plate with interval II longer than medial and apical row of setae (Fig. 7D). Ventrite bearing the circumanal ring strongly sclerotised and well-delimited anteriorly; bearing a row of setae along anterior margin; venter with four transverse rows between abdominal base and anterior margin of terminal ventrite; transverse row IV of setae on abdominal venter consisting of one uneven row of variously long setae (Fig. 8C).

**Distribution.** Bulgaria, Croatia, France, Italy, Slovenia, Mongolia, Turkey (Flor 1861b; Oshanin 1907; Klimaszewski 1982; Burckhardt and Önuçar 1993; Conci et al. 1993; Seljak 2020; Pramatarova et al. 2025).

**Host plant.** *Populus alba* L., *P. nigra* L. (Salicaceae), confirmed by the presence of immatures.

**Biology.** Immatures in leaf roll galls (Fig. 1H). Probably bivoltine (Conci et al. 1993). In the south of France, adults are common in August (S. Grimaud, pers. obs.). Flor (1861b) mentioned that this species was found together with *C. speciosa* ("gleichzeitig und an denselben Stellen …").

**Comment.** According to Klimaszewski (1982), *Camarotoscena ujenci*, erected for two males, differs from *C. subrubescens* in the geographical distribution (Mongolia versus Mediterranean), the opaque yellow forewings with more intense coloration along apical margin (versus uniformly yellow), the rust-yellow antennae with dark segment X (versus dark segments IX and X) and the host association *Populus diversifolia* (= *P. euphratica*) versus *P. robusta* (= *Populus* × *canadensis*). The characters provided by Klimaszewski (1982) are not very convincing to justify a new species. More material is required to solve this problem. Meanwhile, *C. ujenci* is considered a synonym of *C. subrubescens*.

### ***Camarotoscena trjapitzini*** **Loginova**

Figs 2G, H, I, 3K–M, 5C, 6E, 7E

*Camarotoscena trjapitzini* Loginova (1968): 282.

**Material examined.** IRAN • 1 ♂, 2 ♀; Tehran, Karadj; 20.viii.2010; *Populus nigra*, Salicaceae; leg. M. Babmorad; #I code: Te1P.nig.H3; dry mounted; NHMB • 4 ♂, 3 ♀; Yazd, Ashkazar; 18–24.v.1996; leg. R. Linnavuori; dry and slide mounted; NHMB. SPAIN • 2 ♂, 3 ♀, 2 immatures; province Zamora, Zamora; 19.ix.2002; leg. N. Pérez Hidalgo; dry and slide mounted; NHMB.

**Description.** Adult by Loginova (1975b). The colour of the head, thorax and forewings is much more variable than described by Loginova (1975b). The dark dots can cover the head, thoracic dorsum and forewings. Dark adults of *C. trjapitzini* resemble *C. hoberlandti*. In the forewing, the cells $r_1$ and $r_2$ are mostly light (less than half of the cells) in *C. trjapitzini* but mostly dark in *C. hoberlandti*. Fifth instar immature (Fig. 6E). Dorsal sclerites on the head, thorax and abdomen brown (Fig. 6E). Setae on dorsal surface of forewing pads are relatively sparse and short and with almost no sectasetae. Caudal plate with interval II shorter than medial and apical row of setae (Fig. 7E). Ventrite bearing the circumanal ring unsclerotised and not clearly delimited anteriorly; venter, therefore, with five transverse rows between abdominal base circumanal ring; transverse row IV of setae on abdominal venter consisting of two uneven rows of variously long setae.

**Distribution.** Armenia (Gegechkori and Loginova 1990), Jordan (misidentified as *C. hoberlandti* in Al-Khawaldeh et al. (1997) and Burckhardt et al. (2024)); new for Iran (Tehran, Yazd); Spain.

**Host plant.** *Populus* sp. (Salicaceae).

**Comment.** Dark adults of *C. trjapitzini* resemble morphologically those of *C. hoberlandti*. The two species share identical *cytb* sequences but differ in the genetic distance in *COI* (2.6%) (Table 2).

## DNA barcoding

The gene fragments of *COI* and *cytb* were analysed from five species of *Camarotoscena* (Fig. 9; Table 1). For *C. fulgidipennis* and *C. speciosa*, DNA barcodes were obtained from specimens from two localities each, in India (Ladakh) and Jordan of the former, and China (Xinjiang) and the Czechia of the latter. In addition, the *COI* gene fragment was analysed for *C. speciosa* from two localities in Bulgaria.

The genetic distances from both DNA barcodes showed a similar degree of variation, with *cytb* distances being slightly higher overall (Table 2). The divergences of *C. speciosa* and *C. subrubescens* from *C. fulgidipennis*, *C. hoberlandti* and *C. trjapitzini* ranged from 7.3% to 9.1% in both genes. Consistently, the ML tree based on concatenated *COI* and *cytb* sequences recovered two main groups within the analysed *Camarotoscena* (Fig. 9): *C. speciosa* and *C. subrubescens*, and *C. fulgidipennis*, *C. hoberlandti* and *C. trjapitzini*.

The specimens of *C. fulgidipennis* and *C. hoberlandti* showed no genetic differences in *COI*; *C. trjapitzini* was notably divergent from the latter two species (2.6%), supporting it as a good species despite the great morphological similarity to *C. hoberlandti*. Based on *cytb*, no intraspecific or interspecific differences were found

**Table 2.** Pairwise intraspecific and interspecific *p*-distances of five *Camarotoscena* species based on *COI* and *cytb* sequences. BG = Bulgaria; CN = China; CZ = Czechia; IN = India; JO = Jordan.

| ***COI*** | ***C. speciosa* BG/CZ** | ***C. speciosa* CN** | ***C. subrubescens* BG** | ***C. fulgidipennis* IN** | ***C. fulgidipennis* JO** | ***C. hoberlandti* IN** |
|---|---|---|---|---|---|---|
| *C. speciosa* CN | 0.003 | | | | | |
| *C. subrubescens* BG | 0.000 | 0.003 | | | | |
| *C. fulgidipennis* IN | 0.091 | 0.088 | 0.091 | | | |
| *C. fulgidipennis* JO | 0.091 | 0.088 | 0.091 | 0.000 | | |
| *C. hoberlandti* IN | 0.091 | 0.088 | 0.091 | 0.000 | 0.000 | |
| *C. trjapitzini* JO | 0.077 | 0.073 | 0.077 | 0.026 | 0.026 | 0.026 |
| ***cytb*** | | | | | | |
| *C. speciosa* CN | 0.004 | | | | | |
| *C. subrubescens* BG | 0.004 | 0.000 | | | | |
| *C. fulgidipennis* IN | 0.081 | 0.085 | 0.085 | | | |
| *C. fulgidipennis* JO | 0.081 | 0.085 | 0.085 | 0.000 | | |
| *C. hoberlandti* IN | 0.081 | 0.085 | 0.085 | 0.000 | 0.000 | |
| *C. trjapitzini* JO | 0.081 | 0.085 | 0.085 | 0.000 | 0.000 | 0.000 |

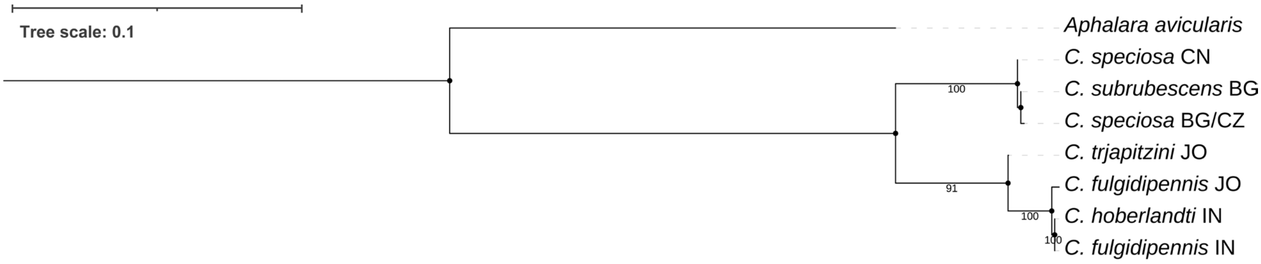

**Figure 9.** Maximum likelihood tree of *Camarotoscena* species based on concatenated *COI* and *cytb* gene fragment sequences. The tree is rooted with *Aphalara avicularis*. Bootstrap support values in percentages are indicated below branches (only values > 60% are shown). BG = Bulgaria; CN = China; CZ = Czechia; IN = India; JO = Jordan.

among the specimens of *C. fulgidipennis* from India and Jordan, *C. hoberlandti* from India and *C. trjapitzini* from Jordan. No or very little difference (0.3–0.4%) was found between the *COI* and/or *cytb* sequences of *C. speciosa* (populations from Bulgaria, China and Czechia) and *C. subrubescens* (Bulgaria).

# Discussion

## Species concepts

The morphological study of adults confirms the species concepts by Loginova (1975b) using characters, such as body and forewing colour and pattern, arrangement of the surface spinules on the forewings, body size and details of the male and female terminalia (see character assessment). While the adult characters diagnosing the species are often subtle, they are consistent. Immatures, available only for five species, differ in the body colour, degree of sclerotisation of the abdominal venter and chaetotaxy. The morphological characters diagnosing the immatures support the species concepts based on adult morphology.

Mitochondrial DNA barcoding in *Camarotoscena* proved only partly useful for identifying species. While *C. fulgidipennis*, *C. hoberlandti* and *C. trjapitzini* could be reliably separated from *C. speciosa* and *C. subrubescens* by both *COI* and *cytb*, neither marker resolved all morphology-based species. Thus, *C. speciosa* and *C. subrubescens* were not separated by either gene fragment, and *cytb* additionally failed to distinguish *C. fulgidipennis*, *C. hoberlandti* and *C. trjapitzini*. The latter was previously misidentified as *C. hoberlandti* from Jordan (Al-Khawaldeh et al. 1997; Burckhardt et al. 2024). At the same time, we found a little difference in both barcodes between populations of *C. speciosa* from China, Bulgaria and Czechia. The patterns of barcode divergence in *Camarotoscena* generally differ from those observed in other psyllid groups (e.g. *Aphalara*, *Cacopsylla*, *Craspedolepta*, *Melanastera*) (Martoni et al. 2018; Cho et al. 2020; Pramatarova et al. 2024; Serbina et al. 2025), where mitochondrial DNA barcoding generally identified most species correctly. This may be the result of mitochondrial introgression or incomplete lineage sorting, as documented in many animal groups (e.g. Toews and Brelsford 2012; Hawlitschek et al. 2022; Lužáková et al. 2025), and therefore further analyses of *Camarotoscena* should also include sequencing of nuclear genes.

The species of two species pairs sometimes occur together (same locality, same tree and rarely same gall): *C. fulgidipennis* – *C. hoberlandti* in the Middle East, Central Asia and the West Himalya, and *C. speciosa* – *C. subrubescens* in the Mediterranean. As the species within each pair do not differ, or differ very little, in the analysed genes, and are morphologically similar, they could putatively constitute forms of the same species, e.g. seasonal forms as known from other psyllids such as some pear psyllids (Burckhardt and Hodkinson 1986; Luo et al. 2012; Cho et al. 2017). This explanation, however, appears unlikely as the two “forms” (= species) were present at the same time, independent of the season.

## Distribution

The genus *Camarotoscena* is widely distributed in the temperate region of the Palaearctic. While the distribution of the species in the former Soviet Union was well documented by Gegechkori and Loginova (1990), this is not the case for other regions in Asia and Europe. New records are provided for *C. fulgidipennis* and *C. hoberlandti* from India (Ladakh), representing the first record of the genus from India and the first record of psyllids from Ladakh, for *C. lauta* from Turkey (Ankara) and *C. trjapitzini* from Iran (Tehran, Yazd) and Spain.

Many species are widely distributed: *C. bianchii*, *C. fulgidipennis*, *C. hoberlandti*, *C. personata*, *C. speciosa*, *C. subrubescens* and *C. trjapitzini*; the others appear more localised: *C. badia*, *C. lauta* and *C. libera*. This may be, however, an artefact of insufficient sampling.

The occurrences of *C. speciosa* in China (Luo 2016) and *C. subrubescens* (as *C. ujenci*) in Mongolia (Klimaszewski 1982) may be due to unintentional introductions as the native ranges of *Populus alba* and *P. nigra* extend only from the west Palaearctic to the West Himalaya, West Siberia and Xinjiang (POWO 2025), but the two tree species are planted also further east.

## Host plants

It appears that all *Camarotoscena* species develop on *Populus* species where the immatures induce galls on the leaves (Fig. 1E–H), but hard evidence is not available for all. The galls on *Populus nigra* resemble those of aphids (Hemiptera, Aphidoidea), e.g. of the genus *Chaitophorus* Koch, 1854 (S. Grimaud, pers. obs.). *Populus alba* and *P. nigra* are confirmed hosts of *C. fulgidipennis*, *C. hoberlandti*, *C. speciosa* and *C. subrubescens*, and *Populus laurifolia* and *P. usbekistanica* are probable hosts of *C. bianchii*, the latter plant also of *C. badia*. For the remaining four *Camarotoscena* species only *Populus* sp. is given as host (Gegechkori and Loginova 1990). According to observations made in the south of France, *C. subrubescens* lives on *Populus nigra* along water courses (rivers or streams), while *C. speciosa*, which appears less common, also colonises black poplar in other humid environments such as edges of ditches (S. Grimaud, pers. obs.).

## Conclusions

While our morphological review of the adults and immatures is consistent with the species recognised by Loginova (1975b), the results of the molecular analyses are at odds. *COI* provides insufficient resolution for separating the two species pairs *C. fulgidipennis* – *C. hoberlandti* and *C. speciosa* – *C. subrubescens*, and *cytb* additionally fails to distinguish *C. trjapitzini* from *C. fulgidipennis* and *C. hoberlandti*. The ML tree based on concatenated *COI* and *cytb* sequences recovered, however, two main groups within the analysed *Camarotoscena* spp. (Fig. 9): *C. speciosa* + *C. subrubescens*, and [*C. fulgidipennis*, *C. hoberlandti*] + *C. trjapitzini*. The same two groups are also defined by the adult and immature morphology (see the keys for identification of the adults and immatures).

The presence of two species in leaf roll galls can be explained be females of the two species laying eggs close together. The gall is induced by the sucking of the first instar immatures. Independent which species would induce the gall, all nearby individuals would be enclosed.

Neither the morphological nor the molecular results are so convincing that they strongly support one of the groupings, ten versus five species. For avoiding ill-based, unnecessary changes in the taxonomy of *Camarotoscena*, we follow the traditional species concept by Loginova (1975b). More targeted field work should be performed to collect fresh material in additional locations of all recognised *Camarotoscena* species. The analysis of nuclear genes or genomic data may provide a better understanding of the taxonomy and diversity of this genus. Immatures of all species are required to find additional characters for species diagnosis.

Our results highlight the limitations of relying solely on mitochondrial DNA barcoding from of a few specimens of few localities for species delimitation in this genus.

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