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A review of the genus *Macrocixius* with descriptions of five new species (Hemiptera: Fulgoromorpha: Cixiidae)

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OROSZ A. 2013: A review of the genus *Macrocixius* with descriptions of five new species (Hemiptera: Fulgoromorpha: Cixiidae). In: KMENT P., MALENOVSKÝ I. & KOLIBÁČ J. (eds.): Studies in Hemiptera in honour of Pavel Lauterer and Jaroslav L. Stehlík. *Acta Musei Moraviae, Scientiae biologicae* (Brno) **98(2):** 97–142. – The genus *Macrocixius* Matsumura, 1914 (Hemiptera: Fulgoromorpha: Cixiidae) is reviewed. Two previously described species, *M. giganteus* Matsumura, 1914 and *M. grossus* Tsaur et Hsu, 1991, are redescribed, and five additional species are described as new: *M. emeljanovi* sp.nov. (from Taiwan and Nepal); *M. gigantomimus* sp.nov. (from Vietnam); *M. lautereri* sp.nov. (from Indonesia: Sumatra); *M. monticola* sp.nov. (from Vietnam); and *M. orophilus* sp.nov. (from Nepal). *M. grossus* and *M. giganteus* are recorded for the first time for Vietnam. All species are illustrated and keys for their identification are provided for the males. The morphology of the genitalia of females is discussed in detail with respect to diagnostic characters.

Keywords. Auchenorrhyncha, planthoppers, taxonomy, new records, morphology, female genitalia, postfrontal area, Oriental Region

Introduction

The genus *Macrocixius* Matsumura, 1914 was established by MATSUMURA (1914) for the newly described *M. giganteus* Matsumura, 1914, designated as type species. It was known at the time from Japan and Taiwan. TSAUR *et al.* (1991) redescribed the genus and the type species in detail with several new distributional records and described an additional species, *M. grossus* Tsaur et Hu, 1991.

Based on extensive material collected mainly by the staff of the Hungarian Natural History Museum in the Oriental Region (largely in Nepal, Vietnam and Taiwan), the species of *Macrocixius* are here revised and five described as new for science. Identification keys are presented for the males, and the morphological diagnostic features of the females, including the female genitalia, are discussed in detail.

Material and methods

The majority of the 125 specimens studied are deposited in the Hungarian Natural History Museum; a few specimens were loaned from other collections. The following abbreviations are used for the depositories of material mentioned in text:

HNHM . . . . . Hungarian Natural History Museum, Budapest, Hungary
MMBC . . . . . Moravian Museum, Brno, Czech Republic
NCHU . . . . . National Chung Hsing University, Taichung, Taiwan
NMNS . . . . . National Museum of Natural Sciences, Taichung, Taiwan
NTU . . . . . National Taiwan University, Taipei, Taiwan
TARI . . . . . Taiwan Agricultural Research Institute, Wufeng, Taiwan
ZIN . . . . . Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia

All the specimens in this project were allocated an individual code number (Nos. 1–125); these were also attached to the specimens. In order to distinguish them from the codes for collecting events, the individual code numbers appear in bold type in the text.

Identification of all males involved study of the genitalia. Detached abdomens were boiled in 10% KOH solution in a water bath for 10–12 minutes and then rinsed in distilled water. After examination, the genitalia were preserved in glycerol in a plastic microvial, which was pinned with the specimen. Wings were largely studied and illustrated on slide mounts; any unique identifiers disclosed were also attached to the specimens. In females, after morphometric measurements had been taken, the abdomen was detached and transferred into distilled water, then photographs taken and drawings made of the anal tube and gonapophysis IX. The study of the internal female genitalia (vagina, spermatheca, bursa copulatrix) started with boiling the abdomen in 10% KOH solution and washing it in distilled water then, after the abdominal plates had been removed, the genital structures were stained with chlorazol black solution, after Carayon (1969). In a couple of instances it proved necessary to relax the whole abdomen in distilled water (without boiling) and then, after removal of the abdominal plates, to stain it with eosin and treat it with chlorazol for the lumen of the bursa copulatrix and structures of the spermatheca to become accessible to photography (Figs 144, 148). Digital photographs of the genitalia were taken with a Leica MZ 95 or a Nikon Coolpix 4500.

Explanations and codes used for morphological terminology and morphometric measurements

Measurements were taken from all specimens; data summarized for each species are given in Tables 1 and 2. Features measured and/or described were:

1. *Postfrontal area* (PFA). PFA is a trapezoid area bounded by the transverse carina at the apex of the vertex and the upper transversal carina of the frons (Fig. 10). Three measurements of the PFA were taken (Fig. 10: A, B and C) and two ratios calculated from them (A/B, C/D).
2. *Vertex*. Length of the vertex along midline (Fig. 10: D).
3. *Frons*. The ratio of the length (FRL) to the width (FRW) of the frons was established for males. FRL is here defined as the distance between the middle ocellus and the upper transversal carina, while FRW is the greatest distance between the two lateral carinae.
4. *Stylus*. Two measurements of the distal lobe were taken: diameter measured in the direction of the stem (DLL), and its width perpendicular to it (DLW) (Fig. 63). In dry preparations, the edges of the distal lobe were sometimes slightly rolled inwards or

creased, so measurements of these may have been slightly inexact; however, this kind of error was considered negligible. The values of DLL/DLW ratio are given in the description of every species and in the key to the males.

5. *Caudal margin of pygofer*. The shape of the caudal margin of the pygofer in males (PCM) proved to be species-specific (Figs 69–76).
6. *Aedeagus* bears appendages, partly on both sides of the apex of the phallotheca, partly on either the apex of the flagellum or in its proximal third (Figs 11–13). The number and position of these appendages are diagnostic at species level. Codes are introduced for the appendages of the aedeagus in order to simplify the descriptions. In a ventral view of the phallotheca, lateral appendages on the right side are labelled as PHR1–4 (Fig. 13), and lateral appendages on the left side as PHL1–3 and, in the same aspect, appendages on the flagellum are labelled as FL1, FL2 and FL3 (Figs 11–12).
7. *Ovipositor*. Gonapophysis IX (GAPIX) bears on its dorsal surface a single, blunt, tooth-like process (clearly visible in lateral view: Fig. 9, see also Figs 145–147). This structure has been termed "middle tooth" in Cicadellidae by Linnavuori & Al Ne'amy (1983: Fig. 13). Also on the dorsal side of GAPIX in lateral view, there is a row of denticles extending to the middle of the GAPL section; the length of the row and the character of the teeth taken together appear to be a useful diagnostic feature at species level. The shape of GAPIX was studied in all female specimens; characteristic formations are illustrated in Figs 105–143 and 145–147. In many cases gonapophysis VIII adheres closely to the surface of gonapophysis IX, making it seem as if the lower, ventral side were also toothed (Figs 7–8); this can be quite confusing workers relatively unfamiliar with the group.

   The following morphometric characters were measured or calculated for GAPIX in females (Fig. 9): distance of the middle tooth from the apex (GAPL); width of GAPIX across the middle tooth (GAPW); GAPL/GAPW ratio; length of denticulate portion (TPRT) and GAPL/TPRT ratio; the last-named proved useful in identification of females to species level (Fig. 169).
8. *Vagina* in Cixiidae was described in general by Bourgoin (1993); it consists of two parts: a posterior vagina and an anterior vagina (VA). A bursa copulatrix is attached to the dorsal part of VA, while a spermatheca and an antero-vaginal gland are attached to VA anteriorly. A common oviduct opens into the antero-ventral part of VA. Several plate-like sclerotized plates may be observed in the ventral and dorsal walls of VA; their pattern provides useful diagnostic information for the identification of females ("vagina wall pattern" VAGPT).
9. *Spermatheca* in Cixiidae was discussed by Remane & Asche (1979) and Bourgoin (1993); the latter author defined a diverticulum ductus (DD), longitudinally surrounded by a spiralling ductus receptaculi (DR, Figs 144, 148, 151–157), together forming a "double helix". Diameters of DD (DDD) and DR (DRD) were measured and the number of the coils (THRS) of DR noted. The DRD values provided in Table 2 are averages calculated from measurements of all the coils in one specimen (Fig. 104).
10. *Length of body* was measured from apex of vertex to apex of forewings.

11. *Length of tegmen* was measured from tegula to apex of forewing.
12. The *anal tube* has three defined parts: a stem, an apical lobe pointing towards the rear, and a short anal style (Fig. 15). In females, the ratio of the anal tube length/width as viewed from above (ANSL/ANSW) was measured and calculated.

Taxonomy

Genus *Macrocixius* Matsumura, 1914

Macrocixius Matsumura, 1914: 393; Tsaur *et al.* (1991): 3; Fennah (1956): 459; Hua (2000): 88.
Type species: *Macrocixius giganteus* Matsumura, 1914, by original designation and monotypy.

Redescription. The redescription of the genus given below is based on the original description (Matsumura 1914) and an extended redescription by Tsaur *et al.* (1991), complemented by some new descriptive notes.

Size. *Macrocixius* includes the largest members of Cixiini. For measurements of all species, see Tables 1–2.

Colour. Body ventrally and dorsally yellowish-brown or brown, lightly covered in powdery wax; frons brightly brown, frontoclypeal suture with bright yellow spots near lateral carinae. Carinae of mesonotum yellowish-brown, brighter than basic colour; tegmina translucent, variably with brownish-black spots; veins yellowish-brown, occasionally with brown spots; labium yellowish-brown.

Structure. Head between eyes narrower than pronotum. Vertex strongly concave, twice as wide as long along midline; apically with strong transverse carina, more or less continuous; median carina flattened apically, not reaching apex. Frons concave, as wide as long, widest at the level of antennae, apically tapering (see Table 1 for values of the FRL/FRW ratio), with well-developed lateral carinae, a median carina flattened apically and with transverse apical carina more or less straight. Between the transverse carinae of vertex and frons is a clearly-distinguishable, trapezoid postfrontal area; the A/B ratio of this area is a diagnostic feature for identification of certain species (see Fig. 168 and Tables 1 and 2). Pronotum tapered, with lateral carinae, medially strongly incised. Mesonotum tricarinate, medially protruding, descending laterally. Tegmina longer than abdomen, tectiform, veins with tubercles bearing setae; the two anal veins joining at clavus mid-point and running farther along the inner margin; twelve apical cells present. Hind wing with veins M3+4 and Cu1a separated, connected by a transverse vein. Hind tibia with 3(–4) lateral spines and a crown of 6 spines distally. Chaetotaxy of hind tarsi (7–)8/9. Labium three-segmented, its apex reaching the hind trochanter.

Male genitalia. Pygofer structured as a symmetrical socket; its caudal margin (PCM), in lateral view, more or less rounded in a species-specific manner (Figs 69–72, 74–76). Apical lobe of anal tube with median and distal parts rounded and elongated towards the rear (Figs 14, 17, 19, 22), or medially slightly incised, with two lateral rounded projections (Figs 25, 28, 31), providing a diagnostic character for species groups. Stem of anal tube straight in lateral view (Figs 15, 23, 26) or sinuate (Figs 18, 20, 29, 32); in ventral view, elliptical (Fig. 30), nearly circular (Fig. 27) or narrow basally

and widening towards the apical lobe (Figs 16, 21, 24, 33, 62). Aedeagus with two parts: phallotheca and flagellum, the latter connected to the apical part of the phallotheca. Phallotheca with two basal triangular lobes (TRA) directed downwards (e.g. Figs 11, 35, 55) and spine-like appendages on both sides apically, near basal part of the flagellum: 2 or 4 on the right side and 2 or 3 on the left side (in ventral view). Flagellum also with 2 or 3 appendages (in left lateral view). The number of appendages, their position, size and orientation are diagnostic for each species. Genital styli composed of two parts: a stem, joining the connectivum, and a widening distal lobe (DL). The stem of the stylus slightly curved outwards in ventral view, with a distinct constriction midway along the inner side; both styli, in ventral view, thus together forming two sides of an oval. Distal lobes of styli turned outwards from axis; the width/length ratio (DLW/DLL, see Fig. 63) varies between species (see key to the males).

Female genitalia. Pygofer nearly oval in caudal view, with two wax-producing plates fused medially. Anal tube nearly parallel-sided in dorsal view; for values of ANSL/ANSW ratio, see Table 2. GAPIX with a gentle protuberance and a row of small teeth; Table 2 for morphometric characters. Posterior vagina sac-like. Surface of bursa copulatrix with peculiar ornamented structure, composed of tiny pits including 2–7 setae (Figs 149, 150). Common oviduct opening into ventral part of anterior vagina (VA); walls of VA with characteristic sclerotized plates, their pattern (vagina wall pattern, VAGPT) an important diagnostic feature for individual species (Figs 77–103, 157–160). Spermatheca attaching to dorsal part of VA, laterally to antero-vaginal gland (AVG); spermatheca consisting of four clearly-distinguishable parts: ductus receptaculi (DR), followed by diverticulum ductus (DD), pars intermedialis, and glandula apicalis (Figs 144, 148, 151, 152: details, Figs 153–156, abbreviations in explanatory Fig. 104). Neither DRD/DDD ratio nor coil numbers (THRS) of DR proved species-specific (Table 2).

Species included. The genus *Macrocixius* currently contains seven species, two of them described previously (*M. giganteus* and *M. grossus*) and five described as new in this paper (*M. emeljanovi* sp.nov., *M. gigantomimus* sp.nov., *M. lautereri* sp.nov., *M. monticola* sp.nov., and *M. orophilus* sp.nov.).

Distribution. The genus is widespread in eastern and south-eastern Asia from Nepal to Sumatra, also known from parts of Japan, Taiwan, southern China and Vietnam.

Biology, host plants and habitats. Information about the biology of *Macrocixius* spp. is quite scarce. The three Taiwanese species were collected between March and December, with most of them captured in September. Collecting data suggest a habitat preference from subtropical monsoon forests (*M. grossus*, *M. emeljanovi*: Taiwan, Kenting National Park, 120–200 m), hard-leaved rainforests (*M. grossus*, *M. emeljanovi*: Taiwan, Fu-Shan National Park ~600 m, Pingtung Co. ~ 900 m, Ming-Chyr 1180 m; Vietnam, Sa Pa 1650–1800 m, Da Lat 1500 m) to high-mountain mossy forests (*M. emeljanovi*, *M. orophilus*: Taiwan, Yakou, 2600 m, Hsiangyang 2200 m; Nepal, Ganesh Himal, 2720 m). There are no data on host plants, except for a general comment that a series of specimens representing *M. grossus* and *M. emeljanovi* was collected from the canopy in Taiwan (Wulu, 1100 m); all other material was collected at light traps.

Key to species of *Macrocixius* based on external characters of males

1 Apical lobe of anal tube medially produced, rounded (Figs 14, 17, 19, 22) (*giganteus* species-group). 2

– Apical lobe of anal tube medially emarginate, concave (Figs 25, 28, 31) (*grossus* species-group). 5

2 Distal lobe of stylus relatively shorter (DLW/DLL >1.5; Fig. 66). Anal tube in ventral view V-shaped, apical part truncate (Fig. 62). Caudal margin of pygofer with a protruding, finger-like lobe (Fig.75). .... ***M. monticola* sp.nov.**

– Distal lobe of stylus relatively longer (DLW/DLL <1.3). Anal tube in ventral view elliptical, apical part not truncate (Figs 16, 21, 24). Caudal margin of pygofer with no protruding lobe, truncate or rounded. 3

3 Stem and apical lobe of anal tube, in lateral view, forming an obtuse angle (Fig. 15). Caudal margin of pygofer truncate in lateral view (Fig. 71). ..... ***M. emeljanovi* sp.nov.**

– Stem and apical lobe of anal tube, in lateral view, forming a near-right angle (Fig.20). Caudal margin of pygofer rounded in lateral view (Figs 70, 72). 4

4 Stylus with large protuberance on apical margin between distal lobe and stem (Fig. 67). Caudal margin of pygofer as Fig. 70. .... ***M. giganteus* Matsumura, 1914**

– Stylus with small protuberance on apical margin between distal lobe and stem (Fig. 63). Caudal margin of pygofer as Fig. 72. .... ***M. gigantomimus* sp.nov.**

5 Stylus with DLW/DLL ratio = 1.3. Anal tube, in ventral view, broadest in its apical third (Fig. 33); in lateral view, stem and apical lobe forming a right angle (Fig. 32), stem strongly sinuate. Pygofer with a pair of short lobes directed towards midline (PCM on Figs 73, 74). Chaetotaxy of first and second tarsomeres of hind legs: 9/9–11. .... ***M. orophilus* sp.nov.**

– Stylus with DLW/DLL ratio = 1.0. Anal tube, in ventral view, elliptical or rounded (Figs 27, 30); in lateral view, stem and apical lobe forming obtuse angle, stem tapering towards apical lobe or parallel-sided (Figs 26, 29). Pygofer with caudal margin rounded, lacking lobes. Chaetotaxy of first and second tarsomeres of hind legs: 7(–8)/9. 6

6 Stem of anal tube elliptical in ventral view (Fig. 30), in lateral view tapering towards apical lobe (Fig. 29). Caudal margin of pygofer with a broadly rounded projection in lateral view (Fig. 69). Distal lobe of stylus elongate (Fig. 64). ..... ***M. grossus* Tsaur et Hsu, 1991**

– Stem of anal tube almost circular in ventral view (Fig. 27); parallel-sided in lateral view (Fig. 26). Caudal margin of pygofer, in lateral

view, with a narrowly-rounded projection (slightly asymmetrical in the single specimen examined, Fig. 76). Distal lobe of stylus short, subtriangular (Fig. 58). ..... ***M. lautereri* sp.nov.**

Key to species of *Macrocixius* based on characters of the aedeagus

1 Outline of basal third of phallotheca forming an obtuse angle in lateral view (Figs 34, 36). ..... ***M. giganteus* Matsumura, 1914**

– Outline of basal third of phallotheca almost straight or very gently curved in lateral view (Figs 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 59, 60). 2

2 Flagellum with three appendages (FL1, FL2, FL3; Fig. 11), FL3 large, directed towards base of phallotheca (Figs 54, 56). .... ***M. grossus* Tsaur et Hsu, 1991**

– Flagellum with two appendages (FL3 absent). 3

3 Second appendage of flagellum (FL2) originating close to mid-point of flagellum (Figs 38, 46). 4

– Both appendages of flagellum originating near apex (Figs 42, 50, 59). 5

4 In left lateral view, appendage PHL2 adhering closely to side of flagellum, long and thin, appendage PHR4 sickle-shaped, curved beyond the stem of phallotheca and extending (in lateral view) over to the left half (Figs 46, 48). ..... ***M. emeljanovi* sp.nov.**

– In left lateral view, appendage PHL2 with ventro-caudal direction; PHR4 long, straight and directed mesiad (Figs 38, 40). .... ***M. monticola* sp.nov.**

5 Flagellum with appendages near apex differing in length, FL2 much shorter than FL1. Appendage PHR4 straight and thin, adhering closely to flagellum (Figs 59, 60). ..... ***M. gigantomimus* sp.nov.**

– Flagellum with appendages near apex of nearly equal length (Figs 42, 50). Appendage PHR4 absent (Fig. 52) or, if present, curved around stem (Figs 42, 44). 6

6 Phallotheca with two appendages on the right and two appendages on the left (Figs 50–52). Appendage PHR2 curved around stem to the left (Figs 50, 52); PHR4 absent. Orifice collar-like (Fig. 52, 53). .... ***M. orophilus* sp.nov.**

– Phallotheca with four appendages on the right and two on the left (Figs 42, 44). Appendage PHR2 adhering closely to stem (Fig. 44); PHR4 present, curved around stem, extending over to the left. Orifice simple (Fig. 42). ..... ***M. lautereri* sp.nov.**

Identification of females

Morphometric characters

The only publication addressing *M. giganteus* and *M. grossus* (Tsaur *et al.* 1991), the two previously-described species, provides very little information about the females. The authors discriminated between the two species largely on the basis of characters of the male genitalia; for the females, they provided only drawings of the pygofer for the two species. In that contribution, the anal tube of *M. giganteus* is considered "very slender, much longer than wide" (length/width ratio about 3:1 in their Fig. 1J), while in *M. grossus* this is merely "slender" (length/width ratio about 2:1 in Fig. 2H; Tsaur *et al.* 1991). Calculations of this ratio (ANSL/ANSW) in a number of specimens identified as *M. giganteus* and *M. grossus* indicated that the ranges of intraspecific variability overlap partially in the two species (and in *M. emeljanovi* sp.nov. as well), rendering this character of only slight diagnostic value (Table 2).

Altogether 42 females of *Macrocixius* spp. collected in Taiwan (33), Vietnam (7) and Nepal (2) were available for examination in this study (together with 83 males). The examination concentrated first on finding characters that might separate females of *M. giganteus* – *M. grossus* – *M. emeljanovi* from Taiwan; the results were then used to

Table 1. Measurements and ratios of *Macrocixius* males (in mm). See the Material and Methods section for explanations of character abbreviations.

Species	*emeljanovi*	*giganteus*	*gigantomimus*	*grossus*	*lautereri*	*monticola*	*orophilus*
A: range	0.51–0.64	0.54–0.57	0.57–0.67	0.57–0.67	0.597	0.49–0.60	0.69–0.70
mean	0.56	0.55	0.62	0.63		0.55	0.697
N	34	2	2	22	1	5	2
B: range	0.17–0.23	0.17–0.18	0.15–0.20	0.15–0.20	0.184	0.16–0.20	0.17–0.18
mean	0.20	0.172	0.176	0.172		0.545	0.172
N	34	2	2	22	1	5	2
C: range	0.37–0.54	0.46–0.51	0.46–0.54	0.47–0.57	0.536	0.40–0.44	0.57
mean	0.46	0.482	0.498	0.507		0.416	0.57
N	34	2	2	22	1	5	2
D: range	0.27–0.36	0.29	0.31–0.32	0.28–0.34	0.291	0.26–0.29	0.20–0.21
mean	0.30	0.29	0.313	0.30		0.28	0.207
N	34	2	2	22	1	5	2
A/B: range	2.53–3.45	3.04–3.36	3.38–3.7	3.30–4.50	3.33	2.83–3.52	3.91–4.18
mean	2.86	3.2	3.54	3.78		3.1	4.05
N	34	2	2	22	1	5	2
C/D: range	1.28–1.77	1.59–1.74	1.5–1.67	1.60–1.95	1.89	1.37–1.53	2.64–2.85
mean	1.53	1.66	1.59	1.76		1.48	2.75
N	34	2	2	22	1	5	2
FRL/FRW:							
range	1.06–1.24	1.12–1.29	0.986–1.08	1.08–1.23	1.107	1–1.11	0.989–1.07
mean	1.14	1.25	0.997	1.14		1.05	1.03
N	30	2	2	26	1	4	3
Tegmen length							
range	6.83–8.7		7.95–8.2		7.7	7.45–8.2	8.3–8.4
N	13		2		1	5	2
Body length							
range	8.2–10.1	9.56–9.62	9–9.56	9.32	8.75	8.45–9.72	9.44–9.46
N	13	2	2	2	1	5	2

Table 2. Measurements and ratios of *Macrocixius* females (in mm). See the Material and Methods section for explanations of character abbreviations.

Species	*emeljanovi*	*giganteus*	*grossus*	*monticola*	*orophilus*
A: range	0.55–0.69	0.58–0.67	0.61–0.73	0.61–0.66	0.704
mean	0.62	0.62	0.69	0.64	
N	20	11	18	3	1
B: range	0.17–0.23	0.16–0.21	1.53–1.99	0.20–0.21	0.168
mean	0.21	0.18	1.75	0.204	
N	20	11	18	3	1
C: range	0.44–0.57	0.47–0.55	0.46–0.60	0.46–0.54	0.566
mean	0.50	0.5	0.55	0.50	
N	20	11	18	3	1
D: range	0.28–0.34	0.29–0.35	0.29–0.35	0.31–0.34	0.245
mean	0.32	0.32	0.33	0.32	
N	20	11	18	3	1
A/B: range	2.64–3.67	3.17–3.81	3.15–4.6	3.07–3.23	4.18
mean	3.04	3.48	3.94	3.13	
N	20	11	18	3	1
C/D: range	1.38–2.06	1.35–1.79	1.45–1.90	1.45–1.66	2.31
mean	1.56	1.58	1.69	1.54	
N	20	11	18	3	1
ANSL/ANSW					
range	1.96–2.59	2.34–3.0	2.0–2.67	2.24–2.42	
mean	2.3	2.63	2.25	2.33	
N	18	10	18	2	
GAPL/GAPW					
range	3.18–4.41	3.89–4.96	3.65–4.29	3.84–4.0	3.86
mean	3.77	4.34	3.88	3.91	
N	5	10	9	3	1
GAPL/TPRT					
range	2.03–2.9	2.17–3.39	3.33–5.77	2.16–2.58	2.59
mean	2.44	2.87	4.40	2.37	
N	16	10	14	2	1
DRD/DDD					
range	2.5–4.9	4.4	2.3–6.3	3.2–4.9	2.9
N	12	1	13	2	1
THRS of DR					
range	12–17	16	9–15	11–13	17
N	12	1	13	2	1
Tegmen length					
range	8.07–8.88	8.39–10	8.94–9.38	7.75–8.7	9.7
mean	8.46	9.1	9.16	8.26	
N	11	9	2	3	1
Body length					
range	9.63–10.37	9.75–11.5	9.32–10.99	9.2–10.3	10.37
mean	9.91	10.46	10	9.8	
N	11	10	4	3	1

separate females of *M. grossus* from *M. monticola*. The following was disclosed in terms of morphometric characters:

1. Morphometric data for the postfrontal area and the vertex (A/B ratio) appear for all male and female specimens in Fig. 168. As the data for *M. grossus* encompass a wide range, females with values near low-point (**No 83, 89, 94**) needed to be checked by examination of other characters. One of the female specimens from Nepal (**No 93**) differed very distinctly from the other specimens (**No 95**, **96, 102**) and fell into the range of *M. emeljanovi*. Subsequently, study of the genitalia confirmed the identity of this specimen as *M. emeljanovi*.

A similar comparison was made with values of C/D ratio: they showed a similar distribution, but the differences were less convincing (see Tables 1–2 for values in males and females respectively).

2. A comparison of the length/width ratio of the frons (FRL/FRW) was made for most of the males. Among 30 *M. emeljanovi* males, thirteen *M. grossus* males from Taiwan and thirteen males from Vietnam, together with four males of *M. monticola*, none of the three species disclosed distinct, non-overlapping ranges (Table 1). This ratio is thus considered less than useful for separation of species of either sex.

3. The length/width ratio of the female anal tube (ANSL/ANSW) overlapped in *M. giganteus* (9 females measured), *M. emeljanovi* (23), and *M. grossus* (17). Only three specimens were available for *M. monticola*, probably too few to draw conclusions.

4. For gonapophysis IX, the GAPL/GAPW ratio was determined for 27 specimens, including six from Vietnam and 21 from Taiwan (Table 2). Because the data set was so limited, this ratio was not employed for species separation .

5. The GAPL/TPRT ratio was recorded in all female specimens and characteristic forms were illustrated with drawings and photos. It appears that this character is effective in discrimination between only a few species, e.g. *M. emeljanovi* from *M. grossus* in Taiwan, but it probably lacks such usefulness in the separation of certain continental Asian species.

Female internal genitalia

The most reliable diagnostic characters for discrimination between *Macrocixius* spp. females may be found in the internal genitalia. Several specialists have addressed the internal female genitalia of the tribe Cixiini (Remane & Asche 1979, Bourgoin 1993, Holzinger 2002, Holzinger *et al.* 2002). Bourgoin (1993) provided a description of the ectodermal genital ducts of *Cixius nervosus* (Linnaeus 1758), largely applicable to *Macrocixius* spp. as well. The descriptions that follow therefore draw much from that work.

There are distinct sclerotized plates in the dorsal and ventral walls of the anterior vagina (vagina wall pattern, VAGPT). Since the bursa copulatrix and the spermatheca open dorsally, these sclerotized areas are best observed in ventral view (Figs 157–160, Figs 77–103); dorsal sclerites are indicated by a dotted contour in Figs 77–103.

The sclerites of the vagina were studied in detail in *M. giganteus* (Figs 95–103, 159, 160), *M. grossus* (Figs 77–83, 157), and *M. emeljanovi* (Figs 86–94, 158) for which

several females were available from Taiwan. The number and shape of the sclerotized plates were shown to be species-specific in these three species and might presumably provide interspecific differences for other species of the genus as well.

The spermatheca in *Macrocixius* has the same basic structure as that of *Cixius* Latreille, 1804, *Tachycixius* Wagner, 1939*, Trirhacus* Fieber, 1875, and others. A study of a large number of specimens of some species (particularly *M. grossus*, *M. emeljanovi*, and *M. monticola*) revealed that the structure of DR is quite variable between most species with respect to the diameters of the helices and the numbers of coils (THRS); these characters are therefore considered to be of no diagnostic value (Table 2).

Review of species of *Macrocixius*

Macrocixius giganteus Matsumura, 1914

(Figs 12, 13, 19–21, 34–37, 67, 70, 95–103, 108, 134–143, 145–146, 156, 159, 160)

Macrocixius giganteus Matsumura, 1914: 394; Tsaur *et al.* (1991): 3; Fennah (1956): 459; Hua (2000): 88. Syntypes: Japan, Kyushu, Kagoshima (coll. Hokkaido University Collection).

Material examined. Taiwan: 1 ♂, Taichung Co., Anmashan, 1650 m, 20.VI.1997, leg. B. Herczig & L. Ronkay (**No 104**, HNHM); 1 ♀, same data but 14.VII.1983, leg. C. T. Yang (**No 108**, NCHU); 1 ♂, Hualien Co., Tzuen, 5.IX.1986, leg. S. C. Tsaur (**No 105**, ZIN); 1 ♀, same data (**No 110**, NCHU); 1 ♀, Hualien Co., Lienhuachih, 5.IX.1988, leg. S. C. Tsaur (**No 107**, NCHU); 2 ♀♀, Hualien Co., Mukwa, 8.VIII.1985, leg. S. C. Tsaur (**Nos 111 and 116**, NCHU); 1 ♀, Ilan Co., Taipingshan, 4.VII.1988, leg. S. C. Tsaur (**No 106**, ZIN); 1 ♀, same data but 1.VII.1988 (**No 114**, NCHU); 1 ♀, Ilan Co., Chihtuan, 1.VIII.1986, leg. S. C. Tsaur (**No 115**, NCHU); 1 ♀, Chiayi Co., Tapan, 19.VI.1988, leg. S. C. Tsaur (**No 109**, NCHU); 1 ♀, Chiayi Co., Fenchifu, 12.VIII.1987, leg. C. T. Yang (**No 113**, NCHU). **Vietnam:** 1 ♀, No.285, Da Lat, 1500 m, 14–20.X.1988, leg. S. Mahunka & T. Vásárhelyi (**No 94**, HNHM).

Redescription. A detailed redescription has been given by Tsaur *et al.* (1991); what appears here is purely complementary. In Tsaur *et al.* (1991: 3), the captions to Figs 1 and 2 have inadvertently been transposed: Fig. 1 refers to *M. giganteus* and Fig. 2 to *M. grossus*.

Colour. General colour yellowish-brown to brownish-black. Tegmen with yellow-to-green veins and several dark brown markings on veins and in cells.

Male genitalia. Pygofer symmetrical; caudal margin (PCM) almost straight; entire outline of pygofer more or less sub-rectangular in lateral view (Fig. 70). Apical lobe of anal tube medially produced and rounded (Figs 19–21). Stylus with well-developed protuberance apically (Fig. 67); DLW/DLL = 1.26. Phallotheca, in lateral view, distinctly angled in basal third (Figs 34, 36), with four apical appendages near base of flagellum on right side (Figs 35–37), and with three appendages on the left surface. Flagellum near orifice with two acute, well-sclerotized appendages (Figs 34, 37).

Female genitalia. The row of teeth at the apex of GAPIX is illustrated (in lateral view) in Figs 108, 134–143, 145 and 146. Anterior vagina, in ventral view, with three sclerotized plates in its ventral wall: one narrow and elongate, on right margin; the second well-defined, elliptical, located centrally; and the third and largest covering the caudal part (Figs 95–103, 159, 160). Spermatheca as in Fig. 156 (specimen **No 94**).

Measurements and ratios in Tables 1–2 and Figs 168–169.

Distribution. Japan (Matsumura 1914, Muir 1925); China (Fennah 1956, Hua 2000); Taiwan (Schumacher 1915a, b; Tsaur *et al.* 1991, and additional records in the current study); Vietnam (first record in the current study, **No 94**).

Habitat. Populations in Taiwan appear to inhabit various types of deciduous forests at altitudes of between 200 m and 2500 m.

Differential diagnosis. Males of *M. giganteus* may be distinguished from all other congeners by apical lobe of anal tube medially produced, rounded (a defining feature of the *giganteus* species-group) and phallotheca distinctly angled in the basal third in lateral view (a unique character within *Macrocixius*). Females may be easily distinguished from other *Macrocixius* spp. by their characteristic vagina wall pattern (VAGPT), as in Figs 95–103 and 159–160. In distinguishing *M. giganteus* from the sympatric *M. grossus*, the GAPL/TPRT ratio is also diagnostic (Figs 108, 134–143, 145–146, 169, Table 2).

Macrocixius grossus Tsaur et Hsu, 1991

(Figs 3, 4, 11, 28–30, 54–57, 64, 69, 77–83, 104, 109–111, 112–123, 144, 148–150, 151–152, 154–155, 157)

Macrocixius grossus Tsaur et Hsu, 1991: 3. Holotype: Taiwan, Taipei Co., Hsinhsien (coll. NTU).

Material examined. Taiwan: 7 ♂♂, 2 ♀♀, Ilan Co., Fu-Shan, 600 m, LTER site, 25–27.IX.2000, leg. L. Papp, L. Peregovits & L. Ronkay (**Nos 1, 16, 61, 71, 73, 75–77, 84,** HNHM); 6 ♂♂, 4 ♀♀ same locality, but 636 m, 15.IX.2007, leg. D. Rédei & J.-F. Tsai (**Nos 66, 68–70, 74, 78–79, 81–82, 85**, HNHM); 1 ♀, Lidao, 1240 m, 26.IX.2007, leg. D. Rédei & J.-F. Tsai (**No 67**, HNHM); 1 ♀, Taoyuan Co., Ming-Chyr, F.R.A., 1100 m, 5–6.X.1996, leg. Gy. Fábián & F. Nemes (**No 15**, HNHM); 1 ♀, Pingtung Co., on the road '199', 900 m, 19.IV.1997, leg. A. Kun & L. Peregovits (**No 88**, HNHM); 4 ♀♀, Taichung Co., Tachen, 1890 m, 29.X.1996, leg. Gy. Fábián & F. Nemes (**Nos 2–4, 7,** HNHM); 2 ♀♀, Taichung Co., 14 km E of Puli, 430 m, 8.V.2010, leg. Gy. Fábián (**Nos 117–118**). **Vietnam:** 2 ♂♂, 1 ♀, Prov. Lao-Cai, Sa-Pa, 1650 m, 24.IX.1963, leg. T. Pócs (**Nos 59, 65, 72,** HNHM); 1 ♂, same, 10 km W of Sa-Pa, Fr. B. C., 1800 m, 17.III.1998, leg. L. Peregovits & T. Vásárhelyi (**No 63**, HNHM); 2 ♂♂, No.100, Moc Chau, 800 m, 25.X.1986, leg. T. Vásárhelyi (**Nos 58, 60**, HNHM); 1 ♂, 1 ♀, No.285, Da Lat, 1500 m, 14-20.X.1988, leg. S. Mahunka & T. Vásárhelyi (**Nos 57, 89**, HNHM); 1 ♂, 1 ♀, same but No.317, 17.X.1988 (**No 64, 92**, HNHM); 1 ♂, same but No.338, 19.X.1988 (**No 56**, HNHM); 1 ♂, same but No.302, 15.X.1988, leg. T. Vásárhelyi (**No 62**, HNHM).

Description. Described in detail by Tsaur *et al.* (1991) in which. however, the captions for Figs 1 and 2 are inadvertently transposed (caption for *M. grossus* under the figure of *M. giganteus* and vice versa). The original description is complemented below.

Colour. General colour brownish-black. Labium and bases of legs pale yellowish-brown. Tegmina with several black markings on veins and in cells, as Fig. 4.

Male genitalia. Pygofer symmetrical, caudal margin (PCM) protruding medially in lateral view (Fig. 69). Apical lobe of anal tube medially emarginate in caudal view, concave, forming two small, rounded projections (Fig. 28); elliptical in ventral view (Fig. 30). Stylus symmetrical, distal lobe quite elongate-elliptical, DLW/DLL = 1.09 (Fig. 64). Phallotheca with four appendages apically on the right (Figs 55–57) and two appendages on the left. Flagellum with three appendages: FL3 well-developed, situated on the left in basal third, FL1 and FL2 acute and sclerotized, located near orifice (Figs 54, 57).

Female genitalia. Ratios ANSL/ANSW and GAPL/GAPW as Table 2 and Fig. 169.

The range of genitalia between a number of females is shown in Figs 144, 148, 152 (from Taiwan), 151, and 157 (from Vietnam). Microsculpture of the bursa copulatrix as Figs 149 and 150. Spermatheca as Figs 154 and 155. Vagina wall pattern (VAGPT) of anterior vagina, in ventral view, with 4 or 5 sclerotized plates, rounded or elliptical, of variable size (Figs 77–82, 157), from which the small ventral-central plate is missing in some specimens (Figs 77, 80–81); the two adjacent anterior sclerotized plates may be fused (Figs 81–83).

Measurements as Tables 1–2.

Distribution. Taiwan (Tsaur *et al.* 1991; and further records in the current study); Vietnam (first record in the current study).

Habitat. The specimens from Taiwan were collected at altitudes of 500–600 m in subtropical monsoon forest and hard-leaved rainforest. Most of the adults were taken in September and October. Specimens from Vietnam were collected by light-trapping in rainforest areas at altitudes of 800–1800 m.

Differential diagnosis. *M. grossus* Males may be differentiated from other members of the genus by the medially emarginate, concave apical lobe of the anal tube (a character defining the *grossus* species-group) and the presence of a third appendage (FL3) of the flagellum (Fig. 54), while the other *Macrocixius* spp. have only two appendages.

Females may be defined by high values of GAPL/TPRT (Fig. 169, Table 2), a short series of teeth on the GAPIX (Figs 109–123), and by a characteristic vagina wall pattern (VAGPT) composed of 4–5 small, rounded, sclerotized plates (Figs 77–82).

Macrocixius emeljanovi sp.nov.

(Figs 5–9, 14–16, 46–49, 68, 71, 86–94, 124–132, 147, 158)

Type material. Holotype: ♂, "Taiwan, Ilan Hsien, Fu-Shan, LTER Site 600 m, 25–27.IX.2000. leg. L. Peregovits, L. Ronkay & L. Papp"/(**No 23**). Deposited in NMNS.
Paratypes: **Taiwan:** 23 ♂♂, 6 ♀♀, same data as holotype (**Nos 5–6, 12, 17, 19–20, 22–29, 32–34, 36–37, 39, 42, 44, 46, 52, 54–55**; HNHM); 5 ♂♂, Yilan Co., Fushan B.G., 636 m, 16.IX.2007, leg. D. Rédei & J.-F. Tsai (**Nos 38, 40–41, 43, 45**; HNHM); 1 ♂, Taipei Co., Pi-Hu, 410 m, 26.III.1997, leg. G. Csorba & L. Ronkay (**No 30**; HNHM); 1 ♂, same data but 600 m, ca. 50 km SE of Taipei, 30.III.2000, leg. A. Kun & L. Peregovits (**No 18;** HNHM); 2 ♂♂, Pingtung Co., on the road '199', 500 m, 19.IV.1997, leg. A. Kun & L. Peregovits (**No 35, 48**; HNHM); 1 ♂, Taitung Co., Hsiangyang 2200 m, 13.VI.1997, leg. B. Herczig & L. Ronkay (**No. 31**; HNHM); 1 ♂, 1 ♀, Ilan Co., Fu-Shan B.G. LTER Site, 600 m, 25–28.III.2003, leg. M. Földvári & L. Papp (**Nos 13, 47**; HNHM); 1 ♂, 3 ♀♀, Taitung Co., Yakou, 2600 m, 6.XII.1998, leg. Gy. Fábián & Z. Korsós (**Nos 9, 14, 21, 53**; HNHM); 2 ♀♀, Pintung Co. Mutan, 12.VI.1997, leg. B. Herczig & L. Ronkay (**Nos 10–11;** HNHM); 1 ♀, Ilan Co. Ming-Chyr, Forest Recreation Area, 1200 m, 5.IV.2002, leg. Gy. Fábián & O. Merkl (**No 8;** HNHM); 1 ♀, Wulu, 1100 m, 26.IX.2007, leg. D. Rédei & J.-F. Tsai (**No 87**; HNHM); 1 ♂, 4 ♀♀, Kenting, 12.V.2010, leg. Gy. Fábián (**Nos 119, 123**, NCHU; **No 122**, ZIN; **Nos 120-121,** HNHM); 2 ♂♂, Taoyuan Co., Ming-Chyr, 1200 m, 4–5.V.2010, leg. Gy. Fábián (**No 124**, HNHM; **No 125,** ZIN); 1 ♀, Nantou, 8.VII.1975, leg. C. T. Yang (**No 112**, NCHU). **Nepal:** 1 ♀, Ganesh Himal, between Godlang-Nesim, 2720 m, 22.X.1995, leg. L. Peregovits & L. Ronkay (**No 93**, HNHM).

Description. Colour. Ventral and lateral parts of body covered in scatterings of powdery wax of variable extent. Ground colour of body dark brown to blackish-brown; mesonotum the darkest part of dorsum, lateral carinae and area under and around tegulae

paler, light yellowish-brown. Postfrontal area brown, marginal carinae with thin, brownish-black keel. Lateral portion of vertex near eye light yellowish-brown, central part darker, as pronotum; pronotum laterally dark brown behind compound eyes. Frons dark brown, central and lateral carinae brownish-black. Anteclypeus and postclypeus dark brown, labium pale brown. Abdominal dorsum and venter blackish-brown, posterior margin of sternites yellowish-brown. Trochanters, coxae and femora of fore- and mid-legs yellowish-brown. Ground colour of hind legs light yellowish-brown, femur and tibia with obscured brown spots. Tegmina translucent, main longitudinal veins with scattered blackish-brown tubercles, each provided with an apical seta, light yellowish-white in colour. Cross-veins at the tips of the wings and spots on membrane more or less blackish-brown (Fig. 6).

Structure. Chaetotaxy of hind tarsi: 8/7(8).

Male genitalia. Anal tube dilated from basal part to apical lobe (incrassate) in ventral view, nearly elliptical (Fig. 16); in lateral view, stem and apical lobe forming a slightly obtuse angle (Fig. 15); in posterior view, outline of middle and distal parts of apical lobe slightly produced and rounded (Fig. 14). Posterior margin of pygophore truncate (Fig. 71). Stylus as Fig. 68, DLW/DLL ratio approximately 1.3. Aedeagus as Figs 46–49. Basal part of phallotheca nearly symmetrical in ventral view; ventrocaudal outline of stem nearly straight in lateral view (Figs 46, 48), only gently curved from base to distal two-thirds; apex of phallotheca with pointed (spine- or blade-like) appendages on both sides; left side of stem with three appendages: pronounced PHL3 adhering closely to stem, and slender, spine-like PHL1 and PHL2 parallel to flagellum; right side of apex with four appendages, two of them large: a flattened, curved and sword-like PHR4 and a straight PHR3 directed downwards at acute angle to the stem. Flagellum with two strong, spine-like appendages (Figs 46, 49): FL1 smaller, located near orifice, FL2 larger, located in medial third of flagellum.

Female genitalia. Vagina slightly asymmetrical in ventral view, left side slightly excavated midway; ventral wall with only two large sclerotized plates: anterior right plate with a characteristic shape, reminiscent of an outline of South America (Figs 86–94, 158), situated mid-vagina, tapering downwards towards its right side.

Measurements in Tables 1–2 and Fig. 169.

Etymology. The species is named after Professor A.F. Emeljanov, an eminent Russian entomologist.

Distribution. The majority of the specimens collected to date are from Taiwan; single specimen from Nepal.

Habitat. The altitude at which specimens were collected in Taiwan ranges between 120 m and 2600 m. The species was thus collected from lowland mixed broad-leave forest, through subtropical monsoon forest, deciduous hard-leaved forest at higher elevations, then subalpine coniferous forests, to high-mountain moss forest.

Differential diagnosis. Males of *M. emeljanovi* sp.nov. may be distinguished from the other species of the genus by: apical lobe of anal tube medially produced, rounded (a character shared with other species of the *giganteus* species-group); stem of anal tube in

lateral view meeting the apical lobe at a slightly obtuse angle (Fig. 15); phallotheca, in lateral view, widening uniformly from basal third to apex (Fig. 46); PHR4 curved, sword-like, flattened in apical half (Figs 46, 48); FL2 arising from medial third of flagellum and parallel to it (Fig. 46).

The females have a specific vagina wall pattern (VAGPT) with two large sclerotized plates (in ventral view), one of them of characteristic shape, reminiscent of South America and tapering towards the right (Figs 86–94, 158).

The A/B ratios of both sexes are the lowest in the genus (Fig. 168).

Remarks. From Nepal, only one female specimen (**No 93**) could be identified as *M. emeljanovi* based on the A/B ratio and a study of VAGPT, both of which match specimens from Taiwan (Fig. 90, compare Figs 86–94). This specimen from Nepal was collected in an undisturbed mossy forest area dominated by *Quercus*.

***Macrocixius gigantomimus* sp.nov.**
(Figs 22–24, 59–61, 63, 72)

Type material. Holotype: ♂, "Vietnam, Da Lat, Nr. 317, 1500 m, 17.X.1988. leg. S. Mahunka & T. Vásárhelyi"/(**No 101**). Deposited in HNHM.
Paratype: 1 ♂, same data as holotype except Nr.285, 14.X.1988, leg. T. Vásárhelyi (**No 103**, HNHM).

Description. Colour. General body colour lustreless dark brown. Frons between frontal suture and border ridge of postfrontal field blackish-brown, postfrontal area, middle of vertex, whole mesonotum and lateral sclerites under tegulae similarly coloured. Frontal suture separates dark areas of frons from honey-yellow postclypeus and anteclypeus, this yellow colouration extending towards genae; remainder of genae darker brown. Pronotum with two small, dark-brown pits close to midline, laterally light yellowish-brown. Genae covered with brilliant-white powdery wax on both sides below insertion of antennae. Legs yellowish-brown without conspicuous spots, apart from obscured darker spots on femora and tibiae near joints. Tarsal segments also darker, sparsely covered in powdery wax. Metatibia with 3–4 spines with dark tips laterally, following one another in a sparse row. Upper and lower part of abdomen honey-brown. Tegmina transparent, without traces of powdery wax, longitudinal veins yellowish-brown, except for scattered brown sections with tuberculi and dark brown setae originating from each tubercule; inner margin of tegmen with conspicuous brown spots at clavus midway; stigma dark brown; apical cells with scattered pale-brown spots; cross-veins blackish-brown; basal part of cubital vein with strongly thickened blackish-brown section.

Structure. Chaetotaxy of hind tarsi: 8/9.

Male genitalia. Caudal margin of pygofer (PCM) rounded in lateral view (Fig. 72). Stem of anal tube parallel-sided in lateral view, meeting apical lobe at a right angle (Fig. 23); stem elongate, elliptical in ventral view; in caudal view, middle part of apical lobe strongly produced and narrowly rounded (Figs 22, 24). Stylus, in inner dorso-lateral view, with a medially constricted stem; ratio DLW/DLL = 1.28, and with a small protruding knob on inner side apically between stem and distal lobe (Fig. 63). Phallotheca, in ventral view, parallel-sided in basal two-thirds, slightly narrowing

distally; apex with spine-like appendages on both sides (Fig. 61): with three appendages in left lateral view (PHL1, PHL2, PHL3), PHL3 the largest, slightly curved to the left, PHL1 directed steeply towards inner body, and PHL2 adhering closely to stem, partly following the direction of PHL3 (Fig. 59); phallotheca with four appendages in right lateral view (PHR1–PHR4), PHR1 running parallel to PHL1, the other three appendages almost equal in size, slender, spine-like (Fig. 60). Flagellum with two appendages: a larger FL1, directed towards inner body, and a smaller FL2 originating on its side (Fig. 59).

Female genitalia unknown.

Measurements in Table 1.

Etymology. The name refers to the close resemblance between *M. gigantomimus* sp.nov. and *M. giganteus*.

Distribution. To date known from only Vietnam.

Habitat. Captured with light traps at elevation of 1500 m, at the border of rainforest and cultivated fields.

Differential diagnosis. The males of *M. gigantomimus* sp.nov. may be distinguished from all other congeners by the medially produced, rounded apical lobe of their anal tube (a character also shared with the other species of the *giganteus* species-group); anal tube parallel-sided in lateral view and forming a right angle between the stem and the apical lobe; PHR4 appendage of phallotheca long and straight, and smallest FL2 appendage of flagellum lying within the *giganteus* species-group.

***Macrocixius lautereri* sp.nov.**

(Figs 25–27, 42–45, 58, 76, 167)

Type material. Holotype: ♂, "W. Sumatra. Bengkulu prov. nr Curup; Bukit Kaba Mt.: 3°29′ S, 102°36′ E, 1000–1500m; D. Hauck leg.: 30.i.–3.ii.2000./Collectio Moravské Museum Brno/(**No.100**)". Deposited in MMBC.

Description. Colour. Vertex, pronotum and postfrontal area dark honey-coloured. Frons with irregular dark brown spots. Edges of middle and lateral carinae thinly brownish-black. Anteclypeus, postclypeus, and labium all yellowish-brown. Legs with similar coloration, partly with a darker brown tint. Mesonotum, in dorsal view, darker than remainder of body. Both dorsal and ventral surfaces of abdomen light honey-coloured. Tegmina translucent, covered in lightly-scattered powdery wax, main veins of tegmen yellow with tuberculi forming elongate brown spots on them. Apical crossveins blackish-brown (Fig. 167).

Structure. Chaetotaxy of hind tarsi 7(8)/9; only second tarsomere with patellae.

Male genitalia. Caudal margin of pygofer (PCM), in lateral view, forming a rounded lobe directed upwards (Fig. 76), sides slightly asymmetrical. Stem of anal tube nearly round in ventral view (Fig. 27); parallel-sided from base to apical lobe in lateral view, (Fig. 26), meeting apical lobe at almost right angles; apical lobe, in caudal view, emarginate midway, concave (Fig. 25), symmetrically rounded on sides. Stylus with

distal lobe forming a perfect equilateral triangle in dorso-lateral view (Fig. 58); DLL/DLW ratio 1:1. Phallotheca, in ventral view, with symmetrical downward-pointed spiny lobes on both sides basally (Fig. 43) and appendages on both sides apically: in left lateral view, with two appendages (PHL3, PHL1, Fig. 42): PHL3 with thickened basal part, oriented parallel to stem; in right lateral view, with four appendages (Fig. 44), of which PHR4 is the largest, flattened, wide, sword-like and curved around stem (in ventral view); other three appendages thin, elongate, spine-like. Flagellum with two short spine-like appendages (FL1, FL2), both situated apically, FL1 smaller, FL2 larger (Fig. 45).

Female genitalia unknown.

Measurements in Table 1.

Etymology. The new species is named after Dr. Pavel Lauterer, entomologist emeritus of the Moravian Museum, with our great appreciation.

Distribution. The only specimen known to date was found in Indonesia: Sumatra.

Differential diagnosis. *Macrocixius lautereri* sp.nov. belongs to the *grossus* species-group in the light of the medially emarginate, concave apical lobe of its anal tube. It may be distinguished from both the other members of the group, *M. grossus* and *M. orophilus* sp.nov., by the shorter and evenly rounded apical half of its anal tube (in ventral view), and by the perfectly equilaterally triangular distal lobe of the style (Fig. 58). It also differs from *M. grossus* in the reduced number of appendages of the flagellum (only FL1 and FL2 present while *M. grossus* has three appendages); and from *M. giganteus* by the lack of the PHL2 appendage at the apical part of phallotheca (present in *M. giganteus*).

Macrocixius monticola **sp.nov.**

(Figs 17, 18, 38–41, 62, 66, 75, 84, 105–107)

Type material. Holotype: ♂, "Vietnam, No.338, Da Lat. 19.X.1988. leg. S. Mahunka & T. Vásárhelyi"/(**No 98**). Deposited in HNHM.

Paratypes. **Vietnam:** 1 ♂, same data as holotype but No.302, 15.X.1988. leg. Vásárhelyi (*No. 2005-03-1003* [code of wing preparation], **No 90**); 1 ♂, Da Lat, 1500m, No.285, 14.X.1988. leg. Vásárhelyi T. (**No 97**); 1 ♂, Da Lat, Thac Prenn waterfall, 10.XII.1994. No.756, leg. S.Mahunka, Gy. Sziráki & L. Zombori (**No 99**); 1 ♂, Da Lat, Institute of Biology, 4.XII.1994, No.697, leg. S. Mahunka, Gy. Sziráki & L. Zombori (**No 86**); 1 ♀, Da Lat, Institute of Biology, 7.XII.1994, No.730, leg. S. Mahunka, Gy. Sziráki & L. Zombori (**No 80**); 1 ♀, Da Lat, 1500m, 14–20. X.1988, No.285, leg. S. Mahunka & T. Vásárhelyi (**No 83**); 1 ♀, Da Lat, No.358, 19.X.1988. leg. Vásárhelyi T. (**No 91**). All paratypes are deposited in HNHM.

Description. Colour. Frons near frontoclypeal suture with pale yellowish-brown spots. Edges of median and lateral ridges of frons appearing as thin, dark-brown lines. Lateral parts of vertex near compound eyes largely yellowish-white. Pronotum and tegulae lighter than mesonotum, yellowish-brown. Metafemora with blackish brown spots at joints, remaining parts yellowish-brown. Forewings transparent, glassy, veins pale yellow, bearing brownish, longitudinally-elongated spots; tuberculi small, almost indistinguishable; in apical third of tegmen longitudinal veins and crossveins dark brown; symmetrical dark brown rows of spots on subcostal vein and inner margin of clavus.

Structure. Chaetotaxy of hind tarsi: 8/8.

Male genitalia. Pygofer symmetrical, caudal margin produced into finger-like lobe (Fig. 75). Anal tube, in ventral view, with stem constricted in basal quarter, widening in apical three quarters, V-shaped, with apex truncate (Fig. 62); apical lobe medially produced, slightly rounded (Fig. 17). Stylus axe-shaped in inner dorso-lateral view (Fig. 66); DLW/DLL = 1.64. Phallotheca narrowing towards flagellum (Fig. 39), apically with thin, pointed appendages on both sides: in right lateral view, with four appendages (PHR1–4, Fig. 40), of which PHR2 and PHR4 are larger and stronger and of nearly the same length, directed towards the inner body, PHR4 curved around stem; three appendages are visible near apex in left lateral view (Fig. 38), of which PHL2 is the longest, directed caudo-ventrad, and PHL3 is two-thirds as long as PHL2. Flagellum with strong, ventral, spine-like appendage FL2 (Fig. 38) and small FL1 near orifice.

Female genitalia. Anal tube nearly parallel-sided in dorsal view. Serrate section of TPRT long, teeth distributed at regular intervals, large in mid-section, similar to those of *M. giganteus*. Sclerotized plates in wall of anterior vagina converging in ventral view and almost entirely filling the space between base and insertion point of ductus receptaculi (Fig. 84).

Measurements appear in Tables 1–2 and Fig. 169.

Etymology. The name of the new species is derived from the Latin *monticola*, indicating that it lives in mountains. Noun in apposition.

Distribution. Currently known from only Vietnam.

Habitat. Specimens of the type series were captured with light traps in two different habitats: at elevations of 900 m (near Thac Prenn waterfall) and around 1500 m (Da Lat) between arable land and rainforests.

Differential diagnosis. *M. monticola* sp.nov. belongs to the *giganteus* species-group, based on the medially produced, rounded apical lobe of its male anal tube. The males of *M. monticola* sp.nov. differ from those of other members of this species-group in stylus with an axe-like distal lobe; V-shaped stem of anal tube, quite widely open, with truncate apex (in ventral view); symmetrical pygofer bearing finger-like process on its caudal margin; and flagellum of aedeagus with a strong and basally broad FL2, situated medio-ventrally (Fig. 38). The females may be distinguished from the other species of the genus by their specific vagina wall pattern (Fig. 84).

Macrocixius orophilus sp.nov.

(Figs 1, 2, 31–33, 50–53, 65, 73, 74, 85, 133, 153)

Type material. Holotype ♂, "Nepal, Ganesh Himal, 2 km E of Thangjet, 2260 m, 1995.VII.20. leg. M. Hreblay & T. Csővári"/(**No 106).** Deposited in HNHM.
Paratypes: **Nepal:** 1 ♂, 1 ♀, same data as holotype (**Nos 95, 96**, HNHM).

Description. Colour. General body colour dull blackish-brown. Frons, anteclypeus and postclypeus, postfrontal area and genae uniformly brown, lateral ridges yellowish-brown, margins thinly lined in black. Vertex, pronotum and mesonotum dark brown dorsally, mesonotum with lateral ridges lighter brown. Lateral parts of vertex near compound eyes

dull honey-brown. Hind legs yellowish-brown, only tips of tarsal segments darker, blackish-brown. Forewings translucent, longitudinal veins yellowish-white, bearing many longitudinally elongated brown spots, each with a tubercle; crossveins and stigma dark brown; apical cells spotted brown; costal vein and inner margin of tegmen thinly blackish-brown, both with a row of brown spots along their length (Fig. 2). Hind wing as Fig. 1.

Structure. Chaetotaxy of tarsi: 9/(9–11);with one or two patellae on second tarsal segment.

Male genitalia. Caudal margin of pygofer with a narrowly rounded lobe medially, curved towards inner body (PCM in Figs 73–74). Anal tube, in lateral view, with stem and apical lobe forming a near-right angle, ventral margin of stem sinuate, strongly bulging outwards medially; apical lobe, in caudal view, medially concave emarginate, with lateral parts rounded and protruding (Figs 31–33). Stylus, in dorso-lateral view, with stem parallel-sided, DLW/DLL = 1.33. Phallotheca asymmetrical in ventral view, stem slightly shifted leftwards at mid-section (Fig. 51); phallotheca apically with spine-like appendages on both sides: in left lateral view, with two appendages (PHL1, PHL2, Fig. 50), of which PHL 2 is larger, slightly sickle-shaped, directed towards inner body; in right lateral view, with two appendages (PHR1, PHR2, Fig. 52), of which PHR2 is larger, sword-like, curved around stem (in ventral view) to left. Flagellum with two spine-like appendages (FL1, FL2), both originating close to each other, near orifice. Orifice surrounded by characteristic collar-like structure (Figs 52–53).

Female genitalia. The single female specimen examined lacks an anal tube. GAPIX with a row of small, uneven teeth near apex (Fig. 133). Sclerotized plates in wall of anterior vagina (VAGPT, Fig. 85) displaying a specific pattern, with most of the sclerotized plates located at basal (posterior) part on both sides.

Measurements in Tables 1–2 and Fig. 169.

Distribution. The species is currently known only from Nepal.

Etymology. The name is derived from the Greek "ο′ρος" (*oros* = mountain) plus the Latinized Greek *philus* (= liking).

Habitat. The type series was captured with light traps in high-mountain moss-forest.

Differential diagnosis. *M. orophilus* sp.nov. belongs to the *grossus* species-group, having a medially emarginate, concave apical lobe of the anal tube. It may easily be distinguished from the other species of the genus by the genitalia of both sexes and by the specific chaetotaxy (9/9–11). Unique features of the male genitalia include the collar-like apical structure of the flagellum near the orifice (Figs 52–53) and the 2-2 apical appendages of the phallotheca (all the other species have totals of more than four appendages); the females have a characteristic vagina wall pattern (Fig. 85).

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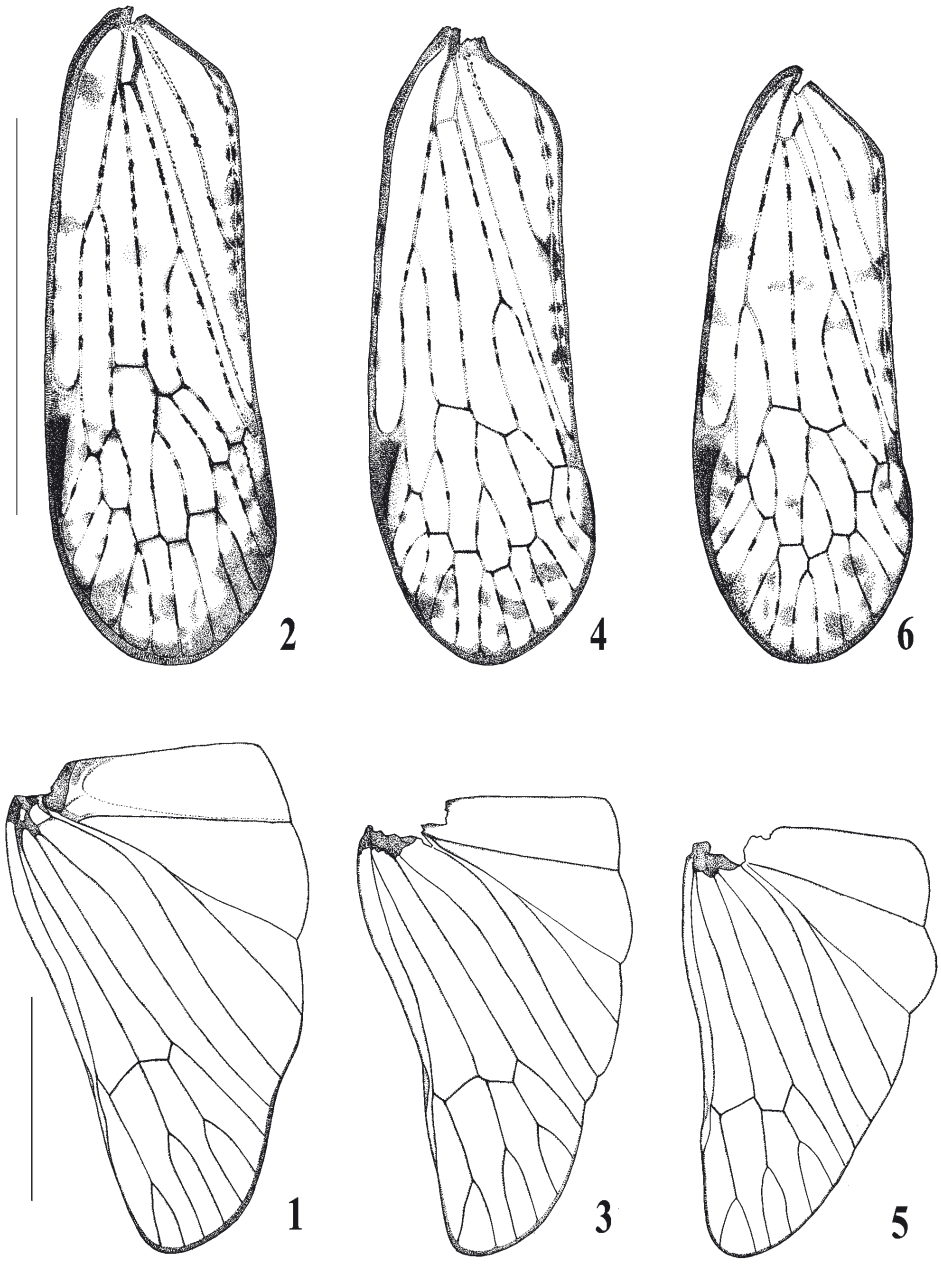
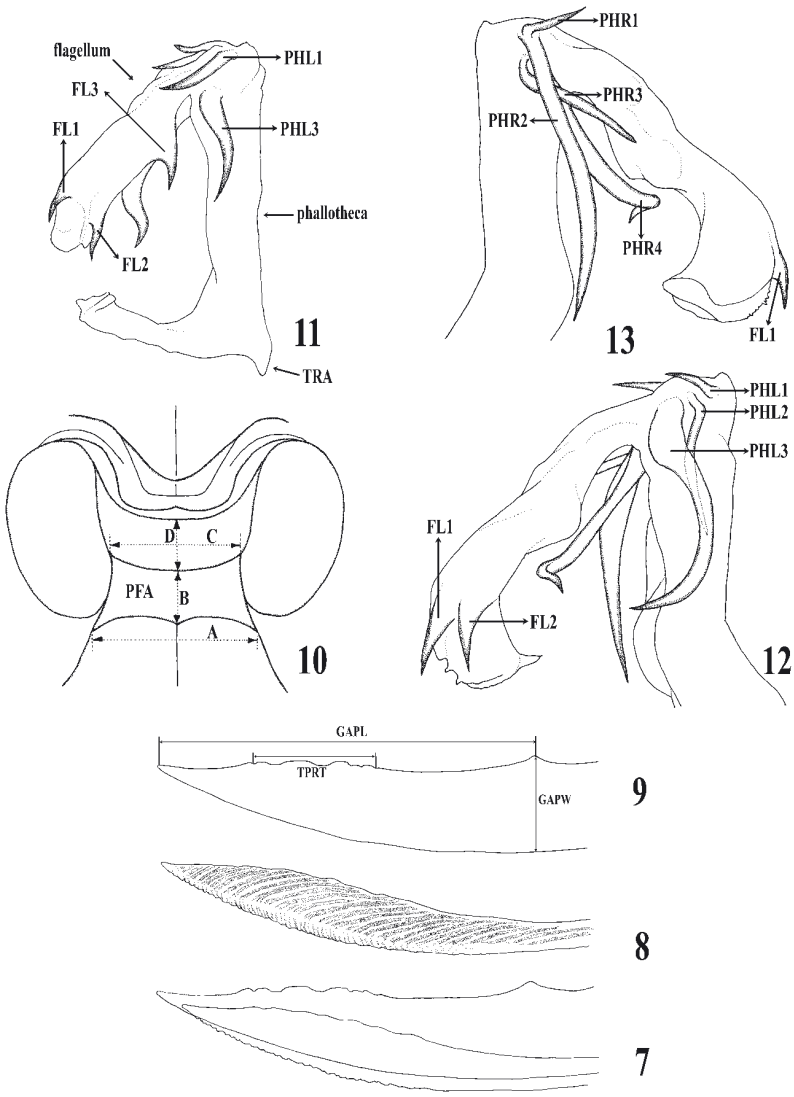
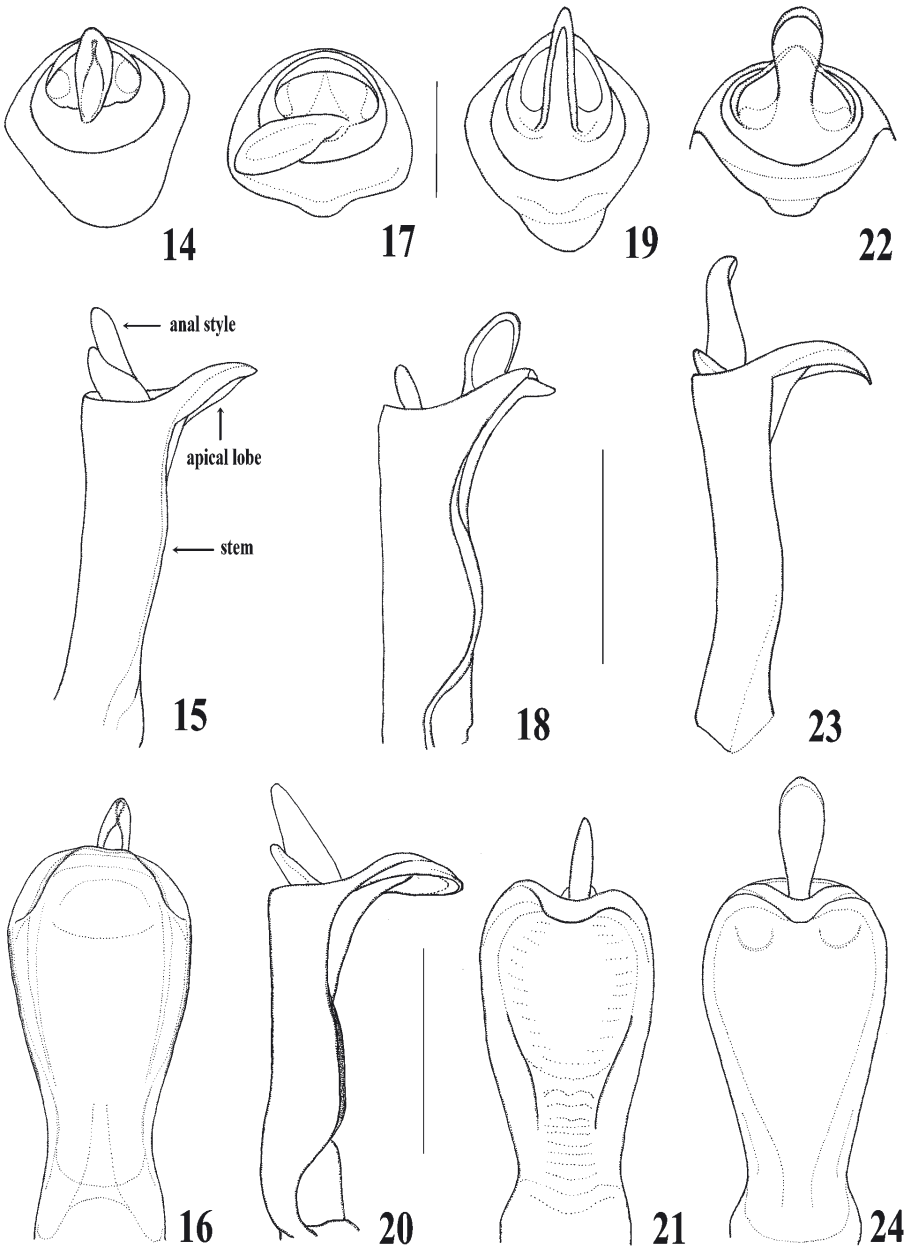


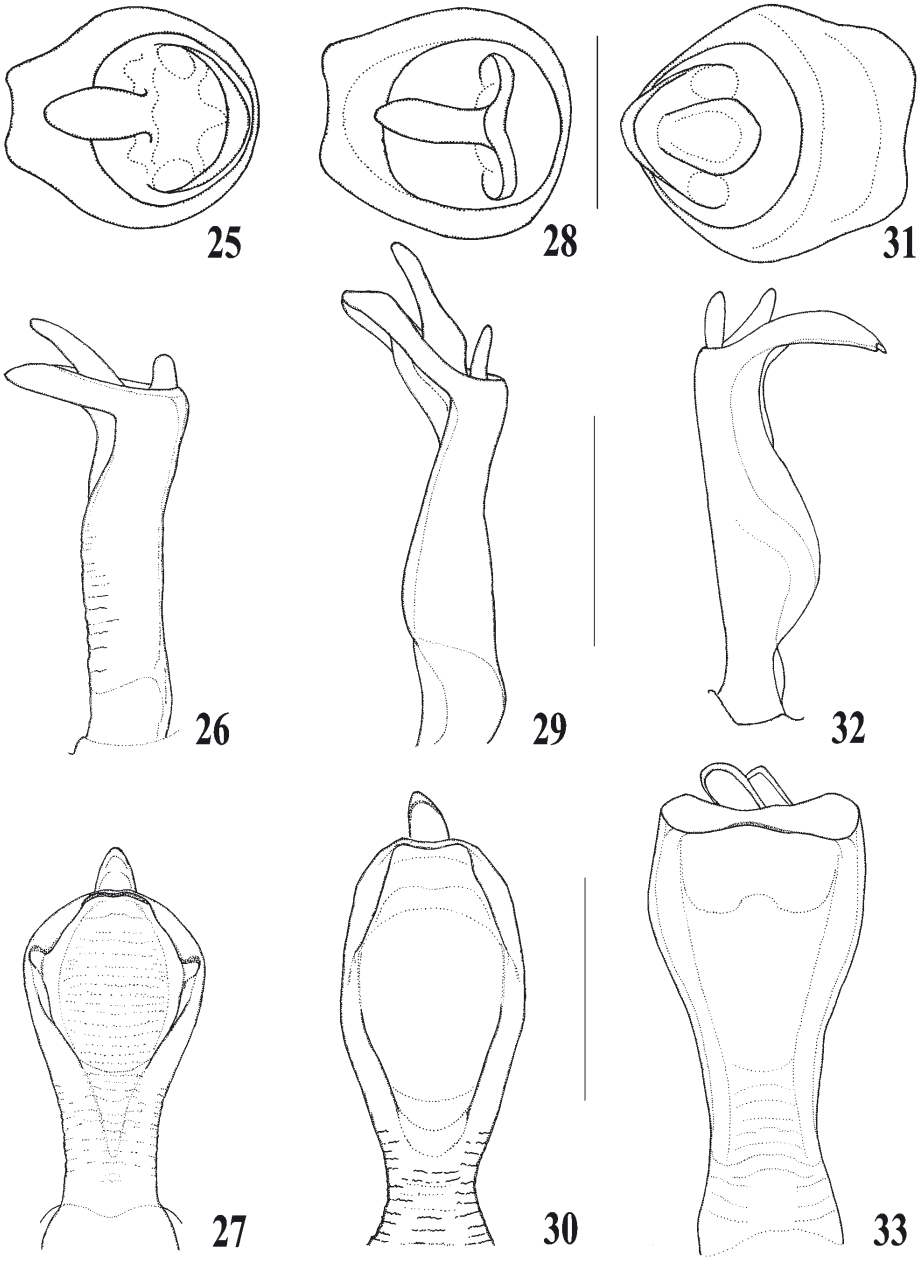
Figs 1–6. Wings of *Macrocixius* spp. 1–2 – *M. orophilus* sp.nov.; 3–4 – *M. grossus* Tsaur et Hsu: 5–6 – *M. emeljanovi* sp.nov. 1, 3, 5 – hind wing, 2, 4, 6 – tegmen. Scale bars = 3 mm (Figs 1, 3, 5); 5 mm (Figs 2, 4, 6).



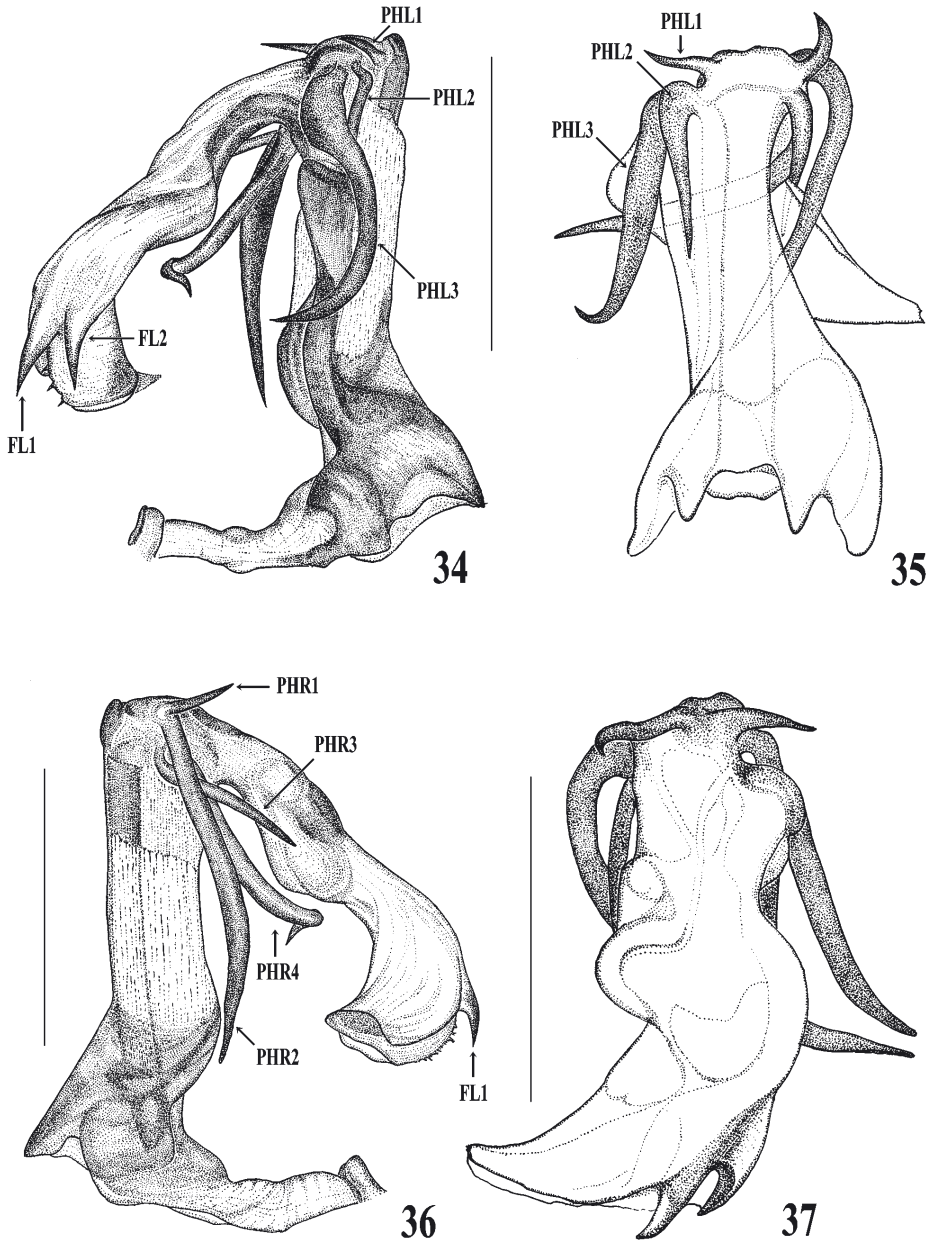
Figs 7–13. Morphology of *Macrocixius* spp. 7–9 – gonapophyses of *M. emeljanovi* sp.nov., in lateral view (**No 93**). 7 – gonapophyses VIII and IX together; 8 – gonapophysis VIII; 9 – gonapophysis IX. 10 – *M. grossus* Tsaur et Hsu, morphometrical characters of head (frons, postfrontal area, vertex). 11–12 – aedeagus in left lateral view, with terminology of appendices: 11 – *M. grossus*; 12 – *M. giganteus* Matsumura; 13 – *M. giganteus*, aedeagus in right lateral view, Abbreviations: A = width of upper carina of frons; B = median lenght of postfrontal area; C = width of vertex between the eyes; D = median lenght of vertex; FL1, FL2, FL3 = first, second and third appendages of flagellum; GAPL = lenght of gonapophysis IX from the middle tooth to apex; GAPW = width of gonapophysis IX; PFA = postfrontal area; PHL1, PHL2, PHL3 = first, second and third appendages of phallotheca on left side; PHR1, PHR2, PHR3, PHR4 = first, second, third and fourth appendages of phallotheca on right side; TPRT= lenght of the serrate part of gonapophysis IX; TRA = basal triangular lobe of phallotheca.



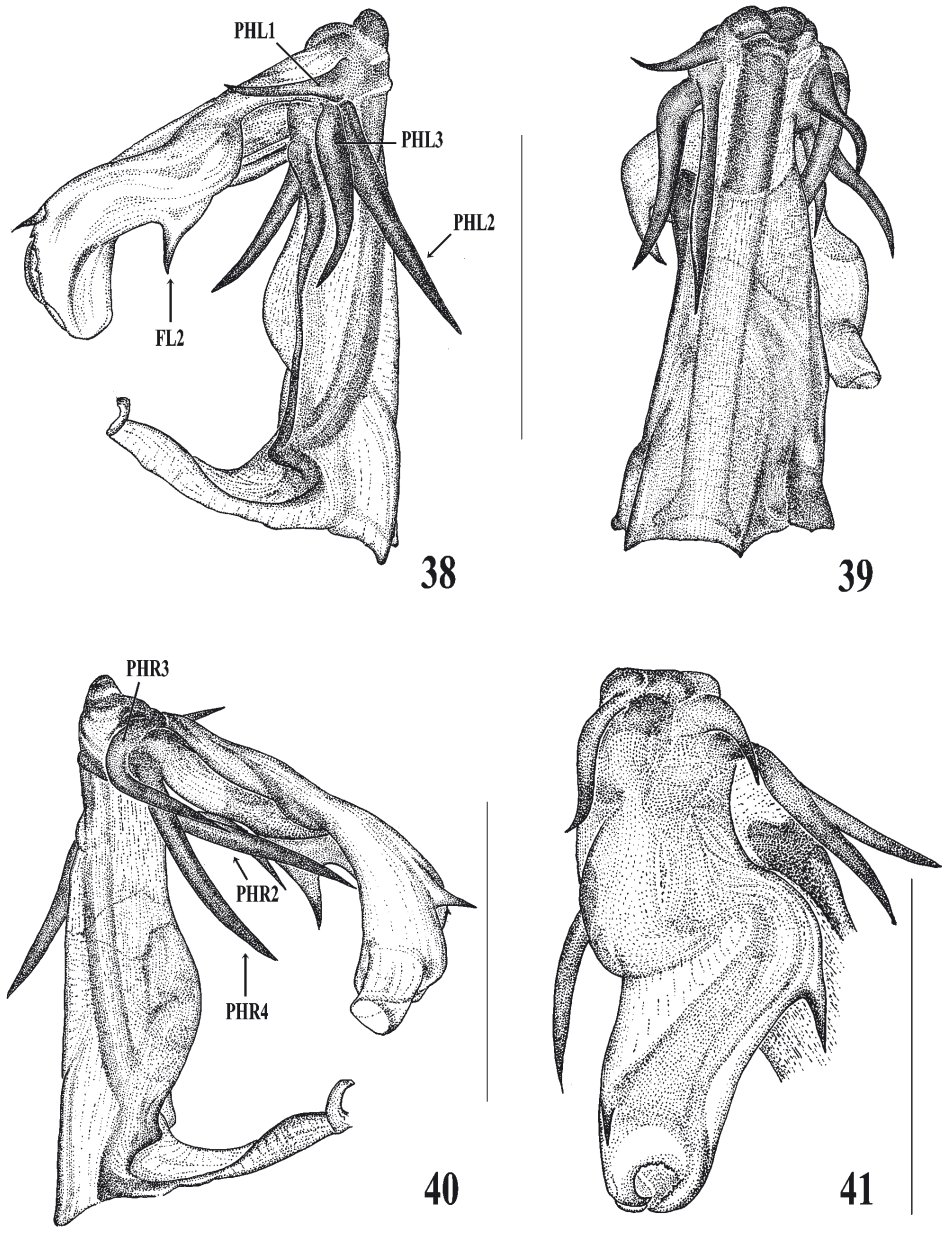
Figs 14–24. Male anal tube of *Macrocixius* spp. 14–16 – *M. emeljanovi* sp.nov. (**No 93**). 17–18 – *M. monticola* sp.nov. (**No 90**). 19–21 – *M. giganteus* Matsumura (**No 105**). 22–24 – *M. gigantomimus* sp.nov. (**No 103**). 14, 17, 19, 22 – apical lobe, caudal view; 15, 18, 20, 23 – anal tube, lateral view; 16, 21, 24 – anal tube, ventral view. Scale bars = 0.3 mm (Figs 14, 17, 19, 22); 0.5 mm (Figs 15, 16, 18, 20, 21, 23, 24).



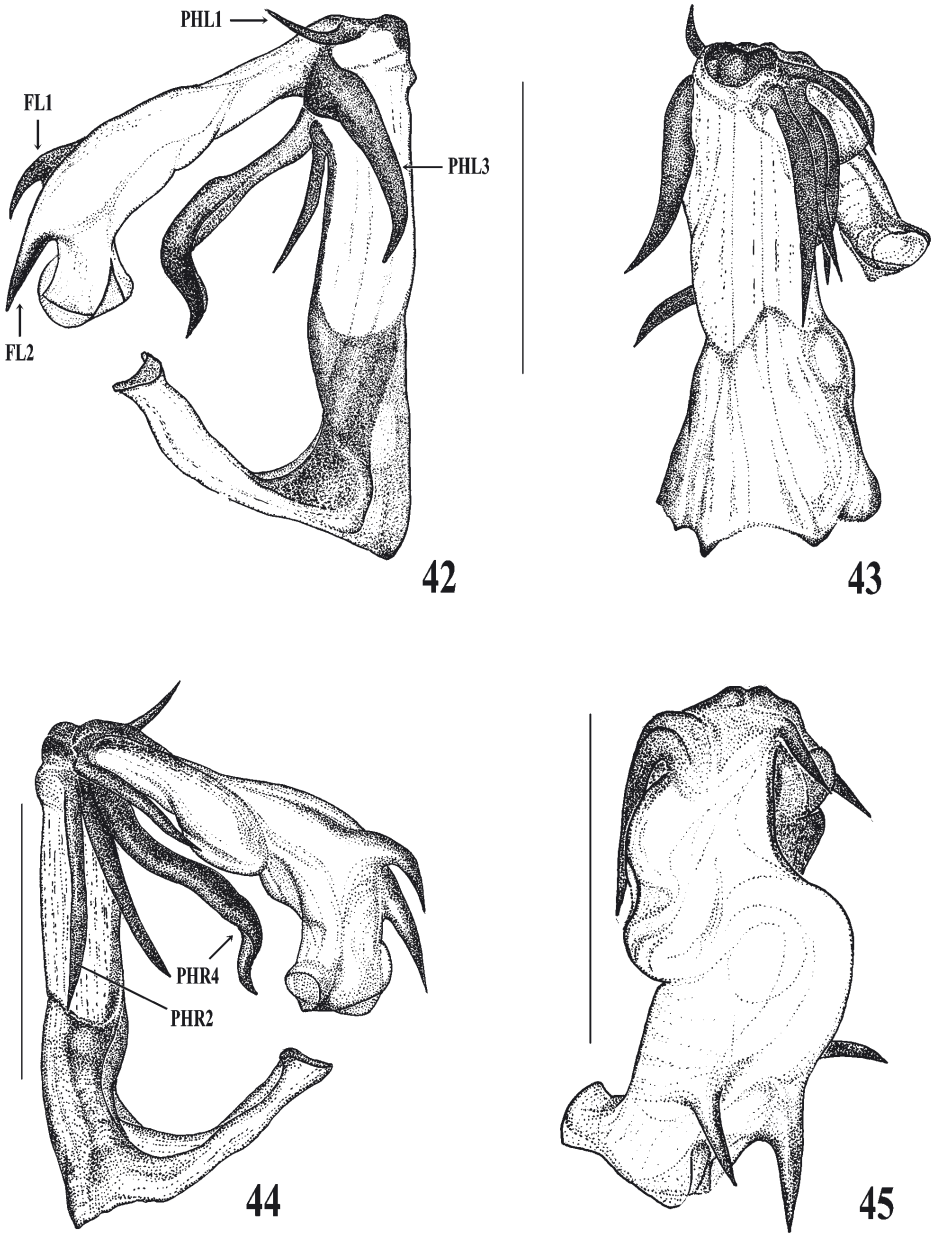
Figs 25–33. Male anal tube of *Macrocixius* spp. 25–27 – *M. lautereri* sp.nov. (**No 100**). 28–30 – *M. grossus* Tsaur et Hsu (**No 73**). 31–33 – *M. orophilus* sp.nov. (**No 96**). 25, 28, 31 – apical lobe, caudal view; 26, 29, 32 – anal tube, lateral view; 27, 30, 33 – anal tube, ventral view; 28, 31 – apical lobe, caudal view. Scale bars = 0.3 mm (Figs 25, 28, 31); 0.5 mm (Figs 26, 27, 29, 30, 32, 33).



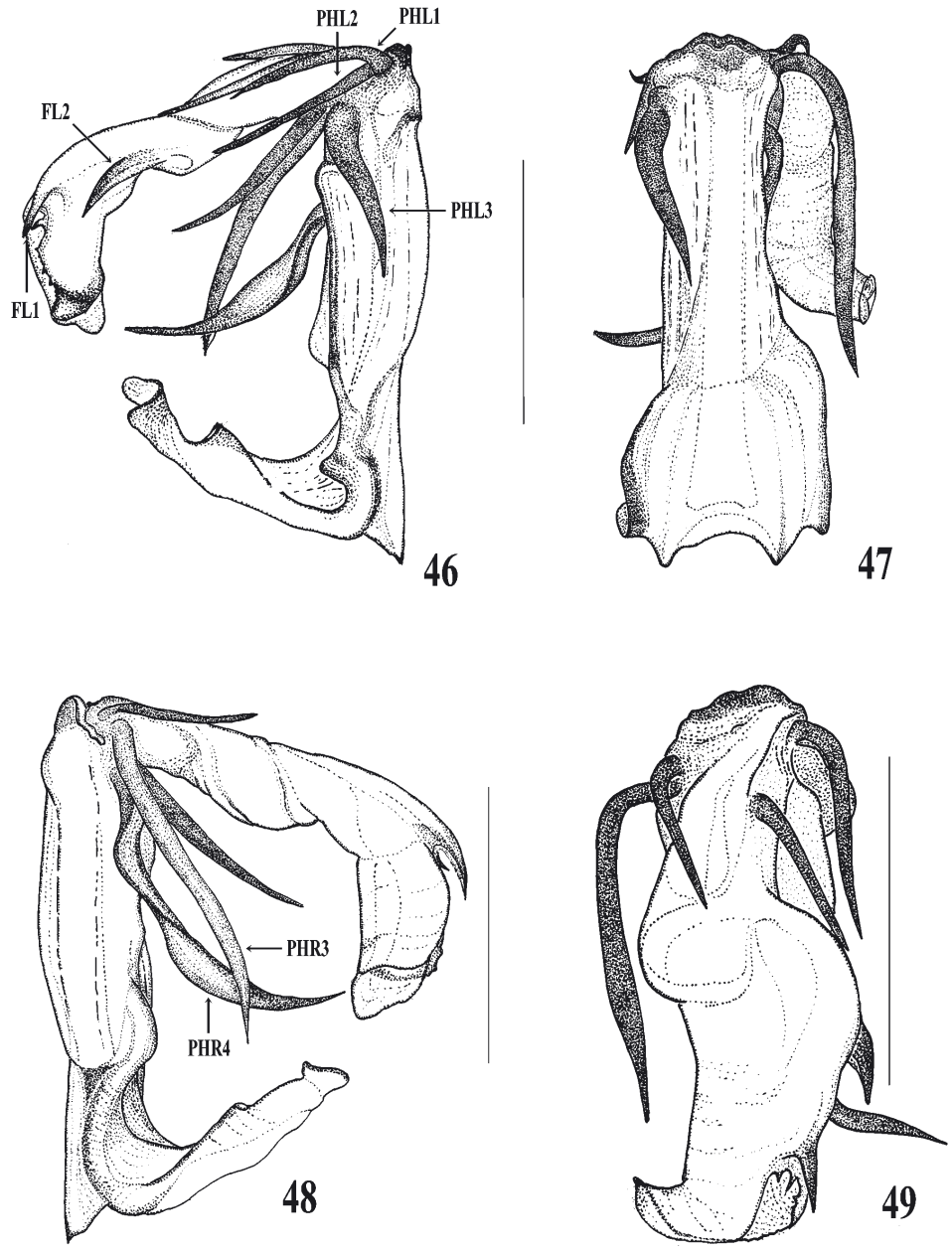
Figs 34–37. Aedeagus of *Macrocixius giganteus* Matsumura (**No 105**): 34 – left lateral view; 35 – ventral view; 36 – right lateral view; 37 – flagellum, dorsal view. Scale bars = 0.5 mm.



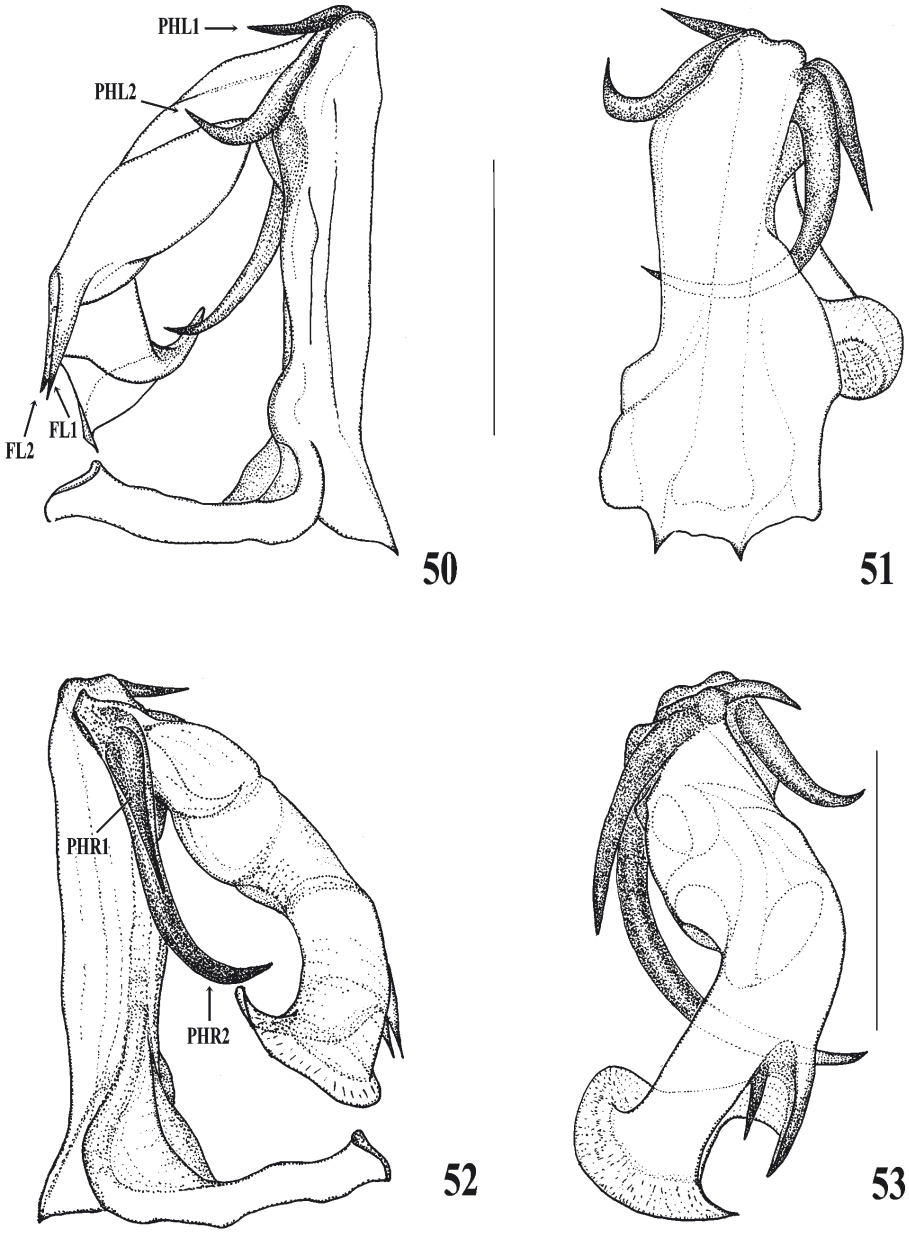
Figs 38–41. Aedeagus of *Macrocixius monticola* sp.nov. (**No 90**): 38 – left lateral view; 39 – ventral view; 40 – right lateral view; 41 – flagellum, dorsal view. Scale bars = 0.5 mm.



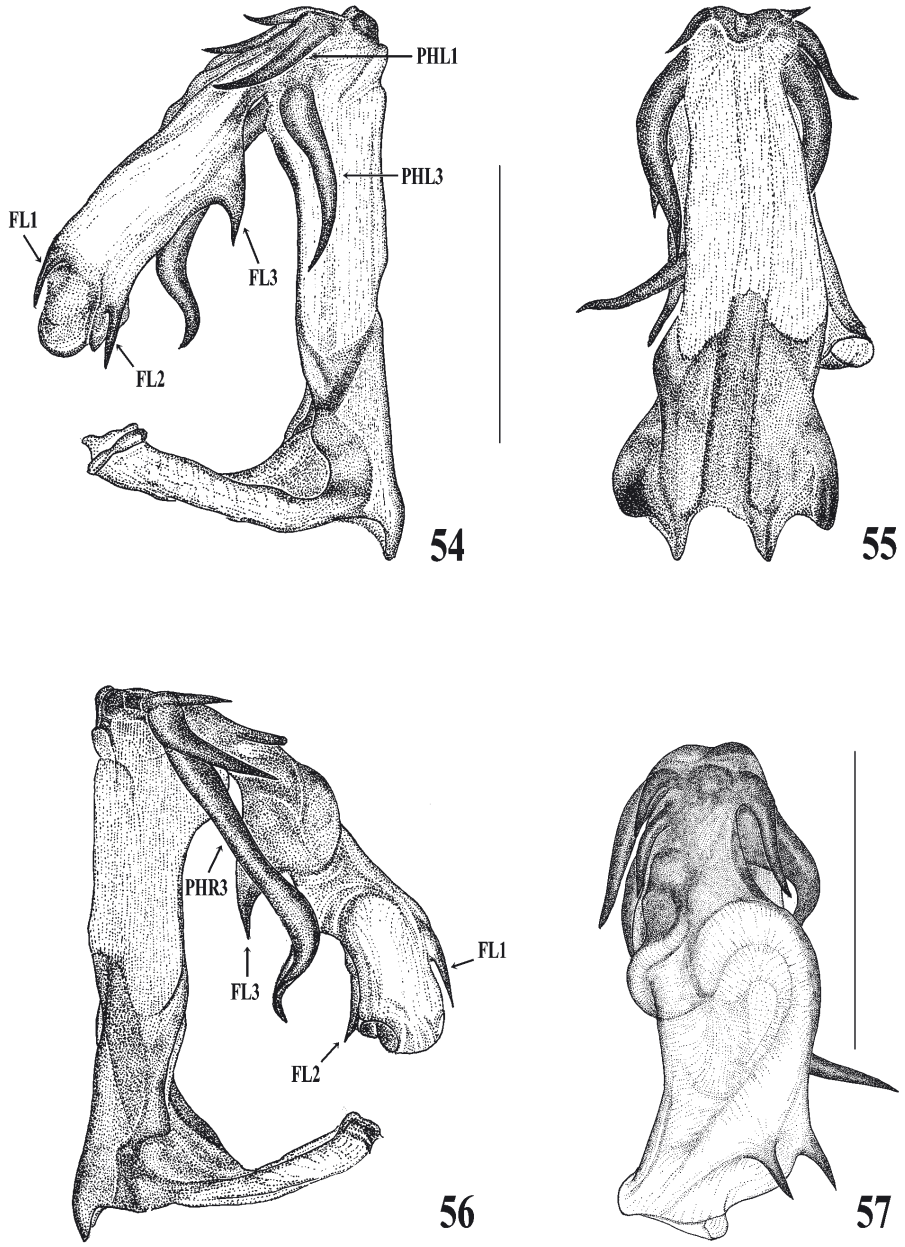
Figs 42–45. Aedeagus of *Macrocixius lautereri* sp.nov. (**No 100**): 42 – left lateral view; 43 – ventral view; 44 – right lateral view; 45 – flagellum, dorsal view. Scale bars = 0.5 mm.



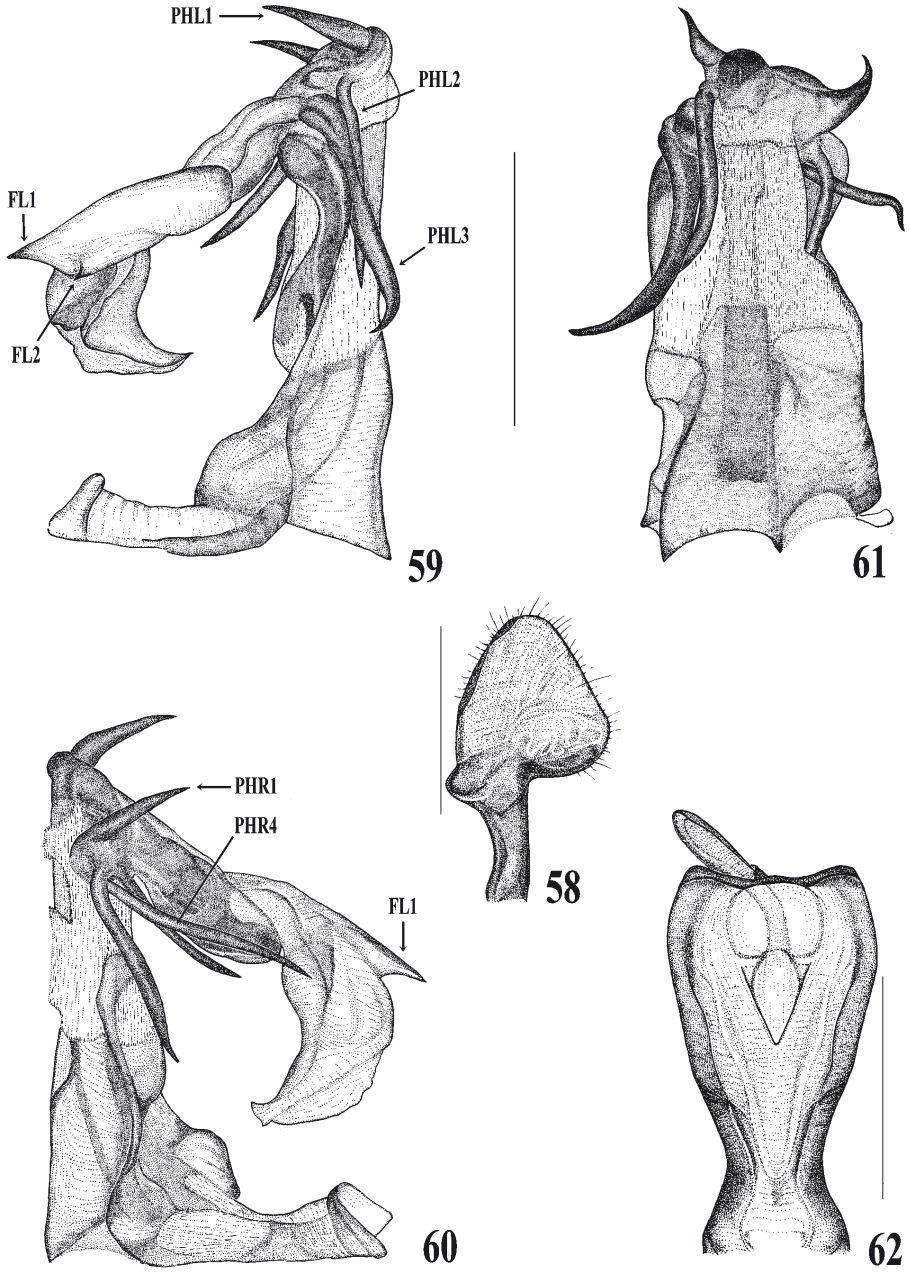
Figs 46–49. Aedeagus of *Macrocixius emeljanovi* sp.nov. (**No 93**): 46 – left lateral view; 47 – ventral view; 48 – right lateral view; 49 – flagellum, dorsal view. Scale bars = 0.5 mm.



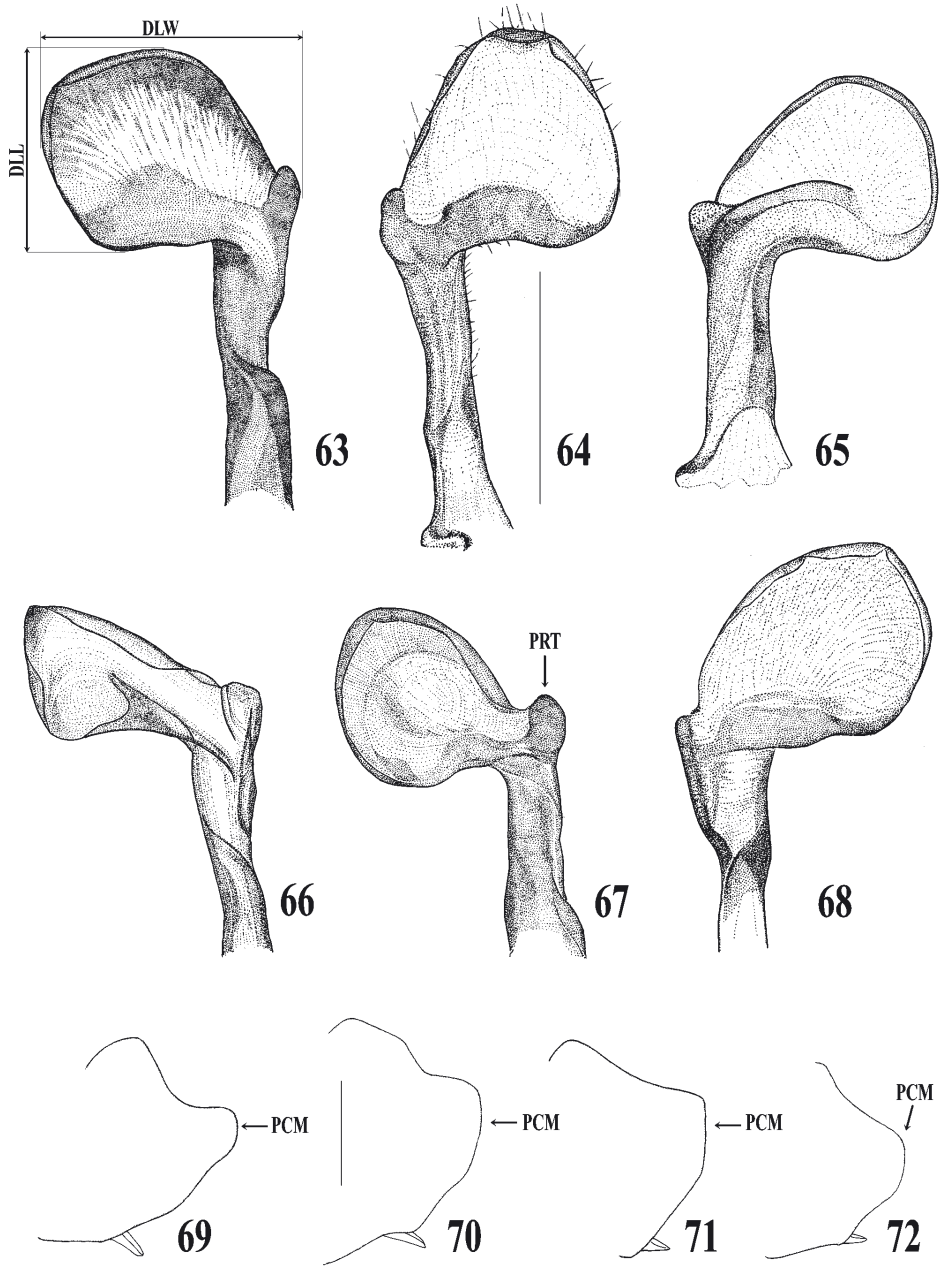
Figs 50–53. Aedeagus of *Macrocixius orophilus* sp.nov. (**No 96**): 50 – left lateral view; 51 – ventral view; 52 – right lateral view; 53 – flagellum, dorsal view. Scale bars = 0.5 mm.



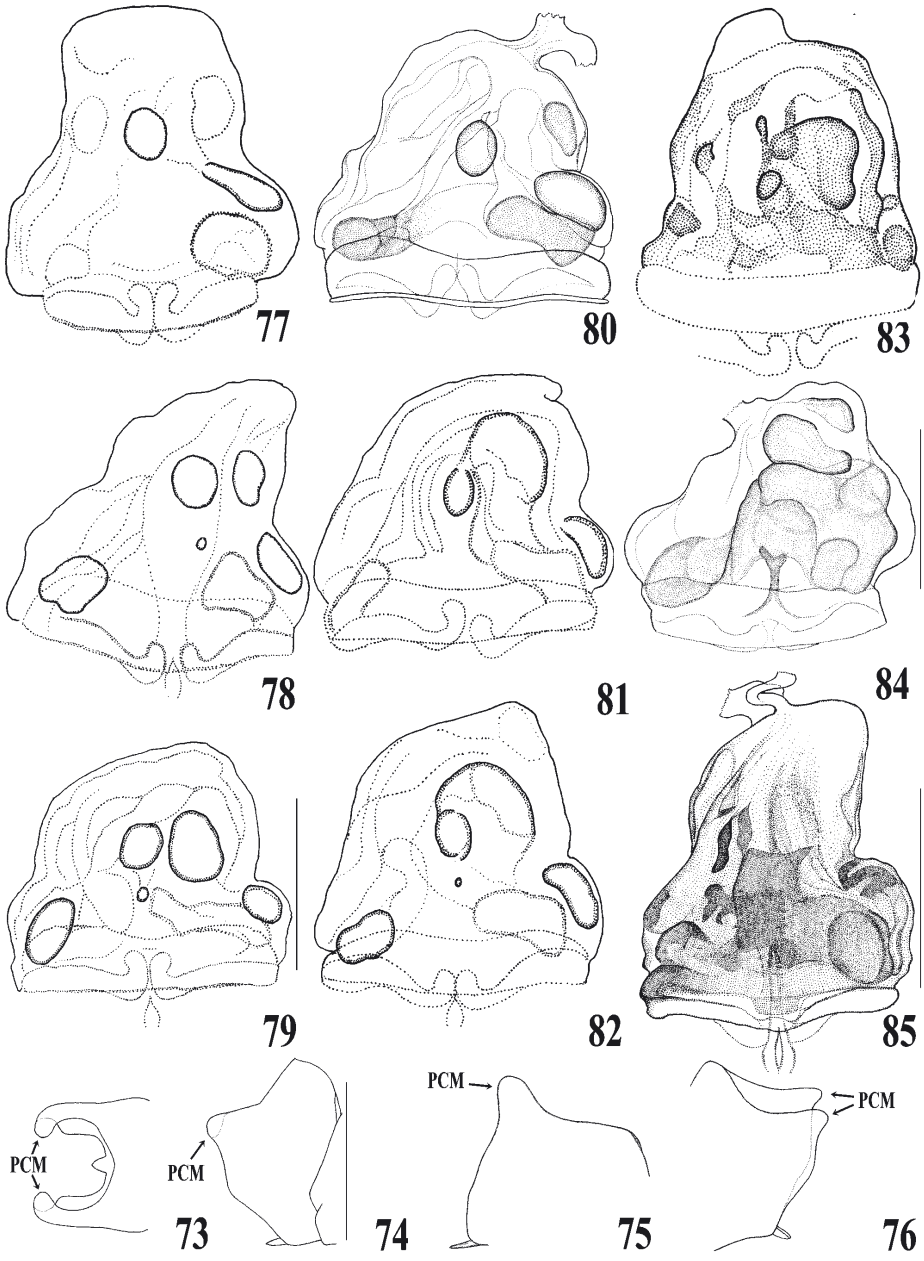
Figs 54–57. Aedeagus of *Macrocixius grossus* Tsaur et Hsu (**No 73**): 54 – left lateral view; 55 – ventral view; 56 – right lateral view; 57 – flagellum, dorsal view. Scale bars = 0.5 mm.



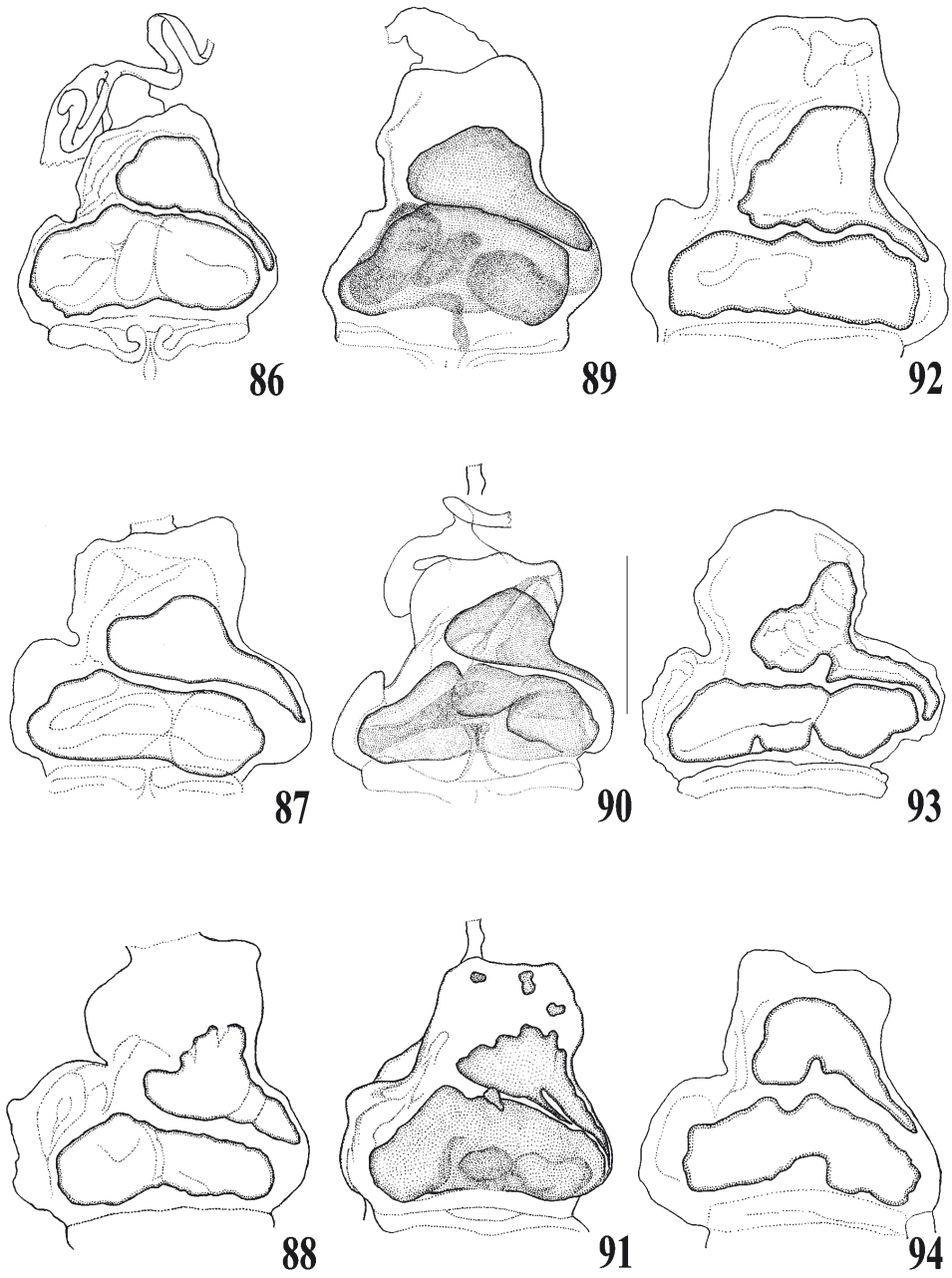
Figs 58–62. Male genitalia of *Macrocixius* spp. 58 – *M. lautereri* sp.nov., style, dorso-lateral view, inner face. 59–61 – *M. gigantomimus* sp.nov., aedeagus: 59 – left lateral view; 60 – right lateral view; 61 – ventral view. 62 – *Macrocixius monticola* sp.nov., male anal tube, ventral view. Scale bars = 0.5 mm.



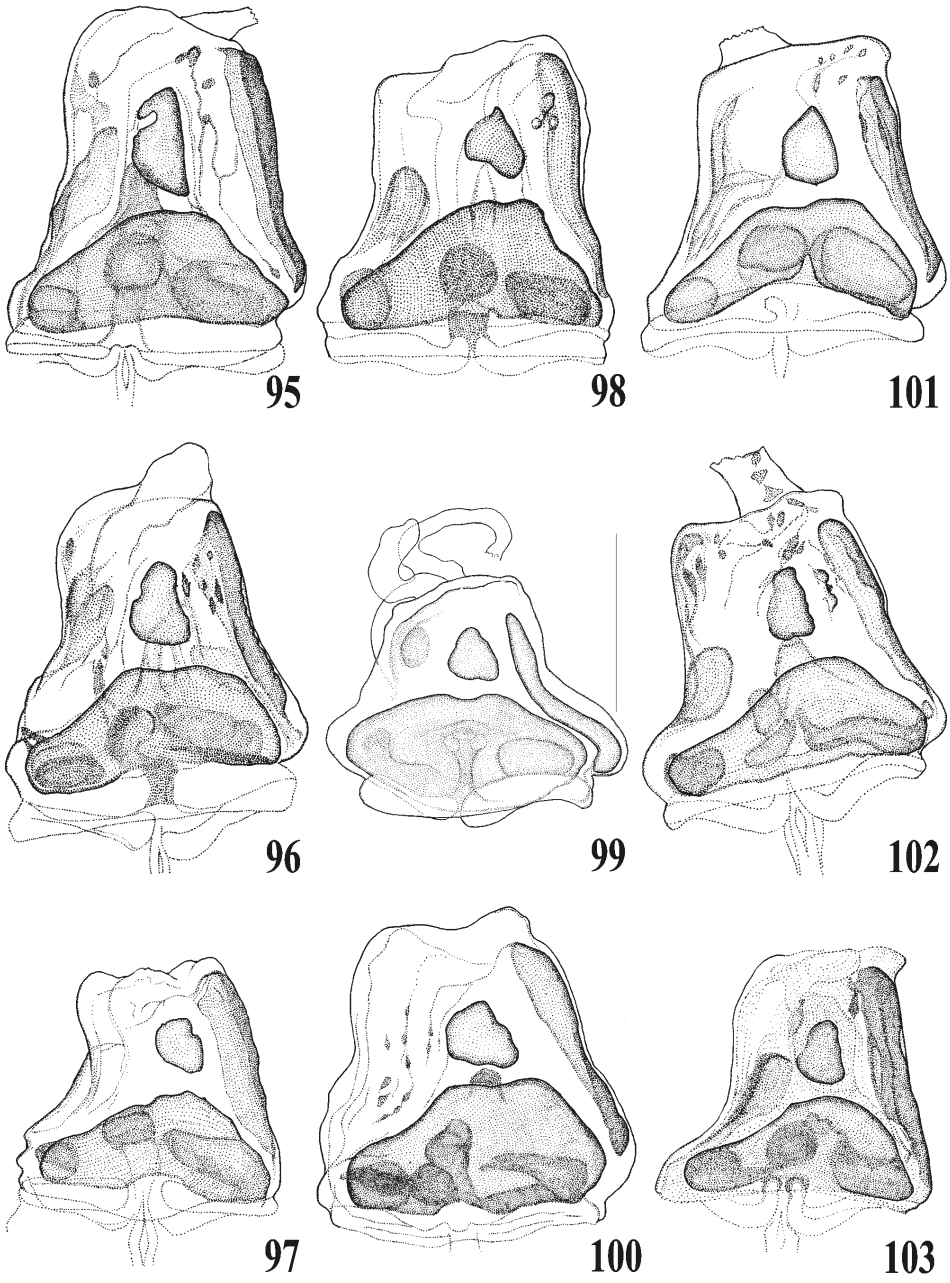
Figs 63–72. Genital styles and male pygofer of *Macrocixius* spp. 63, 72 – *M. gigantomimus* sp.nov.; 64, 69 – *M. grossus* Tsaur et Hsu; 65 – *M. orophilus* sp.nov.; 66 – *M. monticola* sp.nov.; 67, 70 – *M. giganteus* Matsumura; 68, 71 – *M. emeljanovi* sp.nov. 63–68 –style, dorso-lateral view, inner face; 69–72 – pygofer, lateral view. Abbreviations: PCM = caudal margin of pygofer. Scale bars = 0.5 mm.



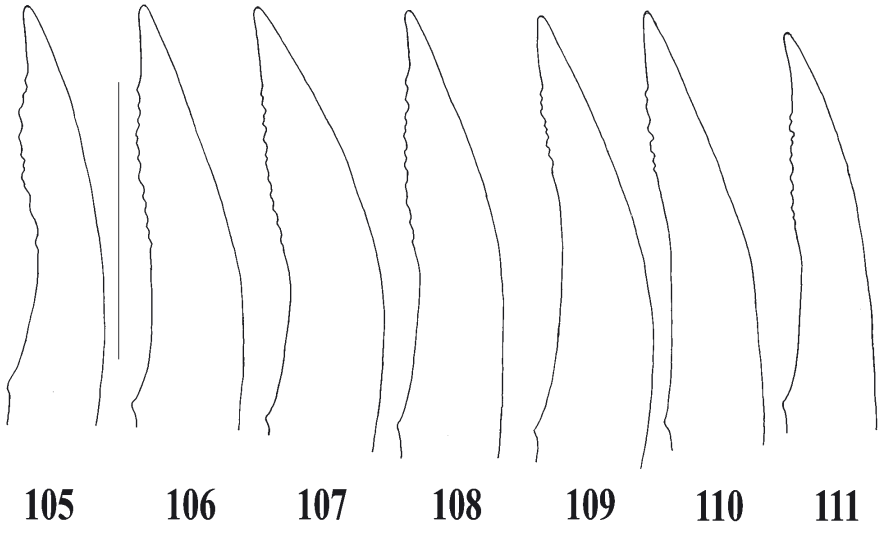
Figs 73–85. Male pygofer and vagina wall patterns of *Macrocixius* spp. 73, 74, 85 – *M. orophilus* sp.nov. (85 – **No 95**): 75, 84 – *M. monticola* sp.nov. (84 – **No 91**); 76 – *M. lautereri* sp.nov., 77–85 – *M. grossus* Tsaur et Hsu (77 – **No 92**, 78 – **No 7,** 79 – **No 67**, 80 – **No 89**, 81 – **No 70**, 82 – **No 15**, 83 – **No 118**). 73–76 – pygofer: 73 – dorsal view; 74 – lateral view. 77 –85 – vagina wall patterns, ventral view. Abbreviations: PCM = caudal margin of pygofer. Scale bars = 1 mm (Figs 73–76); 0.5 mm (Figs 77–85).

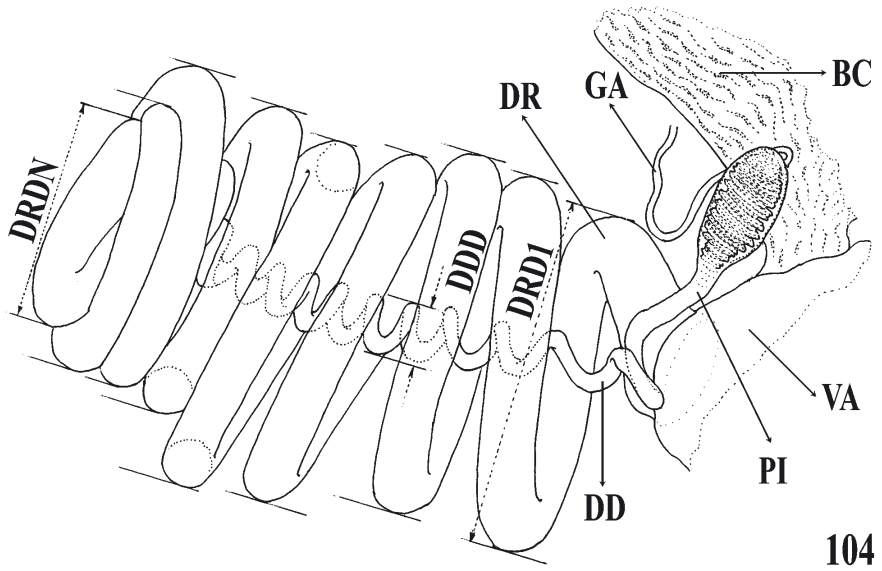


Figs 86–94. Vagina wall patterns of *Macrocixius emeljanovi* sp.nov. (several specimens, in ventral view: 86 – **No 13**, 87 – **No 6**, 88 – **No 11**, 89 – **No 112**, 90 – **No 93**, 91 – **No 120**, 92 – **No 14**, 93 – **No 12**, 94 – **No 10**). Scale bars = 0.5 mm.

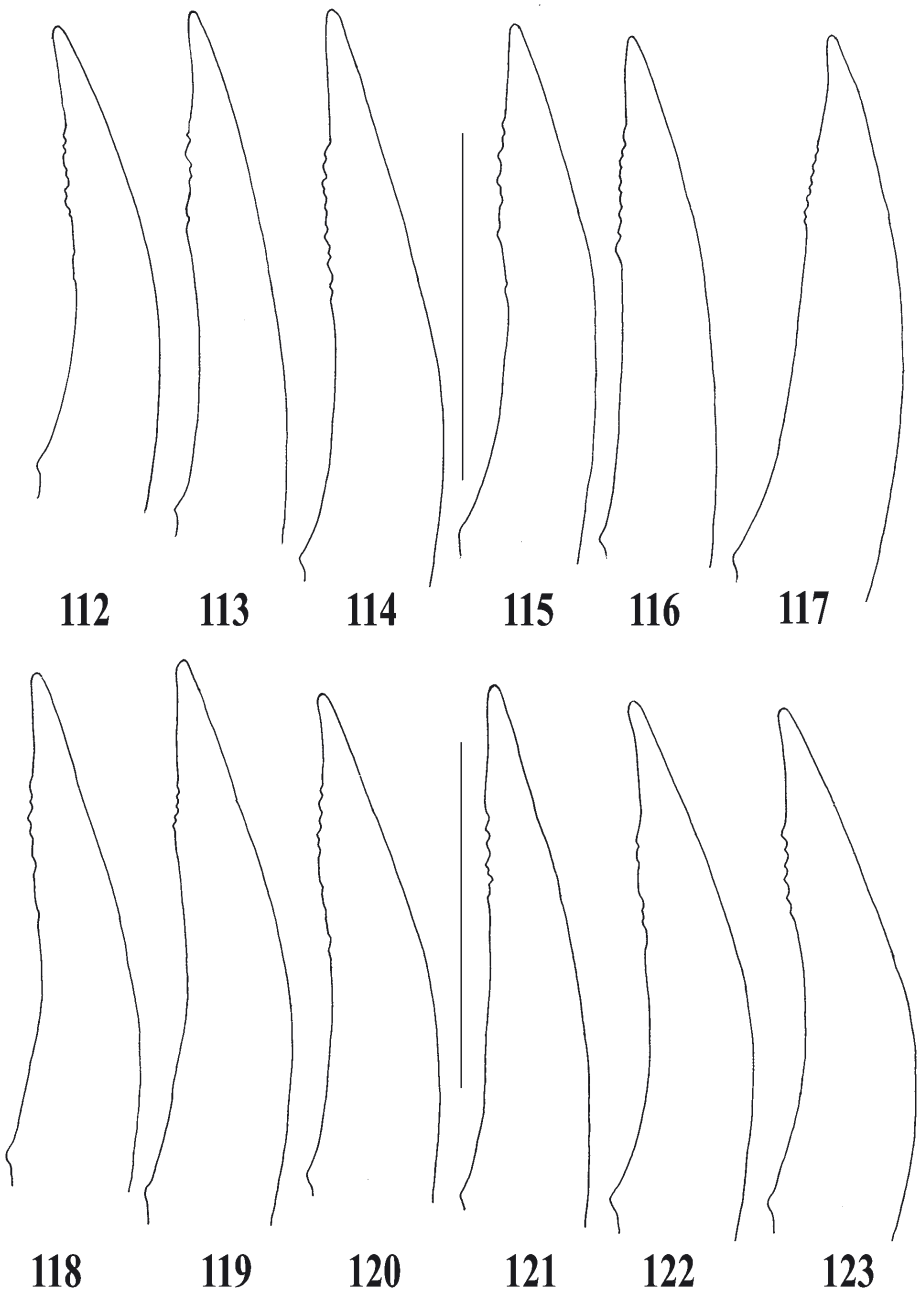


Figs 95–103. Vagina wall patterns of *Macrocixius giganteus* Matsumura (several specimens, in ventral view: 95 – **No 116**, 96 – **No 108**, 97 – **No 114**, 98 – **No 109**, 99 – **No 94**, 100 – **No 115**, 101 – **No 113**, 102 – **No 111**, 103 – **No 110**). Scale bars = 0.5 mm.

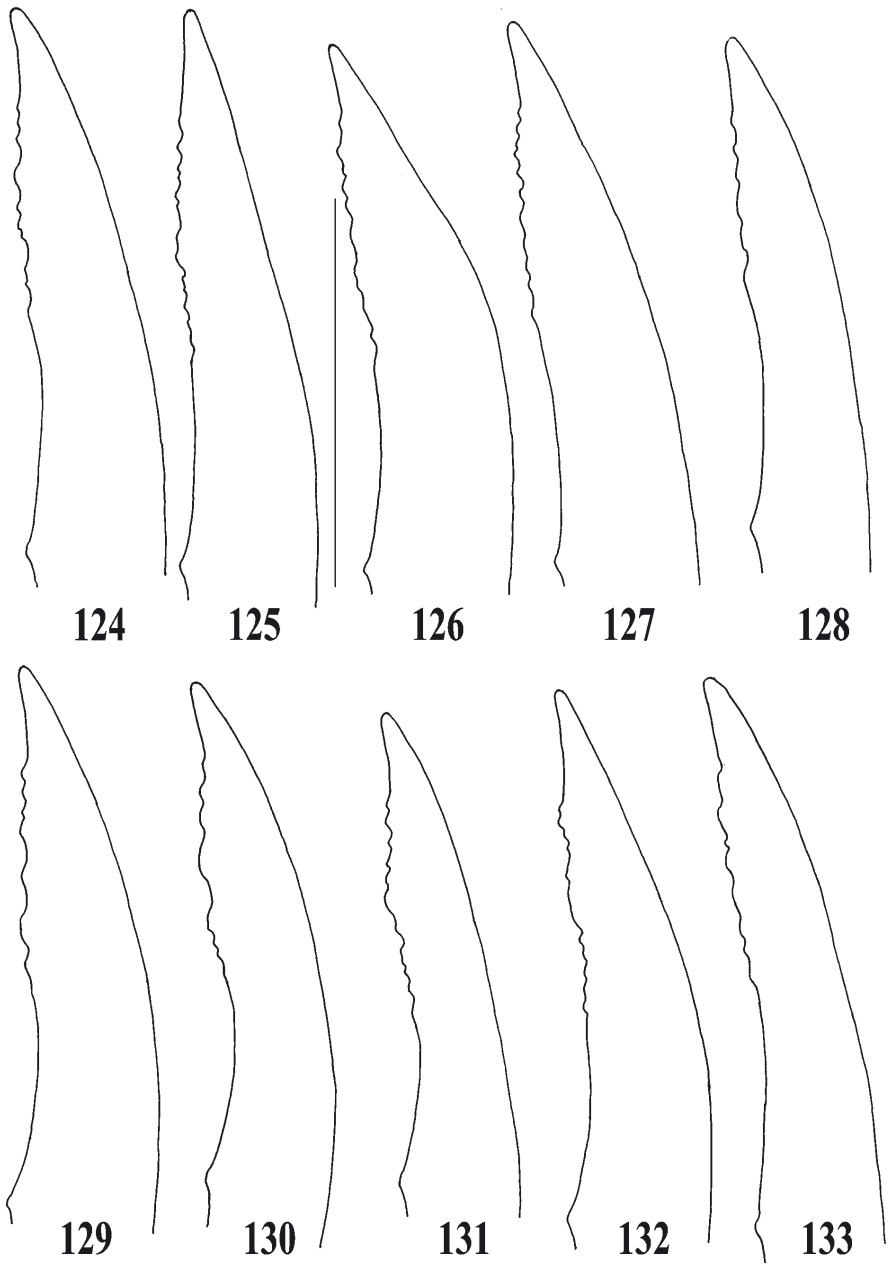




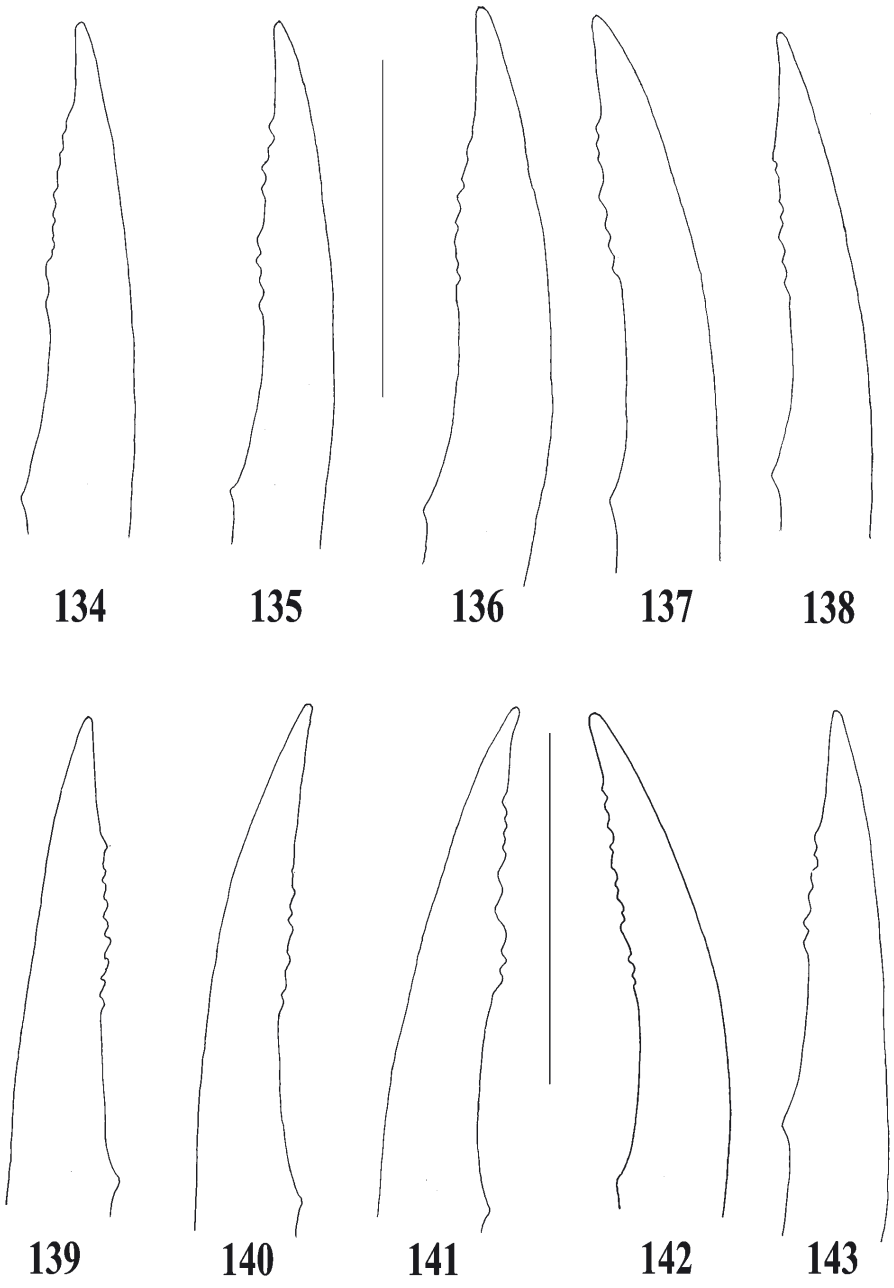
Figs 104–111. 104 – *Macrocixius grossus* Tsaur et Hsu, female inner genitalia, schematic drawing after Fig. 144 (**No 66**). 105–111 – Gonapophysis IX, in lateral view (in different species and specimens of *Macrocixius* collected in Vietnam): 105–107 – *M. monticola* sp.nov. (105 – **No 80**, 106 – **No 83**, 107 – **No 91**); 108 – *M. giganteus* Matsumura (**No 94**); 109–111 – *M. grossus* Tsaur et Hsu (109 – **No 72**, 110 – **No 89**, 111 – **No 92**). Abbreviations: BC = bursa copulatrix; DD = diverticulum ductus; DDD = diameter of the coil of diverticulum ductus; DR = ductus receptaculi; DRD1 = diameter of the first coil of ductus receptaculi; DRDN = diameter of the last coil of ductus receptaculi; GA = glandula apicalis; PI = pars intermedialis; VA = anterior vagina. Scale bar = 0.5 mm (Figs 105–111).



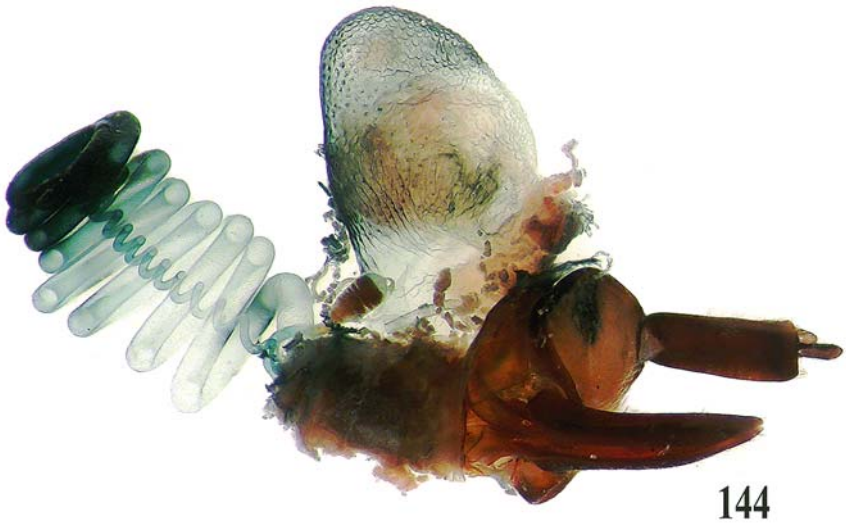
Figs 112–123. *Macrocixius grossus* Tsaur et Hsu, gonapophysis IX, in lateral view, in different specimens collected in Taiwan (112 – **No 3**, 113 – **No 2**, 114 – **No 4**, 115 – **No 7**, 116 – **No 15**, 117 – **No 16**, 118 – **No 66**, 119 – **No 67**, 120 – **No 68**, 121 – **No 69**, 122 – **No 70**, 123 – **No 88**). Scale bars = 0.5 mm.



Figs 124–133. *Macrocixius* spp., gonapophysis IX, in lateral view. 127–132 – *M. emeljanovi* sp.nov. (several specimens: 124 – **No 6**, 125 – **No 8**, 126 – **No 10**, 127 – **No 11**, 128 – **No 14**, 129 – **No 21**, 130 – **No 93**, 131 – **No 20**, 132 – **No 112**). 133 – *M. orophilus* sp.nov. (**No 95**). Scale bars = 0.5 mm.

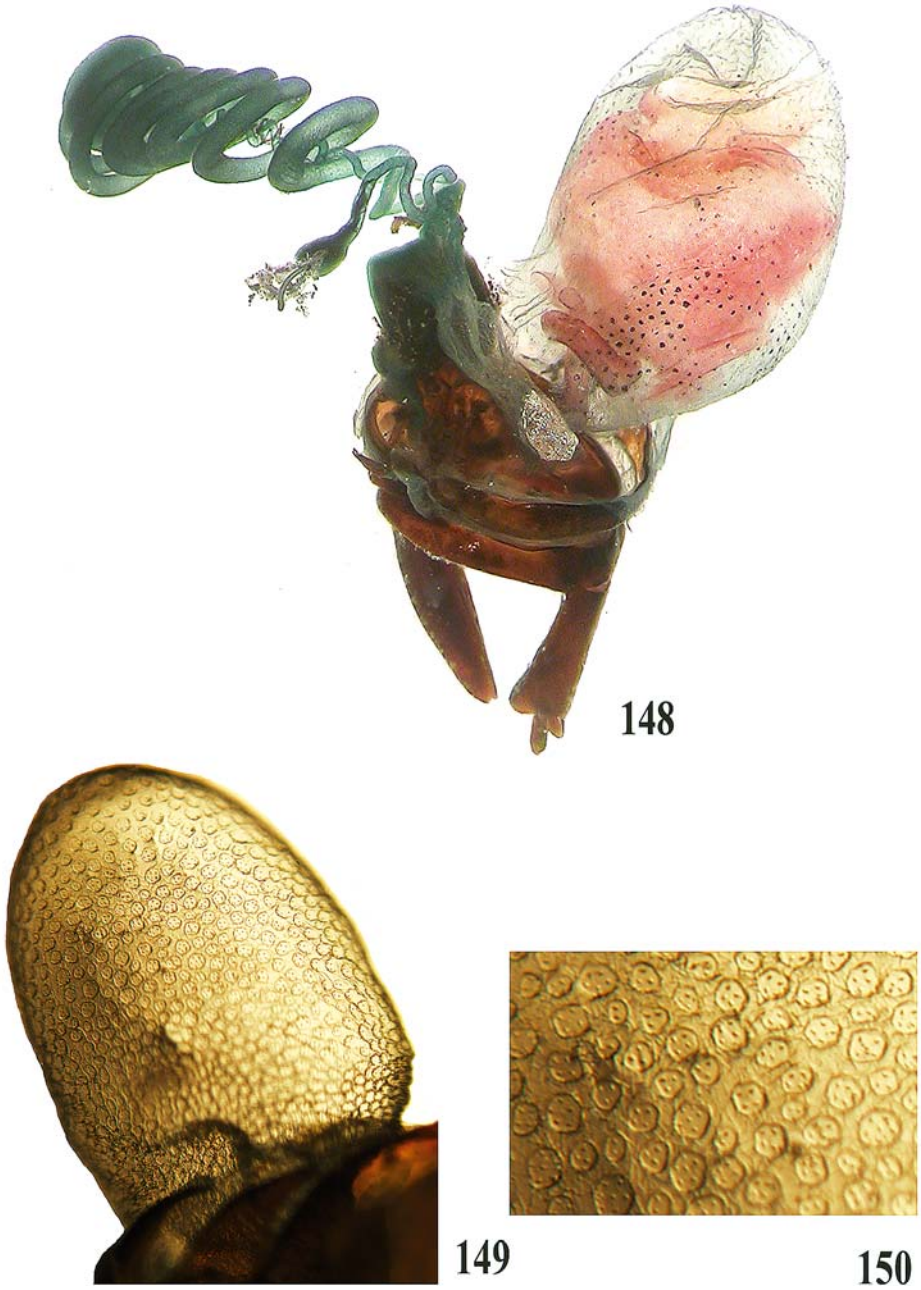


Figs 134–143. *Macrocixius giganteus* Matsumura, gonapophysis IX, in lateral view (several specimens: 134 – **No 113**, 135 – **No 110**, 136 – **No 116**, 137 – **No 111**, 138 – **No 114**, 139 – **No 115**, 140 – **No 109**, 141 – **No 107**, 142 – **No 106**, 143 – **No 108**). Scale bars = 0.5 mm.

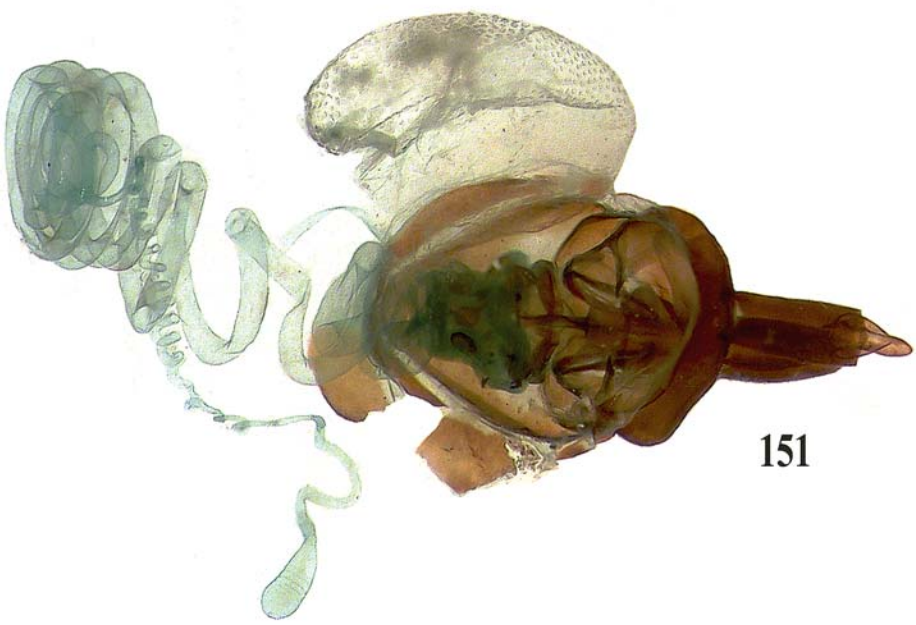




Figs 144–147. *Macrocixius* spp., female genitalia. 144–145 – *Macrocixius grossus* Tsaur et Hsu: 144 – female internal genital structures (**No 66**), 145 – gonapophysis VIII and IX together, lateral view. 146 – *Macrocixius giganteus* Matsumura, gonapophysis IX; lateral view (**No 93**). 147 – *M. emeljanovi* sp.nov., same (**No 13**).

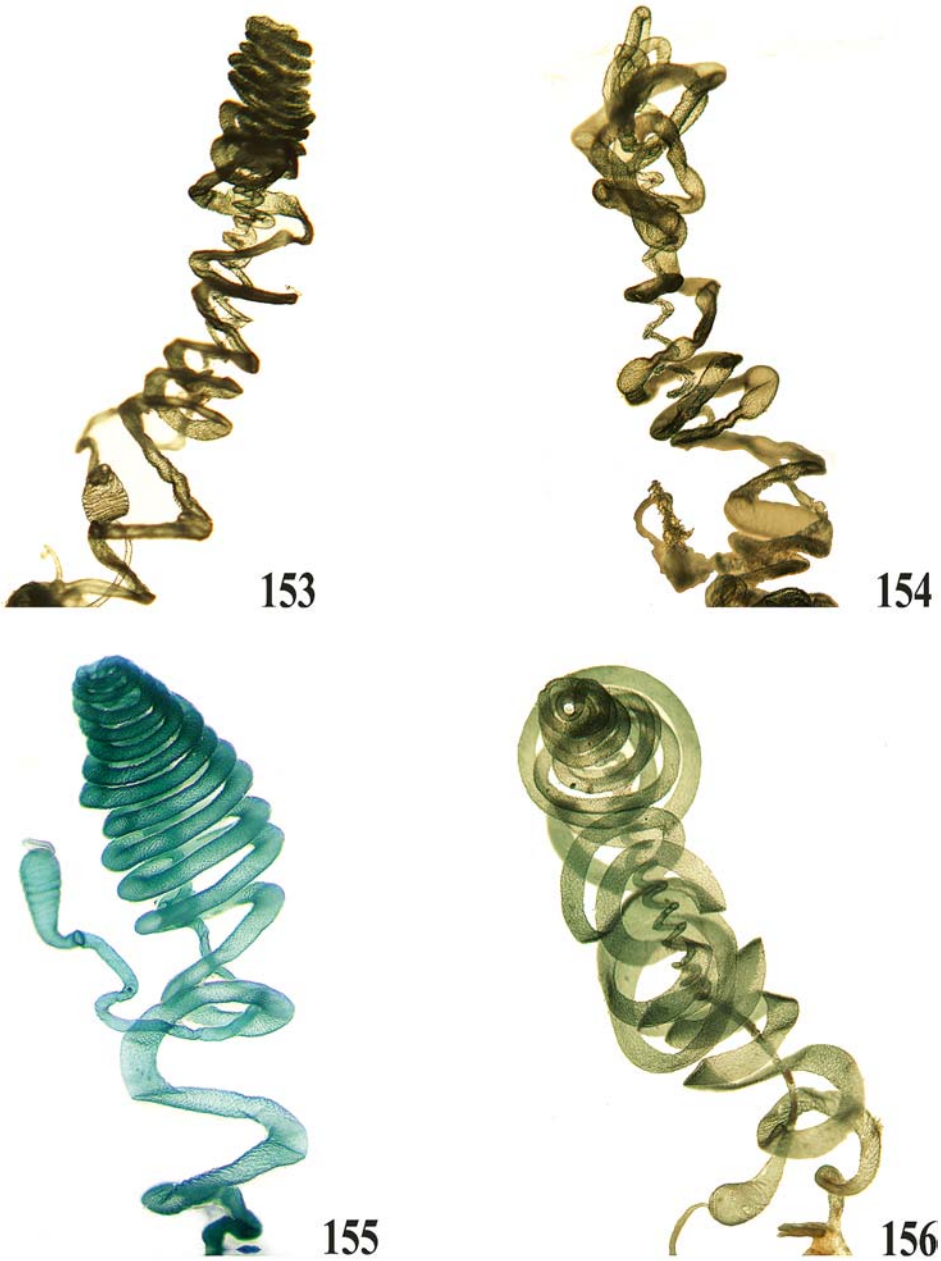


Figs 148–150. *Macrocixius grossus* Tsaur et Hsu, internal female genitalia. 148 – internal genital structures of **No 68**. 149–150 – microsculpture of the bursa copulatrix (150 – enlarged part of Fig. 149, both **No 15**).

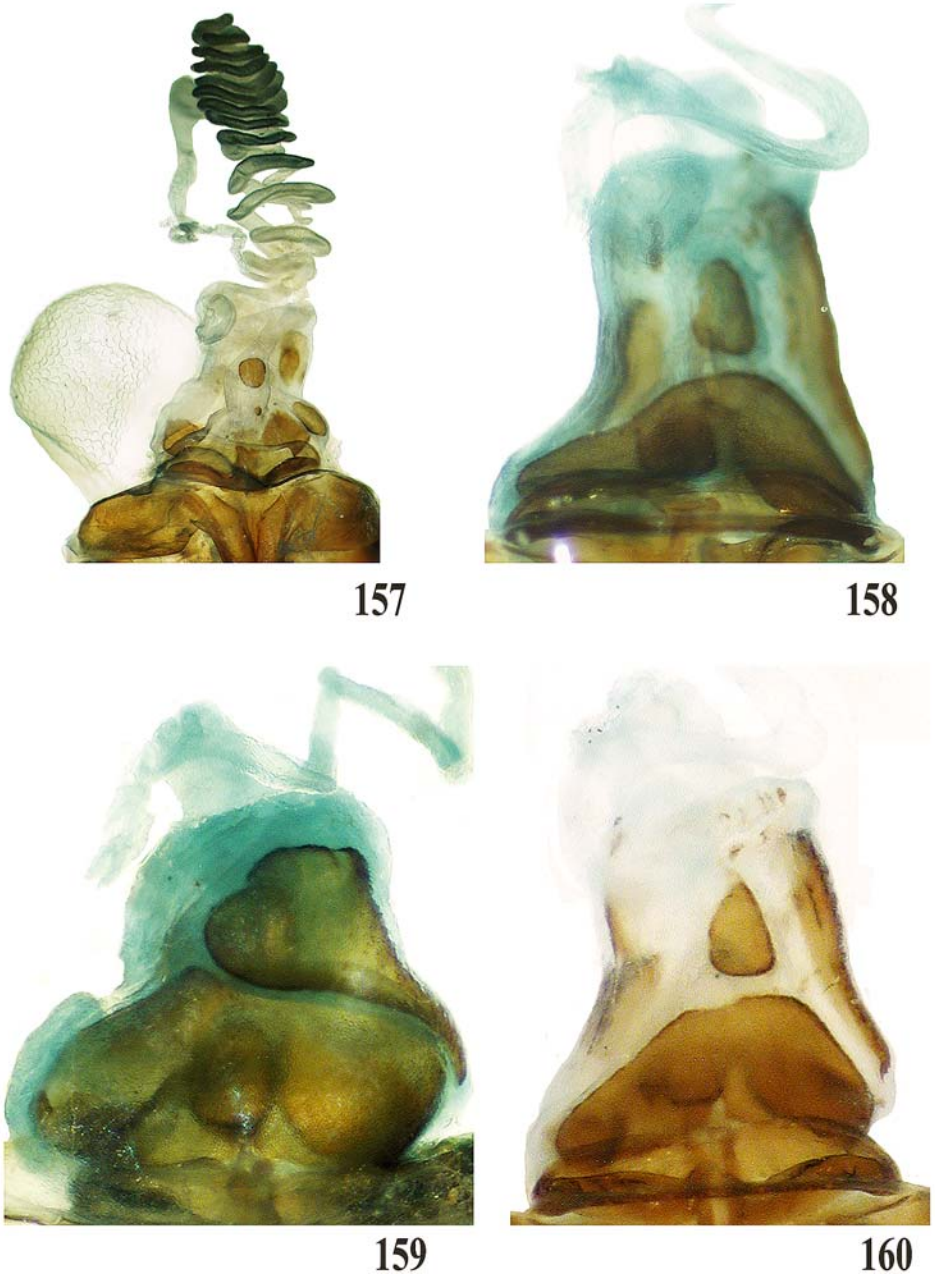




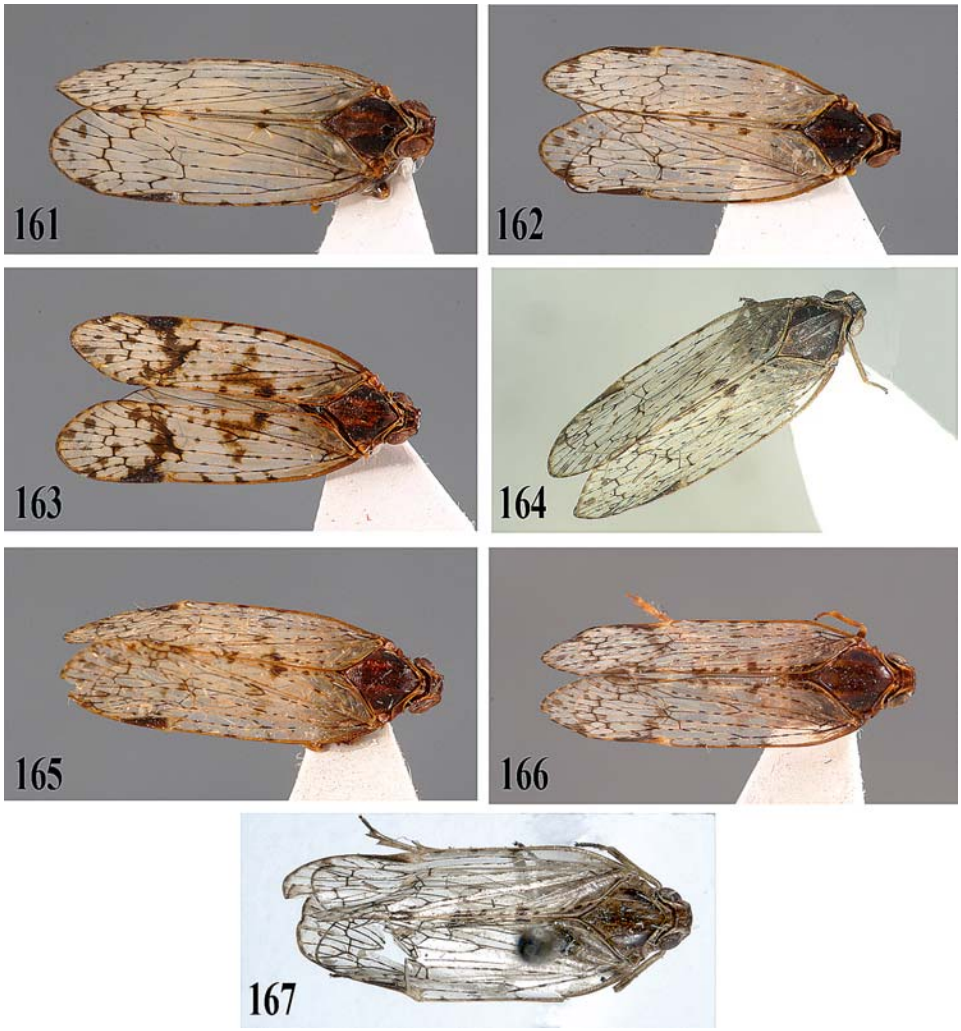
Figs 151–152. *Macrocixius grossus* Tsaur et Hsu, internal female genitalia (151 – **No 92**, 152 – **No 2**).



Figs 153–156. *Macrocixius* spp., spermatheca. 153 – *M. orophilus* sp.nov. (**No 95**); 154–155 – *M. grossus* Tsaur et Hsu (**No 15**, **No 69**); 156 – *M. giganteus* Matsumura (**No 94**).



Figs 157–160. *Macrocixius* spp., internal female genitalia. 157 – *M. grossus* Tsaur et Hsu, internal genital structures (**No 72**). 158 – *M. emeljanovi* sp.nov., vagina wall pattern (**No 13**). 159–160 – *M. giganteus* Matsumura, same (159 – **No 110**; 160 – **No 113**).



Figs 161–167. *Macrocixius* spp., habitus in dorsal view. 161–162 – *M. emeljanovi* sp.nov., males (161 – **No. 119**; 162 – **No. 124**); 163 – *M. emeljanovi* sp.nov., female (**No. 121**); 164 – *M. giganteus* Matsumura, female; 165–166 – *M. grossus* Tsaur et Hsu, females (165 – **No. 1**, 166 – **No. 89**); 167 – *M. lautereri* sp.nov., holotype male (**No. 100**).

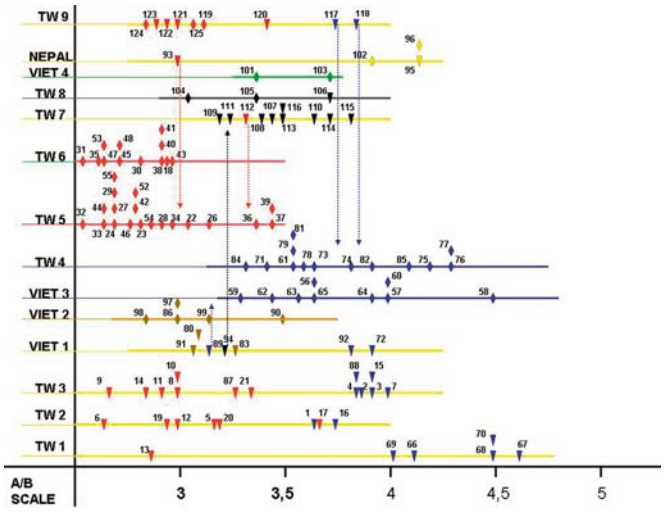


Fig. 168. A/B ratio (see Material and Methods and Fig. 10 for explanation) of *Macrocixius* specimens (horizontal axis, see the text for explanations of code numbers of specimens), grouped according to collecting localities (vertical axis): TW 1, 2, 4, 5 = Taiwan, Fushan Bot. Garden; TW 3, 6–9 = Taiwan, various localities and dates; VIET 1– 4 = Vietnam, various localities and dates; NEPAL = Nepal, various localities and dates. Symbols: rhombus = males, reversed triangle = females; different colours are used for different species: *M. emeljanovi* sp.nov. (red), *M. giganteus* Matsumura (black), *M. gigantomimus* sp.nov. (green), *M. grossus* Tsaur et Hsu (blue), *M. monticola* sp.nov. (ochre), *M. orophilus* sp.nov. (yellow). Arrows show specimens reidentified based on A/B values.

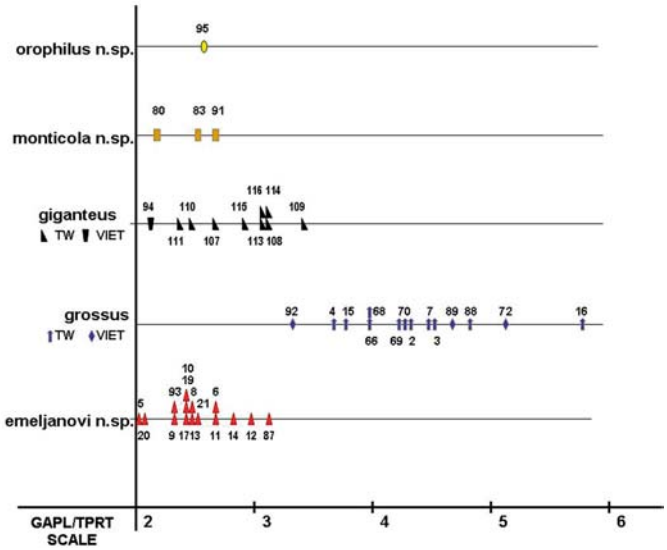


Fig. 169. GAPL/TPRT ratio (see Material and Methods section and Fig. 9 for explanation) of *Macrocixius* female specimens (horizontal axis), different species shown separately (vertical axis). Specimens of *M. grossus* and *M. giganteus* collected in Taiwan and Vietnam are marked with different symbols.