Four new species of West Palaearctic Drosophilidae (Diptera)

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Four new species of West Palaearctic Drosophilidae (Diptera)

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Amiota (Amiota) allemandi sp. nov. (type locality: Turkey, Karaovabeli), *Drosophila (Drosophila) schachti* sp. nov. (type locality: Turkey, Province Kars, Aras Valley, west of Karakurt) belonging to the *quinaria* species group, *Drosophila (Drosophila) vireni* sp. nov. (type locality: Finland, Oulanka) belonging to the *robusta* species group, and *Leucophenga helvetica* sp. nov. (type locality: Switzerland, Canton Ticino, Cevio-Cerentino) are described and their terminalia illustrated. *Drosophila (Drosophila) curvispina* WATABE & TODA, 1984, recently collected in Switzerland, and *Drosophila (Drosophila) unispina* OKADA, 1956, are redescribed and their phylogenetic relationships with the European members of the *quinaria* species group are evaluated by DNA sequence analysis. The new *Leucophenga sorii* species group is established for *L. sorii* KANG, LEE & BHANG, 1965, *L. hungarica* PAPP, 2000, and *L. helvetica* sp. nov., which share features not present in any species so far described in *Leucophenga*. The homology of the elements of the male terminalia of the species belonging to the genus *Leucophenga* in relation to those of the genus *Drosophila* is reconsidered.

Keywords: Drosophilinae, Steganinae, new species, Turkey, Switzerland, Finland.

INTRODUCTION

The West Palearctic species of Drosophilidae, containing some 140 species, seem to be almost completely known, in spite of many more or less large areas where recording is still scanty. After checking several Museum collections, we found specimens belonging to obviously unknown species and we take the opportunity to describe them in the present paper.

Three specimens of a new species of *Amiota* were collected by R. ALLEMAND in southern Turkey; they are very similar to *A. subtusradiata* DUDA or *A. filipes* MACA, but are much smaller and differ with respect to the male terminalia.

Five specimens of *Drosophila* were collected by W. SCHACHT in eastern Turkey; they belong to an undescribed species of *Drosophila* of the Holarctic *quinaria* species group.

One single male collected in southern Switzerland belongs to an undecribed species of *Leucophenga* that seems to be closely related to *L. sorii* KANG, LEE & BHANG, 1965 from Korea and Japan, and the recently described *L. hungarica* PAPP, 2000. These three species differ remarkably from the remaining *Leucophenga* species and a new species group is proposed to include them.

While checking specimens considered to belong to *Drosophila subarctica* HACKMAN, 1969, by starch gel electrophoresis, S. LAKOVAARA (pers. comm.) realized that two sibling species were involved which also presented subtile differences regarding to the male terminalia. We take the occasion to describe this new sibling species based on specimens kindly supplied by S. LAKOVAARA and to compare it with the holotype

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of *D. subarctica*, whose terminalia are also redescribed. Additionally, several specimens of one initially undetermined species of *Drosophila* belonging the *quinaria* species group, and recently collected in Swizerland, were compared to *D. unispina* and *D. curvispina*, both from the East Palearctic region, which are redescribed.

MATERIAL AND METHODS

Label data attached to each type specimen are cited in full with a slash indicating a label change. Our own notes or interpretations are included in brackets.

For preparations of microscope slides, illustrations, measurements, indices as well as morphological terminology see VILELA & BÄCHLI (2000). Unless two scales are shown in the same plate, all figures are drawn to the same scale and all photomicrographs were taken and enlarged to the same magnification.

All type specimens are deposited in the Zoologisches Museum, Universität Zürich, Zürich, Switzerland (ZMUZ).

Phylogenetic analysis

DNA was extracted from single flies preserved in 70% ethanol by incubation in 300 µl of a 10% Chelex (Biorad) solution containing proteinase K (0.5 mg/ml). After incubation (4 h, 50°C, with agitation) solutions were heated to 98 °C for 5 min and centrifuged for 1 min. The supernatant was purified by two PCI (phenol / chloroform / isoamylalcohol, 25:24:1) and one CI (chloroform / isoamylalcohol, 24:1) extractions followed by precipitation with 1/10 vol. 3M NaAc, 3x vol. EtOH. DNA was resolved in 100 µl TE buffer, 3–7 µl of the DNA solution were used for the PCR. Control extractions without tissue were prepared for the PCR amplifications. PCR was performed with an Eppendorf Thermocycler in a volume of 25 µl, containing 1 unit Dynazyme DNA polymerase (Finnzymes OY), 0.5 µM of each primer, and 0.2 mM of each dNTP. The solutions were heated to 95°C (2 min) and then put through 30 reaction cycles: 95°C (10 s), 54°C (10 s), 72°C (20 s), followed by a final extension at 72°C (5 min). Negative controls for PCR reactions were performed to screen for contaminated reagents: i) control extractions (without DNA) instead of template; ii) reaction with A.d. instead of template. The following primers were used to amplify a section of about 480 bp (depending on the length of the intron) of the alcohol dehydrogenase gene (*Adh*) spanning exon2 – intron2 – exon3: Adh-e2+ (CTGGACTTCTGGGACAAGCG); Adh-e3- (TAGATGCCCGAGTCCC AGTG) (HAGEMANN *et al.* 1996). PCR products were extracted from agarose gels using the QIAquick Gel Extraction Kit (QIAGEN) and cloned (TOPO TA Cloning Kit, Invitrogen). Sequencing (both directions) was performed by MWG-Biotech (Ebersberg, Germany) with a Li-Cor Sequencer. The *Adh* gene of *D. immigrans* (ALBALAT & GONZALEZ-DUARTE 1993; GenBank accession number M97638) was used as an outgroup. The sequences determined in the present study are registered under the GenBank accession numbers AY095935–AY095951.

Sequence analysis: Alignments were produced manually, exon sequences were checked for intact open reading frames. Both distance (neighbor-joining algorithm, NJ; SAITOU & NEI 1987) and maximum parsimony (MP) methods were used to infer the phylogenetic relationships. All dendrograms were calculated with the software package PAUP (version 4b4-8; SWOFFORD 2000). p-distances were used for the NJ tree. Applying other models for the computation of distances did not alter tree topology. MP trees were generated with branch and bound search, all characters were weighted equally.

RESULTS

Genus *Amiota* LOEW, 1862

alboguttata species group

Amiota allemandi sp. nov.

(Figs 1, 2, 3A)

Material examined. Holotype ♂, (dissected), labelled « TR : Karaovabeli G., 22–27–VII.1997, R. ALLEMAND leg. / ♂ / Holotype », two ♀ paratypes : same collection labels as holotype, except the last (« Paratype »).
Type locality : Turkey, Karaovabeli.

Diagnosis. Generally black flies but frons brownish ; dorsal and ventral aristal branches of almost equal length ; hb-index at most about 0.7 ; posterior branch of the three-branched anterior paraphysis sinuous and cobra-shaped in profile view.

Description. ♂. Head. Frons brownish, dull, darker and subshiny at vertex, usually pale yellowish above antennae, frontal length 0.36 mm ; frontal index = 1.50, top to bottom width ratio = 1.64. Frontal triangle indistinct ; ocellar triangle slightly prominent, blackish, subshiny in the hind corners, about 29% of frontal length. Orbital plates narrow, brownish, subshiny, about 62% of frontal length. Orbital setae black, strong, virtually in a line, distance of or3 to or1 = 180% of or3 to vtm, or1 / or3 ratio = 1.15, or2 / or1 ratio = 0.73, postvertical setae = 19%, ocellar setae = 71% of frontal length ; vibrissal index = 0.83. Face yellowish-brown in upper half, usually shiny white below. Carina prominent between pedicels, flat downwards, not noselike. Cheek index about 12. Eye index = 1.16. Occiput blackish-brown, brown above foramen. Pedicel brownish. Flagellomere 1 dark brown, length to width ratio = 1.50. Arista with 4–5 dorsal and 2–3 ventral branches, about 10–15 inner branches which are in basal half arranged in more than one row, with small fork. Clypeus narrow, dark brown. Palpi brownish, darker along lower border, medially broad, apically narrowed, with about 5 black setae along the lower border.

Thorax length 1.14 mm. Scutum black, shiny, postpronota white, about 10 rows of acrostichal setae. Only 1 postpronotal seta. Transverse distance of dorsocentral setae 256% of longitudinal distance ; dc index = 0.45, 2 distinct prescutellar setae, length about 80–108% of that of the anterior dorsocentral setae. Scutellum greyish microtrichose, scutellar setae virtually equidistant ; basal ones divergent ; scut index = 1.12. Pleura brownish, with a distinct, triangular white spot below the wing base, sterno index = 0.90, mid katepisternal seta about 21% of the anterior one. 2 minute proepisternal setae. Halteres white. Legs pale yellowish, preapical setae on all tibiae, ventral apical seta on mid tibia.

Wing hyaline, veins C_{4+5} and M apically distinctly converging, discal and second basal cells separated, C-III apical-ventrally with a few hardly visible warts, length 1.96 mm, length to width ratio = 2.24. Indices : C = 1.67, ac = 3.60, hb = 0.67, 4C = 1.80, 4v = 2.60, 5x = 2.00, M = 0.80, prox. x = 1.40.

Abdomen blackish-brown, shiny, with a diffuse, median yellowish area at base, tergites 1–4 subshiny ; some tergites may show a more or less narrow, pale apical band.

♂ *Terminalia* (Figs 1, 2, 3A). Epandrium not sclerotized at dorsomedian region, mostly microtrichose, with about 14 lower setae, and 3 upper setae ; ventral lobe not covering surstylus. Cerci linked to hypandrium by membranous tissue, anteriorly microtrichose. Surstylus not microtrichose, with 10 cone-shaped pren-

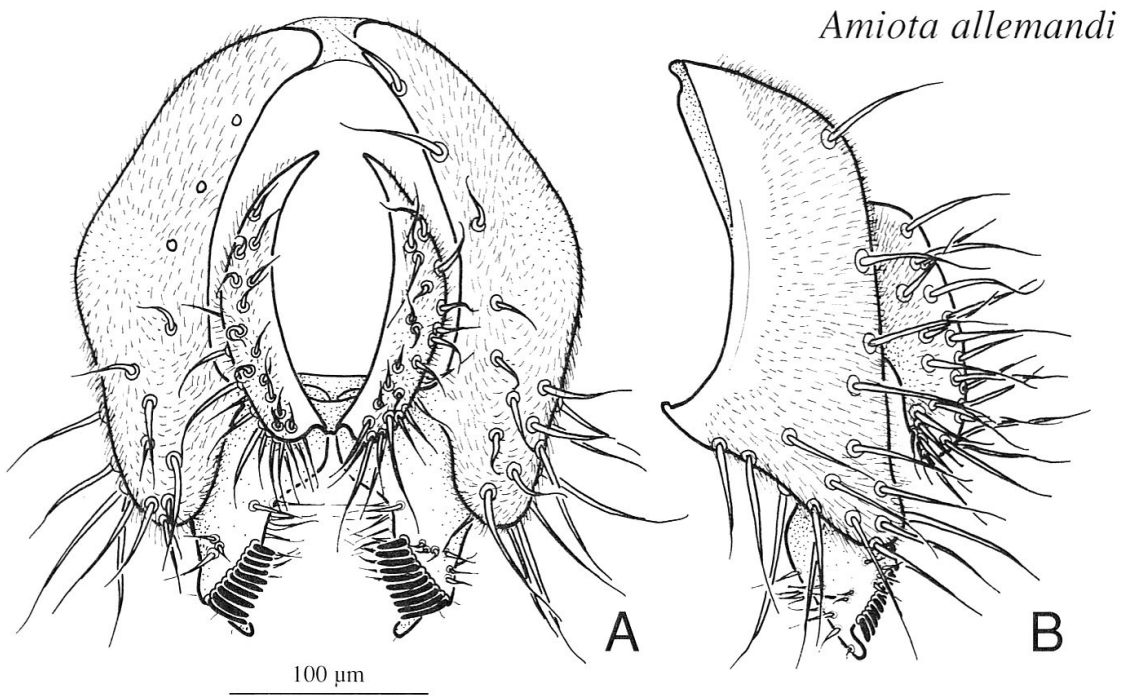

Fig. 1. *Amiota allemandi* sp. nov., holotype ♂. A, epandrium, cerci, surstyli and decasternum, posterior view. B, idem, left lateral view.

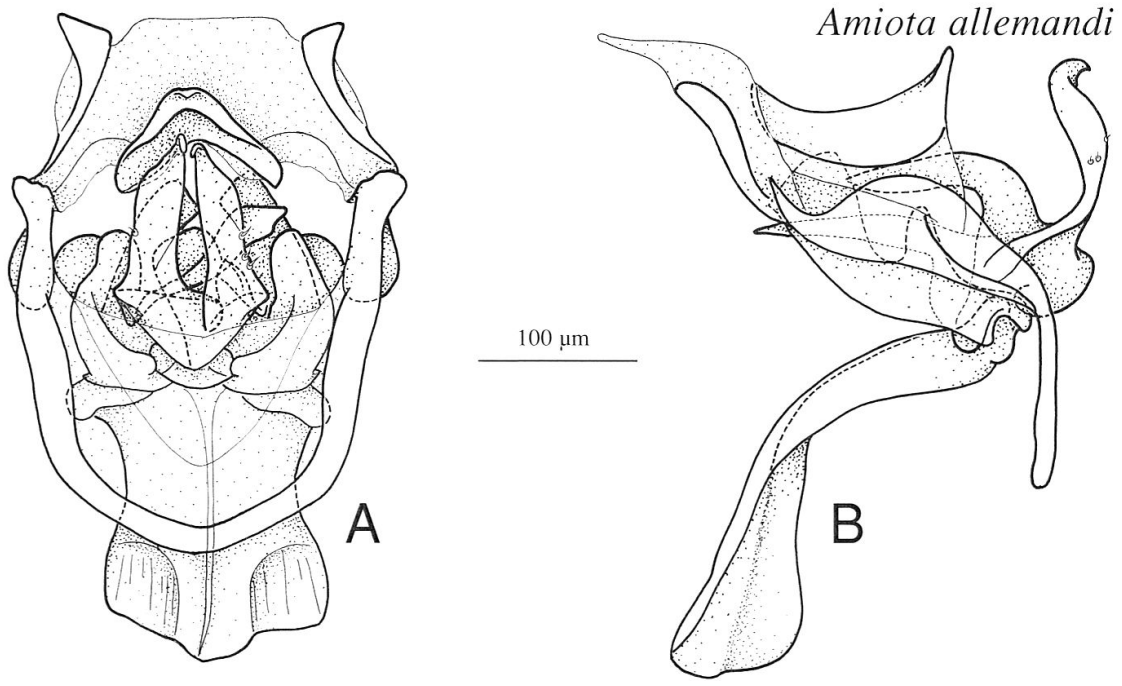

Fig. 2. *Amiota allemandi* sp. nov., holotype ♂. A, hypandrium, paraphyses, gonopods, and aedeagal apodeme, posterior view. B, idem, left lateral view.

sisetae roundish at tip, about 6 outer long setae and ca. 15 long inner setae, ventrally conspicuously bearing a finger-shaped expansion. Decasternum as in Fig. 1A. Hypandrium longer than epandrium, dorsal arch (= bow) present, gonopod linked to anterior paraphysis by membranous tissue, bearing no seta. Aedeagus absent. Aedeagal apodeme strongly developed, dorsoventrally flattened, distally bifid. Ventral rod

absent. Anterior paraphysis strongly developed and sclerotized, trifid, posterior branch cobra-shaped in profile view, bearing three setulae, linked to distal margin of aedeagal apodeme by membranes; anterior paraphyses slightly fused to each other ventrally. Posterior paraphysis anteriorly straight, dorsomedially expanded.

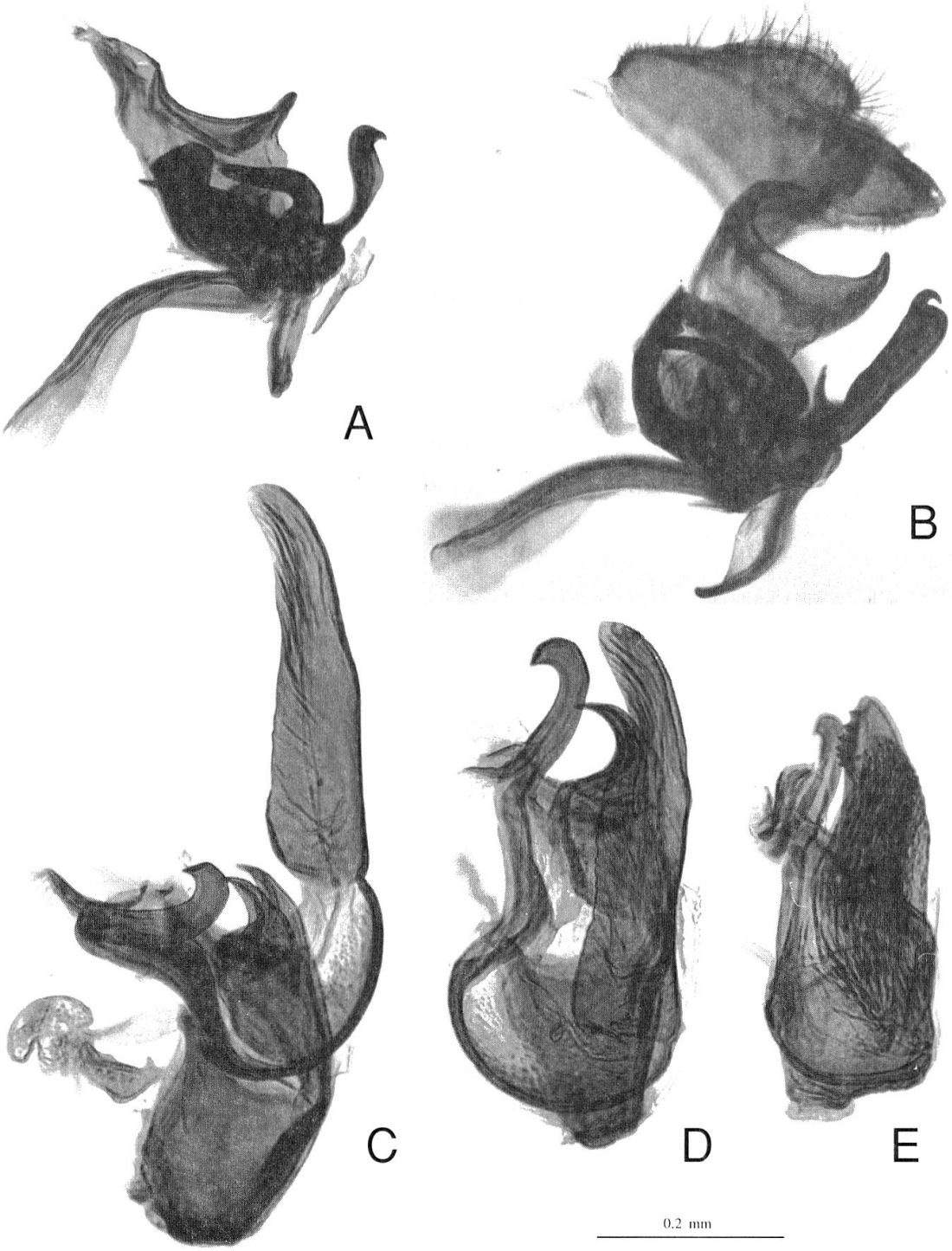

Fig. 3. Left lateral view of internal male terminalia (for B, also external) of: A, *Amiota allemandi* sp. nov., holotype ♂; B, *Amiota filipes* MACA (Duillier VD, Switzerland, VI–VII.1995); C, *Leucophenga sorii* KANG, LEE & BHANG (Tomakomai, Japan, 22.VIII.2000; everted); D, *Leucophenga hungarica* PAPP (paratype); E, *Leucophenga helvetica* sp. nov. (holotype).

♀. *Measurements*: Frontal length 0.34 mm; frontal index = 1.12 (1.05–1.18), top to bottom width ratio = 1.28 (1.21–1.35). Ocellar triangle about 35% of frontal length. Orbital plates about 65–70% of frontal length. Distance of or3 to or1 = 225–250% of or3 to vtm, or1 / or3 ratio = 1.04 (1.00–1.08), or2 / or1 ratio = 0.81 (0.77–0.86), postvertical setae = 28 (25–30) %, ocellar setae = 70% of frontal length; vibrissal index = 0.38 (0.33–0.44), cheek index about 11–18. Eye index = 1.21. Thorax length 1.22 (1.20–1.24) mm. Transverse distance of dorsocentral setae 267% of longitudinal distance; dc index = 0.66 (0.63–0.70). Distance between apical scutellar setae about 80–90% of that of the apical to the basal one; scut index = 1.16, sterno index = 0.90, mid katepisternal seta about 22% of the anterior one. Wing length 2.12 (2.10–2.14) mm, length to width ratio = 2.16 (2.14–2.18). Indices: C = 1.72 (1.70–1.74), ac = 3.59 (3.17–4.00), hb = 0.69 (0.68–0.70), 4C = 1.70 (1.67–1.73), 4v = 2.39 (2.36–2.42), 5x = 1.50 (1.40–1.60), M = 0.65 (0.64–0.67), prox. x = 1.31 (1.25–1.36).

Etymology. Named after Roland ALLEMAND, collector of the type series.

Relationship. According to the key of CHEN & TODA (2001), this species belongs to the *alboguttata* species group; it is most closely related to *A. filipes* MACA, from which it differs regarding the male terminalia, mainly in the shape (as seen in profile view) of anterior paraphysis, which is sinuous and cobra-shaped in *A. allemandi* sp. nov. and somewhat straight, wider and dorso-apically bearing a talon-shaped expansion in *A. filipes* (Fig. 3B).

Comments. The specimens have been collected by wine-beer traps (according to ALLEMAND & ABERLENC 1991).

Genus *Leucophenga* MIK, 1886

sorii species group (nov.)

Taxa included. *Leucophenga sorii* KANG, LEE & BHANG, 1965; *L. hungarica* PAPP, 2000; *L. helvetica* sp. nov.

Diagnosis. Posterior reclinate orbital seta closer to the anterior proclinate than to the median vertical seta (differing from normal position, i.e. closer to the median vertical seta, in other *Leucophenga* species); the curved costal pegs (warts) on the ventral surface of the third section of the costal vein are virtually absent (Fig. 9B), or are so minute (Fig. 9C) that they are hardly visible even under high magnification; usually visible even under low magnification e.g. in *Leucophenga maculata* (DUFOUR), Fig. 9D; in both sexes, no silvery microtrichose areas on frons, mesonotum and abdomen (in most *Leucophenga* species at least some silvery areas are visible in males); the characters of the male terminalia are generally of the *Leucophenga* type; however, the hook-shaped dorsal arch of the hypandrium of these three species is more or less parallel to the aedeagus, when in non-erected position, but almost perpendicular in other species of *Leucophenga*.

Comments. Due to these unusual features, the three species included in the *sorii* group will not run to the genus *Leucophenga* in any key to genera of Drosophilidae. However, in spite of these differences the overall structure of the male terminalia is much the same as in those belonging to the remaining species of *Leucophenga* and we believe that this fact does not justify placing them in a separate genus, but rather establishing a new group of closely related species within the subgenus *Leucophenga*. To give an extended characteristic of the group, we include also redescriptions of the other two members of the group.

The male terminalia of the *Leucophenga* species are very peculiar and there are various approaches to homologize their elements (e.g. WHEELER 1952, BURLA 1954, OKADA 1956, BÄCHLI 1971, GRIMALDI 1990). In the following, we propose some changes in the usual terminology of those elements for the species belonging to the genus *Leucophenga*, based on evidence provided by the analysis of the relative position and the way those elements are connected and articulated to each other.

According to GRIMALDI (1990) the folded, dorsal aedeagal process, slightly longer than the aedeagus itself, is one of several autapomorphies which is characteristic for *Leucophenga* species. He believes its homologous counterpart in other drosophilids is very much uncertain. We do not agree with him that this process is longer than the aedeagus because, as far as we know, it is generally much shorter, as we interpreted it as formed by two components, the hook-shaped process itself that is fused to the posterior paraphysis, which are parallel and anteriorly positioned regarding to the aedeagus. On the other hand, we have interpreted this three-folded dorsal process (the uppermost layer being hooked and usually dorsad directed at tip) as a result of the sclerotization of the usually membranous tissue that links the two posterior arms of the hypandrium and forms the « bridge » of MALOGOLOWKIN (1952) and FROTA-PESSOA (1954), and the dorsal arch of GRIMALDI (1990), as it happens in several species of *Drosophila*, for instance those belonging to the *tripunctata*, *guarani* and *cardini* groups, although in quite different shape and extent. In species of *Leucophenga*, this process is usually linked by membranous tissues both to the very end of the arms of the hypandrium and to the distal end of the posterior paraphyses. The aedeagal apodeme is considered to be missing in most species of *Leucophenga*, however it seems that it is represented by the channel-shaped, laterally membranous component, which is posteriorly linked to the aedeagus and anteriorly linked to the paired and bare posterior paraphysis, which in turn are distally linked to the dorsal arch. It is possible to see in some preparations of the male terminalia that the tube connecting the aedeagus with the ejaculatory apodeme goes across through this channel-shaped component between the dorsad directed posterior paraphyses. The anterior paraphyses are the paired structures that bear setulae and are apparently articulated by membranous tissue both to the aedeagus and the gonopods.

Leucophenga sorii KANG, LEE & BHANG, 1965

(Fig. 3C, 4, 5)

Leucophenga (Leucophenga) sorii KANG, LEE & BHANG, 1965: 97 (description); OKADA 1988: 8 (key); OKADA 1990: 558 (in *maculata* species group); LEE 1993: 41 ff.; PAPP 2000: 253 (comparison with *L. hungarica*).

Material examined. 1♂ (dissected, right wing in microslide), labelled: « Tomakomai Hokkaido, JAPAN 22.VIII.2000 »; 1♂ and 1♀, same collection labels.

Type locality. Mt. Sori (Kwangneung area), Kyungki Province, South Korea.

Diagnosis. Generally yellow fly; tergites 2–4 with narrow, dark brown marginal bands which are medially broadened, forming a narrow medial stripe, laterally not reaching to the ventral margin of the tergite; the band on tergite 2 is laterally broadened, forming a short stripe; tergite 5 usually with a narrow marginal band which is medially interrupted; anterior paraphysis distally sharply pointed dorsad, hypandrium anteriorly square-shaped in profile view.

Redescription. ♂. Head. Frons golden yellowish, pale yellowish above antennae, frontal length 0.47 (0.42–0.51) mm; frontal index = 1.23 (1.20–1.25), top to bottom width ratio = 1.11 (1.10–1.12). Frontal triangle indistinguishable, ocellar

triangle prominent, blackish along the inner margins of the ocelli, about 32–33% of frontal length. Orbital plates narrow, not diverging from eye margin, greyish-brown, subshiny, about 60–67% of frontal length. Orbital setae black, strong, or2 outside and behind or1, distance of or3 to or1 = 64–69% of or3 to vtm, or1 / or3 ratio = 0.96 (0.91–1.00), or2 / or1 ratio = 0.52 (0.44–0.60), postvertical setae = 44 (40–47) %, ocellar setae = 73 (68–73) % of frontal length; vibrissal index = 0.40. Face flat, whitish. Carina almost missing. Cheek index about 21–26. Eye index = 1.29 (1.27–1.31). Occiput concave, dark brown in upper half, yellowish along eye margins, pale yellowish in lower half. Pedicel yellowish. Flagellomere 1 white, length to width ratio about 1.80. Arista with 7–8 dorsal, 3–5 ventral and about 12 short inner branches, plus small terminal fork. Proboscis yellow. Palpi whitish.

Thorax length 1.48 (1.34–1.62) mm. Scutum yellow, shiny. 8–10 rows of acrostichal setae. h index = 0.49 (0.36–0.61). Transverse distance of dorsocentral setae 267–278% of longitudinal distance; dc index = 0.54 (0.51–0.57). Scutellar setae nearly equidistant; basal ones divergent; prescutellar setae about 90% of the anterior dorsocentral setae, scut index = 1.18 (1.16–1.21). Pleura yellowish, sterno index = 0.76, mid katepisternal seta fine, about 26–30% of the anterior one. Halteres yellow. Legs yellow, preapical setae on all tibiae but strong on mid tibia only, ventral apical seta on mid tibia.

Wing hyaline, ventral surface of C-III bearing curved costal pegs (warts) very thin and almost absent, length 3.18 (2.69–3.68) mm, length to width ratio = 2.50. Indices: C = 3.63 (3.33–3.94), ac = 2.00, hb = 0.61, 4C = 0.71 (0.67–0.75), 4v = 1.67, 5x = 1.00, M = 0.37 (0.33–0.40), prox. x = 0.79 (0.78–0.80).

Abdomen yellow, shiny, tergites 2–4 with a narrow apical band and a more or less distinct, triangular median stripe which in some specimens is forming a median stripe; tergite 5 usually with the same but distinctly smaller and paler pattern; width and darkness of the pattern is obviously variable.

♂ *Terminalia* (Figs 3C, 4, 5). Epandrium posteriorly microtrichose with about 7 lower setae, and 7 upper setae; ventral lobe absent. Cerci linked to hypandrium by membranous tissue, mostly microtrichose. Surstylus slightly microtrichose, with no prensiseta, ca. 7 long outer setae and ca. 6 long inner setae. Decasternum extremely reduced as in Fig. 4A. Hypandrium shorter than epandrium, anteriorly channel-shaped, laterally flattened, and somewhat square-shaped in profile, posteriorly dorsoventrally flattened; dorsal arch hook-shaped in profile view, parallel to aedeagus, and linked to aedeagal apodeme through posterior paraphyses; gonopod linked to anterior paraphysis by membranous tissue, bearing no seta. Aedeagus tube-shaped, distally bifid, wrinkled and slightly bent dorsally at distal third. Aedeagal apodeme linked to aedeagus by membranous tissue, channel-shaped, bent, laterally membranous, shorter than aedeagus. Ventral rod absent. Paraphysis dorsodistally sharply pointed, distally bearing ca. 5 setulae.

♀. *Measurements*: Frontal length 0.46 mm; frontal index = 1.13, top to bottom width ratio = 1.13. Ocellar triangle about 30% of frontal length. Orbital plates about 59% of frontal length. Distance of or3 to or1 = 70% of or3 to vtm, or1 / or3 ratio = 0.86, or2 / or1 ratio = 0.61, postvertical setae = 56%, ocellar setae = 78% of frontal length; vibrissal index = 0.42. Cheek index about 22. Eye index = 1.26. Thorax length 1.53 mm. h index = 0.35. Transverse distance of dorsocentral setae 322% of longitudinal distance; dc index = 0.63; scut index = 1.26, sterno index = 0.79, mid katepisternal seta about 22% of the anterior one. Wing length 3.08 mm, length to width ratio = 2.38. Indices: C = 3.69, ac = 2.00, hb = 0.69, 4C = 0.70, 4v = 1.65, 5x = 1.29, M = 0.39, prox. x = 0.83.

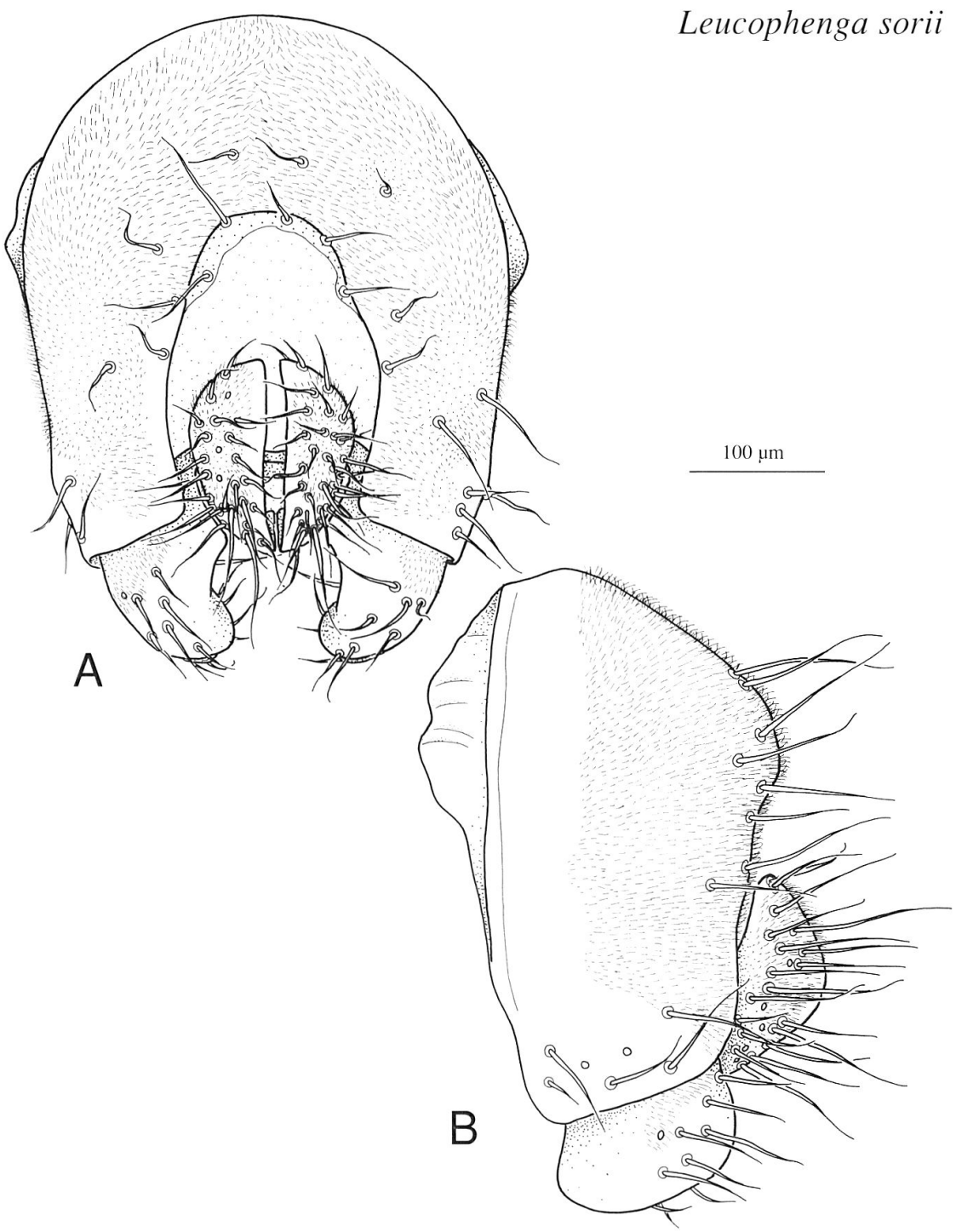

Fig. 4. *Leucophenga sorii* KANG, LEE & BHANG (Tomakomai, Japan, 22.VIII.2000). Epandrium, cerci, surstyli and decasternum, A, posterior view. B, left lateral view.

Distribution. South Korea, Japan, Russia (East Siberia).

***Leucophenga hungarica* PAPP, 2000**

(Figs 3D, 6, 7, 9C)

Leucophenga (Leucophenga) hungarica PAPP, 2000: 249 (description, comparison with *L. sorii*).
Material examined. 1♂ paratype (dissected, right wing in microslide), labelled « Zempléni TK : Regéc,

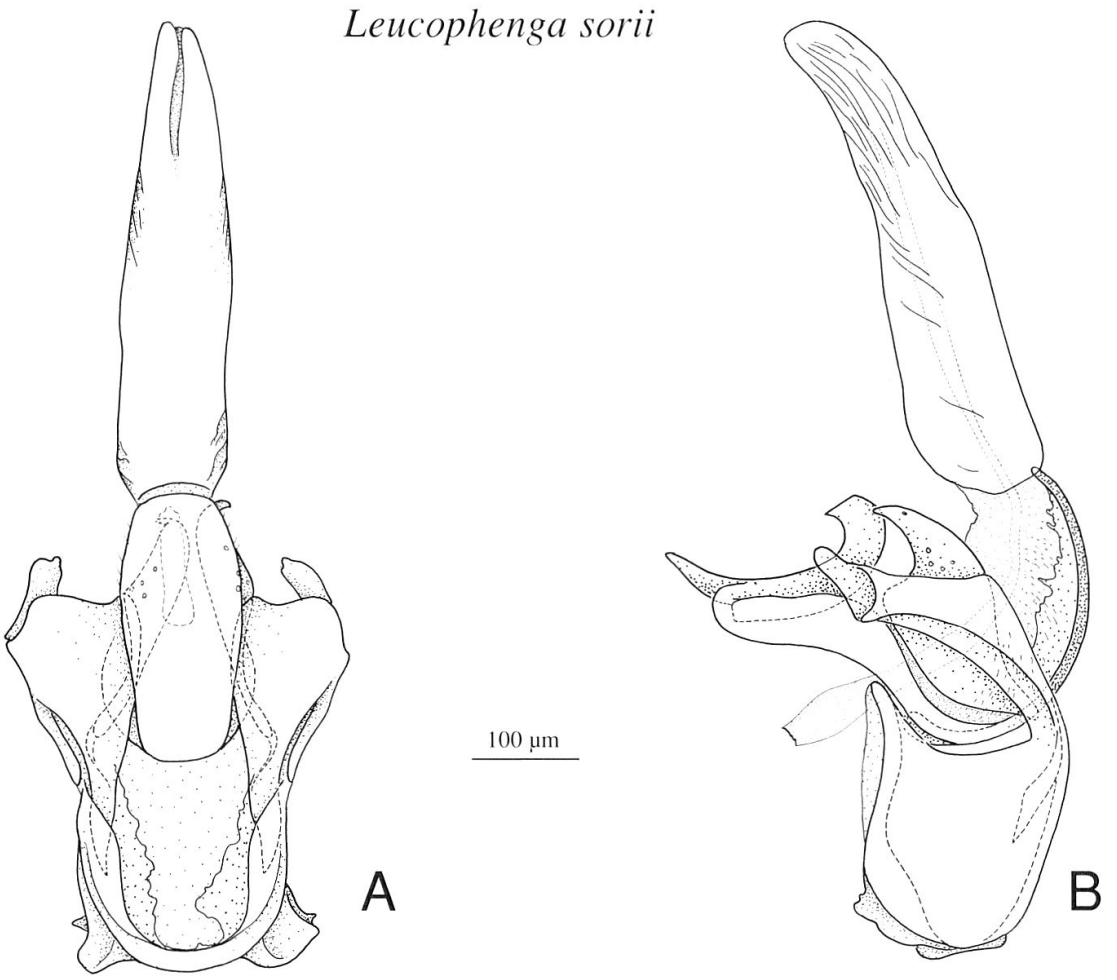

Fig. 5. *Leucophenga sorii* KANG, LEE & BHANG (Tomakomai, Japan, 22.VIII.2000). Internal male terminalia (everted), A, ventral view. B, left lateral view.

Ördög-v., patak föllöt korhadt bükkön tapló [tinder fungus on mouldy oak] / 1999 június 8., leg. PAPP Lázló, Szappanos Albert / Paratypus *Leucophenga hungarica* L. PAPP »; 1 ♀ paratype, same collection labels; 2 ♀, labelled « CH: Hönggerberg ZH 3.–7.VII.1998 G. BÄCHLI leg. »; 1 ♀, labelled: « CZ: Hluboka n.V. 20.VIII.1998 G. BÄCHLI leg. »; all deposited in ZMUZ.
Type locality: K-Mecsek TK, Óbánya, Hungary.

Diagnosis. Generally yellow fly; tergites 2–4 with narrow, dark brown marginal bands which are medially broadened, forming a narrow medial stripe, laterally not reaching ventral margin of tergite; the band on tergite 2 is laterally broadened, forming a short stripe; tergite 5 usually with a narrow marginal band which is medially interrupted; anterior paraphysis distally sharply pointed dorsad, hypandrium anteriorly triangle-shaped in profile view.

Redescription. ♂. Head. Frons golden yellowish, frontal length 0.51 mm; frontal index = 1.11, top to bottom width ratio = 1.07. Frontal triangle indistinguishable, ocellar triangle prominent, blackish along the inner margins of the ocelli, or completely black, about 33% of frontal length. Orbital plates narrow, not diverging from eye margin, slightly darker greyish and subshiny, about 63% of frontal length. Orbital setae black, strong, almost in a line, or2 slightly more close to or1 than to or3, distance of or3 to or1 = 62% of or3 to vtm, or1 / or3 ratio = 0.87, or2 / or1 ratio = 0.55, postvertical setae = 50%, ocellar setae = 73% of frontal length;

Leucophenga hungarica

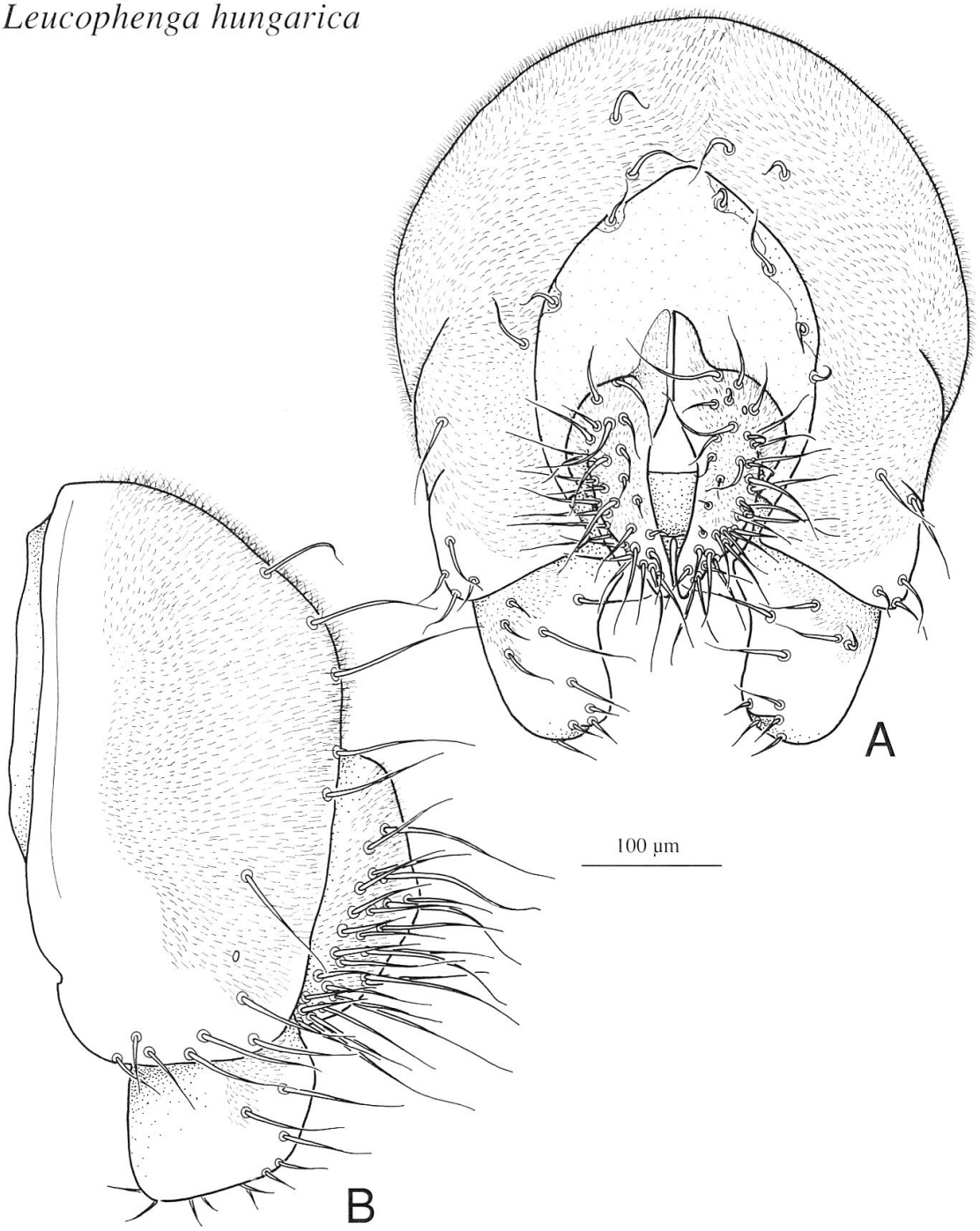

Fig. 6. *Leucophenga hungarica* PAPP (paratype). A, epandrium, cerci, surstyli and decasternum, posterior view. B, left lateral view.

vibrissal index = 0.45. Face flat, whitish. Carina almost absent. Cheek index about 17–18. Eye index = 1.13. Occiput concave, dark brown in upper half, brownish along eye margins, pale yellowish in lower half. Pedicel yellowish. Flagellomere 1 white, length to width ratio about 1.80. Arista with 7–8 dorsal, 3–4 ventral and about 10 short inner branches, plus small terminal fork. Proboscis yellow. Palpi whitish.

Thorax length 1.89 mm. Scutum yellow, shiny. 8–10 rows of acrostichal setae. Only one posthumeral seta. Transverse distance of dorsocentral setae 300% of

longitudinal distance; dc index = 0.57. Scutellar setae nearly equidistant; basal ones divergent; prescutellar setae about 67% of the anterior dorsocentral setae, scut index = 1.21. Pleura yellowish, sterno index = 0.68, mid katepisternal seta minute, about 22% of the anterior one. Halteres yellow. Legs yellow, preapical setae on all tibiae but strong on mid tibia only, ventral apical seta on mid tibia.

Wing hyaline, ventral surface of C-III bearing tiny and hardly visible, curved costal pegs (warts) (Fig. 9C), length 3.96 mm. Indices: C = 3.75, ac = 2.00, hb = 0.60, 4C = 0.67, 4v = 1.67, prox. x = 0.73.

Abdomen yellow, shiny, tergite 2 with a blackish-brown apical band which is medially triangularly extended and laterally reaching tergite 1, forming a laying capital E, tergites 3–4 with a narrow apical band and a narrow median stripe, connecting the tergites; tergite 5 usually with the same but distinctly smaller and paler pattern; width and darkness of the pattern is obviously variable.

♂ *Terminalia* (Figs 3D, 6, 7). Epandrium posteriorly microtrichose with about 9 lower setae, and 5 upper setae; ventral lobe absent. Cerci linked to hypandrium by membranous tissue, mostly microtrichose. Surstylus slightly microtrichose, with no prensiseta, ca. 9 outer long setae and some inner setae. Decasternum extremely reduced as in Fig. 6A. Hypandrium shorter than epandrium, anteriorly channel-shaped, laterally flattened, and somewhat triangle-shaped in profile view, posteriorly dorsoventrally flattened; dorsal arch hook-shaped in profile, parallel to aedeagus, and linked to aedeagal apodeme through posterior paraphyses; gonopod linked to anterior paraphysis by membranous tissue, bearing no seta. Aedeagus tube-shaped, distally bifid, wrinkled, slightly microtrichose and bent dorsad at distal third. Aedeagal apodeme linked to aedeagus by membranous tissue, channel-shaped, bent, laterally membranous, shorter than aedeagus. Ventral rod absent. Anterior paraphysis dorsodistally sharply pointed, distally bearing ca. 3 setulae.

♀. *Measurements*: Frontal length 0.49 (0.45–0.55) mm; frontal index = 1.05 (1.03–1.08), top to bottom width ratio = 1.10 (1.06–1.15). Ocellar triangle about 31–36% of frontal length. Orbital plates about 62–68% of frontal length. Distance of or3 to or1 = 62–67% of or3 to vtm, or1 / or3 ratio = 0.92 (0.87–0.95), or2 / or1 ratio = 0.53 (0.50–0.57), postvertical setae = 52 (44–61) %, ocellar setae = 81 (75–89) % of frontal length; vibrissal index = 0.49 (0.46–0.55). Cheek index about 13–16. Eye index = 1.23 (1.18–1.26). Thorax length 1.74 (1.63–1.92) mm. Transverse distance of dorsocentral setae 282–340% of longitudinal distance; dc index = 0.58 (0.56–0.59); scut index = 1.11 (1.06–1.15), sterno index = 0.70 (0.69–0.73), mid katepisternal seta about 17–29% of the anterior one. Wing length 3.65 (3.32–4.06) mm, length to width ratio = 2.36 (2.26–2.47). Indices: C = 3.67 (3.55–3.78), ac = 2.14 (1.89–2.25), hb = 0.65 (0.60–0.68), 4C = 0.69 (0.65–0.71), 4v = 1.63 (1.58–1.69), 5x = 1.26 (1.20–1.38), M = 0.39 (0.38–0.42), prox. x = 0.78 (0.73–0.85).

Distribution. Hungary, Czech Republic, Slovakia, Switzerland.

Leucophenga helvetica sp. nov.

(Figs 3E, 8, 9A, B)

Material examined. Holotype ♂ (dissected, right wing in microslide), labelled « CH : Cevio-Cerentino, 15.–16.VII.1997, G. BÄCHLI leg. / ♂ / Holotype », deposited in ZMUZ.
Type locality: Between Cevio and Cerentino, Ticino, Switzerland.

Diagnosis. Generally yellow fly; tergites 2–5 with dark brown marginal bands which are medially broadened and usually reaching the base of the tergite, laterally

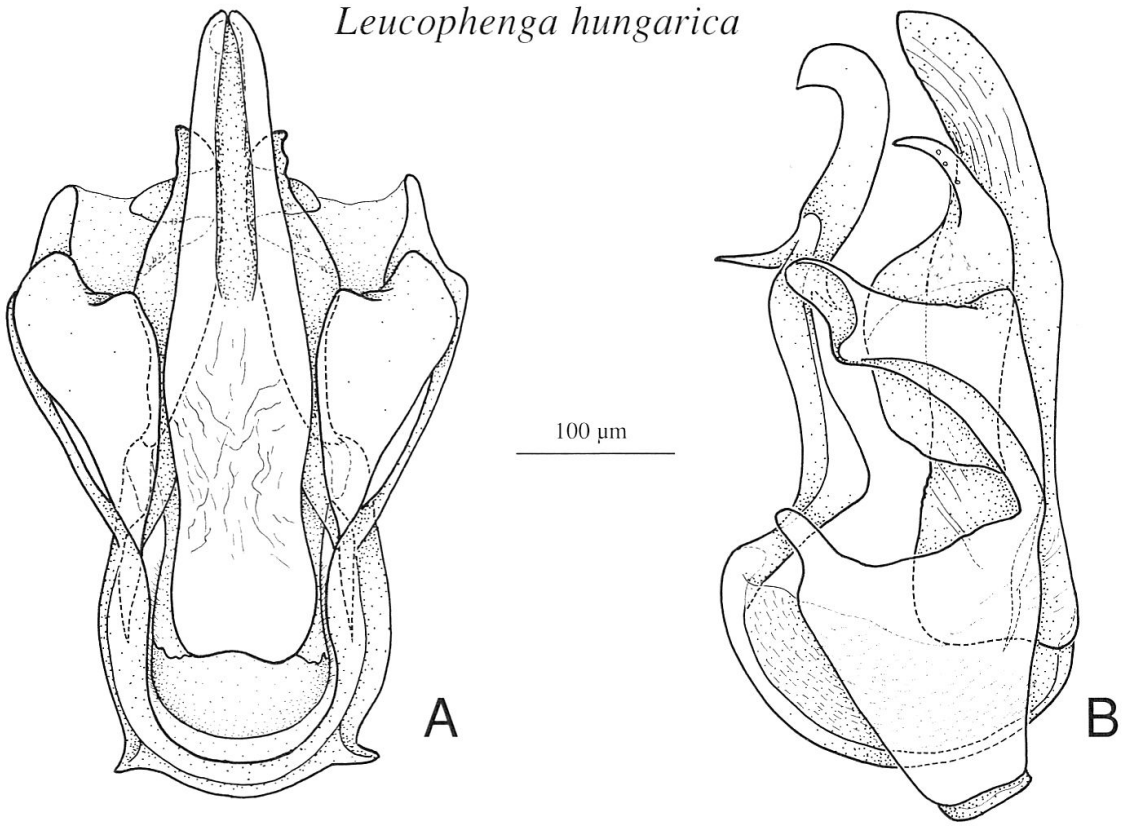

Fig. 7. *Leucophenga hungarica* PAPP. Internal male terminalia, A, ventral view. B, left lateral view.

broadened and diffusely reaching the base of the tergite, leaving two more or less triangular yellow areas; laterally not reaching to the ventral margin of the tergite. Anterior paraphysis bearing about 9 short and strong setae (Figs 3E, 8C, D).

Description. ♂. Head. Frons brownish-yellow, microtrichose, paler yellowish above antennae, almost parallel-sided, frontal length 0.50 mm; frontal index = 1.32, top to bottom width ratio = 1.09. Frontal triangle indistinct or more or less restricted to ocellar triangle which is prominent, blackish-brown, subshiny, the latter about 31% of frontal length. Orbital plates brownish, subshiny, about 69% of frontal length. Orbital setae black, strong, or2 outside and slightly behind or1, distance of or3 to or1 = 62% of or3 to vtm, or1 / or3 ratio = 0.95, or2 / or1 ratio = 0.42, postvertical setae crossed, about 45%, ocellar setae = 69% of frontal length; vibrissal index = 0.75, oral setae distinctly shorter and uniserial. Face brownish, subshiny, more or less flat. Carina only visible between the pedicels, then flattened downwards. Cheek very narrow, posteriorly with a ventrad directed black seta, index about 25. Eye bare, index = 1.32. Occiput blackish, brownish along margins. Pedicel brownish-yellow, with 2 stronger setae and a ventral row of about 6 small setae. Flagellomere 1 pale yellowish, covered with short setulae, length to width ratio = 1.63. Arista with 6 dorsal, 3 ventral and about 6–8 small inner branches, plus small terminal fork. Proboscis brownish-yellow. Palpi yellow, with a distinct apical and a few smaller setae along the lower margin.

Thorax length 1.67 mm. Scutum yellowish, almost shiny, 8 rows of acrostichal setae. h index = 0.45. Transverse distance of dorsocentral setae about 280% of longitudinal distance; dc index = 0.58. 1 pair of distinct prescutellar setae, length about 90% of that of the anterior dorsocentral setae. Scutellum yellowish, subshiny,

scutellar setae nearly equidistant; distance between apical scutellar setae about 93% of that of the apical to the basal one; basal ones almost parallel; scut index = 1.15. Pleura whitish-yellow, subshiny, 2 small proepisternal setae, sterno index = 0.78, mid katepisternal seta minute. Halteres yellow. Legs pale yellow, preapical setae on all tibiae, short on foreleg, ventral apical seta on mid tibia.

Wing (Fig. 9A) hyaline, ventral surface of C-III apparently without curved costal pegs (warts) (Fig. 9B), costa very thin between the tips of R_{4+5} and M, veins R_{4+5} and M apically slightly converging, length 3.32 mm, length to width ratio = 2.26. Indices: C = 3.82, ac = 1.89, hb = 0.53, 4C = 0.71, 4v = 1.75, 5x = 1.57, M = 0.46, prox. x = 0.79.

Abdomen with yellowish ground color, shiny; tergites 2–5 generally with a broad, dark brown marginal band which is medially and laterally more or less extended, reaching at least partially the basal margins of the tergites; tergite 6 dorsally fully dark; ventro-lateral edges of all tergites pale.

♂ *Terminalia* (Figs 3E, 8, 9). Epandrium dorsally and ventroposteriorly microtrichose with about 4 lower setae, and 5 upper setae; ventral lobe absent. Cerci linked to hypandrium by membranous tissue, mostly microtrichose. Surstylus not microtrichose, with no prensiseta, 1 outer long seta and ca. 8 long inner setae. Decasternum extremely reduced as in Fig. 8A. Hypandrium as long as epandrium, anteriorly channel-shaped, laterally flattened, and somewhat square-shaped in profile, posteriorly dorsoventrally flattened; dorsal arch hook-shaped in profile view, parallel to aedeagus, and linked to aedeagal apodeme through posterior paraphyses; gonopod linked to anterior paraphysis by membranous tissue, bearing no seta. Aedeagus tube-shaped, bifid at distal 2/3, mostly corrugated, wider medially. Aedeagal apodeme linked to aedeagus by membranous tissue, channel-shaped, bent, laterally membranous, shorter than aedeagus. Ventral rod absent. Anterior paraphysis distally roundish and bearing ca. 9 conspicuously short, strong, and sharply pointed setae.

♀ unknown. We assume that most of the external characters are shared with the male.

Etymology. Named after the collecting area, Switzerland.

Relationship. This species most closely resembles the East Asian species *L. sorii* KANG, LEE & BHANG, 1965 and the central European species *L. hungarica* PAPP, 2000 in all group characters, differs from both, however, in the abdominal pattern and details of the male terminalia, mainly the shape of aedeagus and anterior paraphysis, which is not sharply pointed distally as in the latter species and conspicuously bear short, and stronger peglike setae.

Distribution. Switzerland.

Genus *Drosophila* FALLÉN, 1823

robusta species group

***Drosophila vireni* sp. nov.**

(Figs 10, 11, 14D–F)

Material examined. Holotype ♂ (dissected), labelled «*D. subarctica* sukul, Oulanka V 9.7.1982 S. LAKOVAARA / Holotype». 1 ♂ paratype, 4 ♂, labelled «SF: Oulanka 10.VI.1986 S. LAKOVAARA leg.»
Type locality. Oulanka, Finland.

Diagnosis. Dark greyish-brown flies; abdomen brown, with diffuse darker marginal bands which are usually medially narrowed or interrupted; wing with

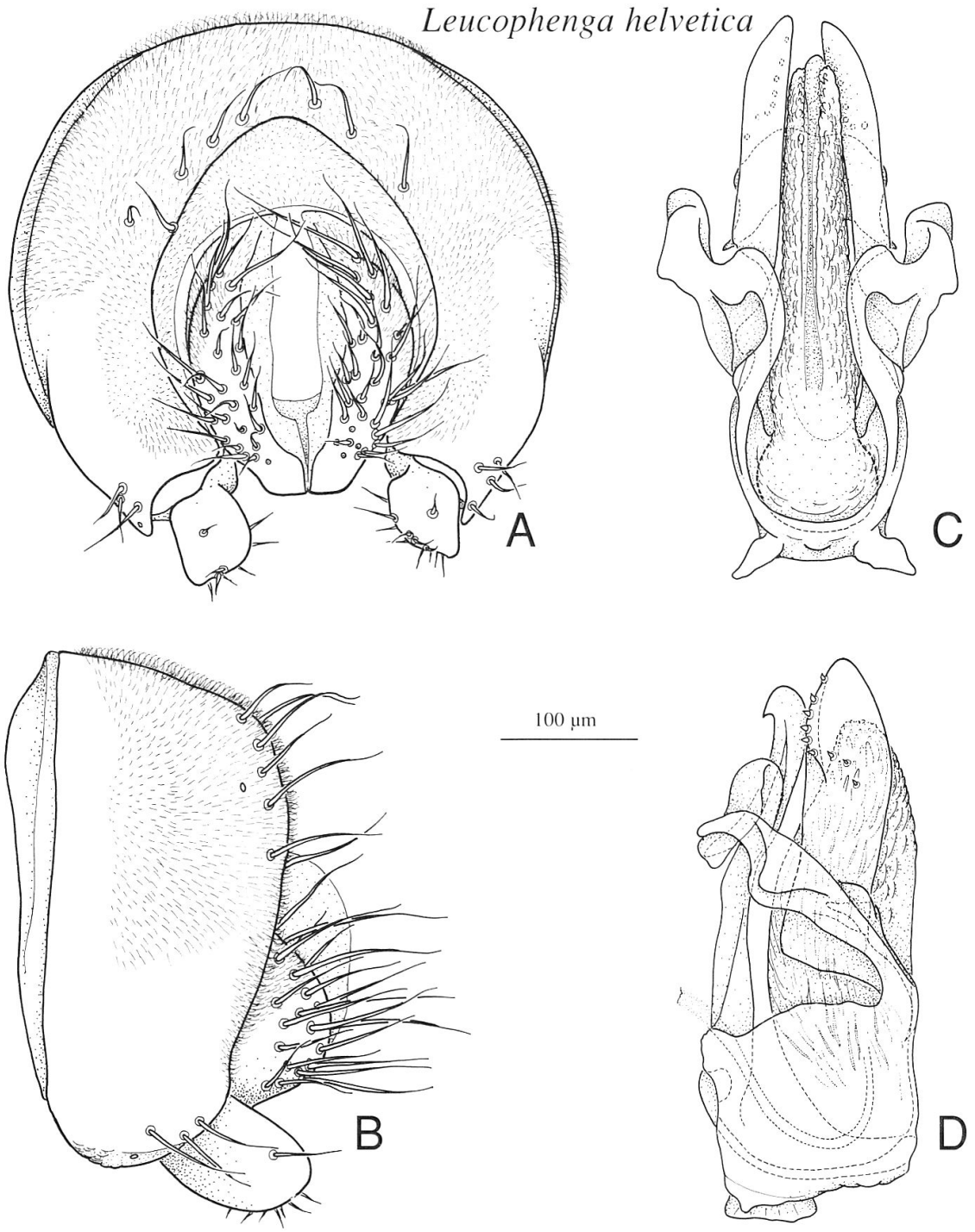

Fig. 8. *Leucophenga helvetica* sp. nov., holotype ♂. A, epandrium, cerci, surstyli and decasternum, posterior view. B, idem, left lateral view. C, Internal male terminalia, ventral view. D, idem, left lateral view.

faintly shadowed crossveins; aedeagus strongly narrowed at distal end (in dorsal and ventral views), and conspicuously bearing three anterodorsal pleats.

Description. ♂. All specimens checked except the holotype are completely colorless, most probably due to inadequate storage. As there are virtually no external differences between this new species and *D. subarctica* HACKMAN (S. LAKOVAARA, pers. comm.), we restrict the description to available metric data.

Measurements: Frontal length 0.41 mm; frontal index = 0.96, top to bottom width ratio = 1.40. Ocellar triangle about 42% of frontal length. Orbital plates about 92% of frontal length. Distance of or3 to or1 = 100% of or3 to vtm, or2 / or1 ratio = 0.33, postvertical setae = 63 of frontal length; vibrissal index = 0.85. Cheek index

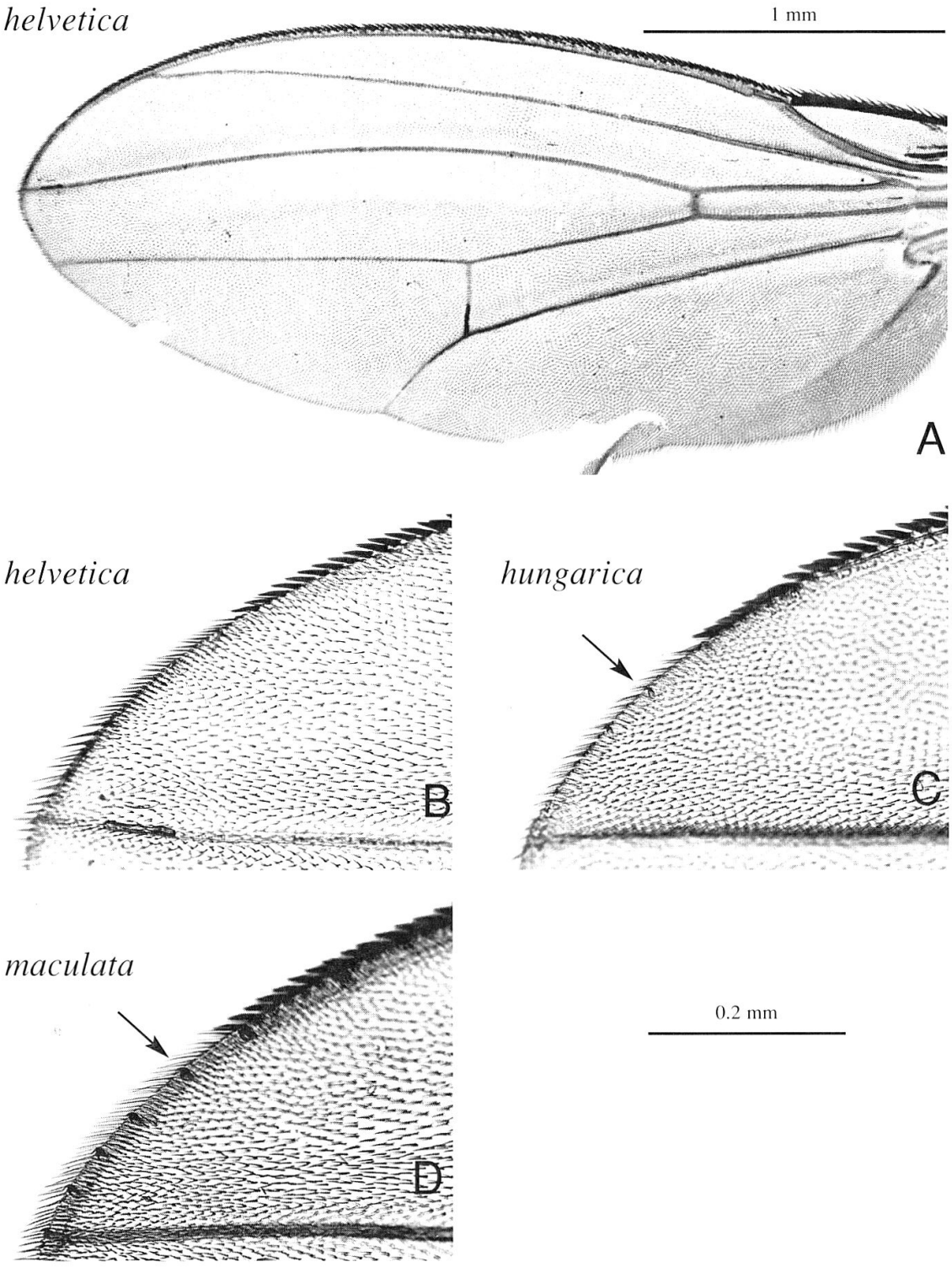

Fig. 9. A, *Leucophenga helvetica* sp. nov., holotype ♂, right wing, ventral view – Right wing tip, ventral view of third costal section, of: B, *Leucophenga helvetica* sp. nov (holotype ♂). C, *Leucophenga hungarica* Papp (paratype). D, *Leucophenga maculata* (DUFOUR) (Seelisberg, Switzerland, VIII, 1973).

about 3–5. Eye index = 1.09 (1.07–1.11). Thorax length 1.25 (1.17–1.34) mm. 6–8 rows of acrostichal setae. Transverse distance of dorsocentral setae 169–180% of longitudinal distance; distance between apical scutellar setae about 69–71% of that of the apical to the basal one. Wing length 3.08 (2.94–3.29) mm. Indices: ac = 2.11, 4C = 0.66 (0.63–0.70), 4v = 1.33, 5x = 1.22, prox. x = 0.47 (0.43–0.52).

♂ *Terminalia* (Figs 10, 11, 14D–F). Epandrium posteriorly microtrichose with about 19 lower setae, and 7 upper setae; ventral lobe roundish, posteriorly microtrichose. Cerci linked to hypandrium by membranous tissue, mostly microtrichose. Surstylus not microtrichose, with 10 cone-shaped setae roundish at tip, and about 15 inner setae. Decasternum as in Fig. 10A. Hypandrium as long as epandrium, posteriorly narrowed; dorsal arch present, medially membranous; gonopod mostly fused to paraphysis and to hypandrium, bearing one thin seta near the median inner margin. Aedeagus short, distally slightly bifid, strongly narrowed at distal end in dorsal and ventral views (Figs 11C, G, 14F), and posteriorly bent dorsad in profile, anteriorly and submedianlly serrated on ventral margin; anterodorsal half conspicuously bearing three pleats, outer ones smaller and slightly serrated. Aedeagal apodeme longer than aedeagus, slightly bent, laterally flattened. Ventral rod as long as paraphysis, dorsoventrally flattened, triangular. Paraphysis linked to distal margin of aedeagal apodeme by membranous tissue, distally convex, bearing ca. 6 setulae.

Etymology. Named in honor of the Finnish runner, fourtimes olympic gold winner, Lasse VIREN (as suggested by P. LANKINEN).

Relationship. This species is most closely related to *D. subarctica* HACKMAN, whose male holotype has been dissected and its terminalia (Figs 12, 13, 14B,C) in addition to the terminalia of an ordinary specimen (Fig. 14A) are redescribed below and also illustrated in the present paper for comparison purposes.

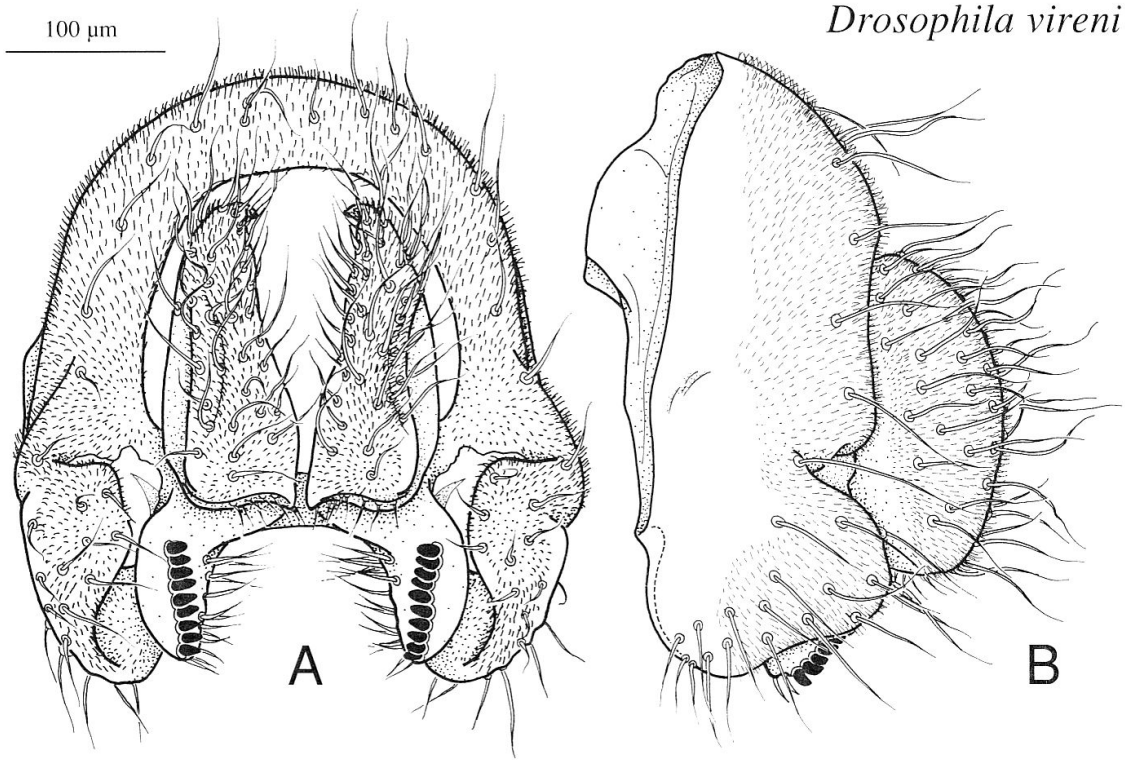

Fig. 10. *Drosophila vireni* sp. nov., holotype ♂. A, epandrium, cerci, surstyli and decasternum, posterior view. B, idem, left lateral view.

Comments. Collecting and ecological background studies of *D. vireni* were predominantly undertaken by P. LANKINEN and J. LUMME. The identity was established by starch gel electrophoresis of specimens collected in the wild, showing banding patterns obviously different from those of its sibling *D. subarctica*. In addition, it was impossible to breed *D. vireni* in the laboratory, because of an obligatory adult diapause which by no means could be broken. On the other hand, *D. subarctica* can be cultured under constant daylight conditions (pers. comm. P. LANKINEN).

♂ Terminalia of *Drosophila subarctica* (Figs 12, 13, 14A–C). Epandrium posteriorly microtrichose with about 19 lower setae, and 4 upper setae; ventral lobe roundish, posteriorly microtrichose. Cerci linked to hypandrium by membranous tissue, mostly microtrichose. Surstylus not microtrichose, with 8 cone-shaped setae roundish at tip, and several inner setae. Hypandrium as long as epandrium, slightly square-shaped; dorsal arch present, medially membranous; gonopod mostly fused to paraphysis and to hypandrium, bearing one small seta near the median inner margin. Aedeagus short, distally slightly bifid, slightly narrowed at distal end in dorsal and ventral views (Figs 13C, G, 14C), and posteriorly bent dorsad in profile, anteriorly and submedially serrated on ventral margin; anterodorsal half conspicuoulsy bearing three pleats, outer ones smaller and slightly serrated. Aedeagal apodeme longer than aedeagus, strongly bent, laterally flattened. Ventral rod as long as paraphysis, dorsoventrally flattened, triangular. Paraphysis linked to distal margin of aedeagal apodeme by membranous tissue, distally convex, slightly microtrichose, and bearing ca. 6 setulae.

Distribution. Northern Finland.

quinaria species group

Drosophila (_Drosophila_) _schachti_ sp. nov.

(Figs 15, 16, 23C-E)

Material examined. Holotype ♂ (dissected), labelled « Turkey, Pr. [Province] Kars / Aras-Tal [valley], w. Karakurt, 1300 m, 4.7.1985, leg. W. SCHACHT / ♂ / Holotype », four paratypes (3 ♂, dissected and 1 ♀): same labels as holotype, except the last (« Paratype »), all deposited in ZMUZ.
Type locality. Aras river valley, west of Karakurt, Province of Kars, Turkey.

Diagnosis. Generally yellowish flies; tergites with four dark brown spots, each lateral pair is usually partially confluent along the hind margin; wing with both crossveins shadowed, a diffuse shadow is usually visible along vein R_1; male terminalia as given below.

Description. ♂. Head. Frons brownish-yellow, somewhat dull, frontal length 0.33 (0.30–0.34) mm; frontal index 0.76 (0.74–0.77), top to bottom width ratio 1.25 (1.22–1.27). Frontal triangle paler yellow, about 59–73% of frontal length; ocellar triangle slightly darker, brownish on the inner sides of the ocelli, somewhat prominent, about 35–40% of frontal length. Frontal vittae darker brownish, Orbital plates narrow, greyish-brown, subshiny, slightly diverging from eye border, about 64–85% of frontal length. Distance of or3 to or1 = 44–56% of or3 to inner vtm, or1 / or3 ratio = 0.74 (0.71–0.79), or2 / or1 ratio = 0.42 (0.36–0.50), postvertical setae = 65 (61–70) %, ocellar setae = 92 (89–95) % of frontal length; vibrissal index 0.85 (0.53–1.33). Face brownish, carina prominent, slightly noselike, narrow, slightly broader downwards. Cheek index about 4–6. Eye index 1.14 (1.11–1.19). Occiput brown with yellowish border. Antennae yellowish. Arista with 4–6 dorsal and 2–3

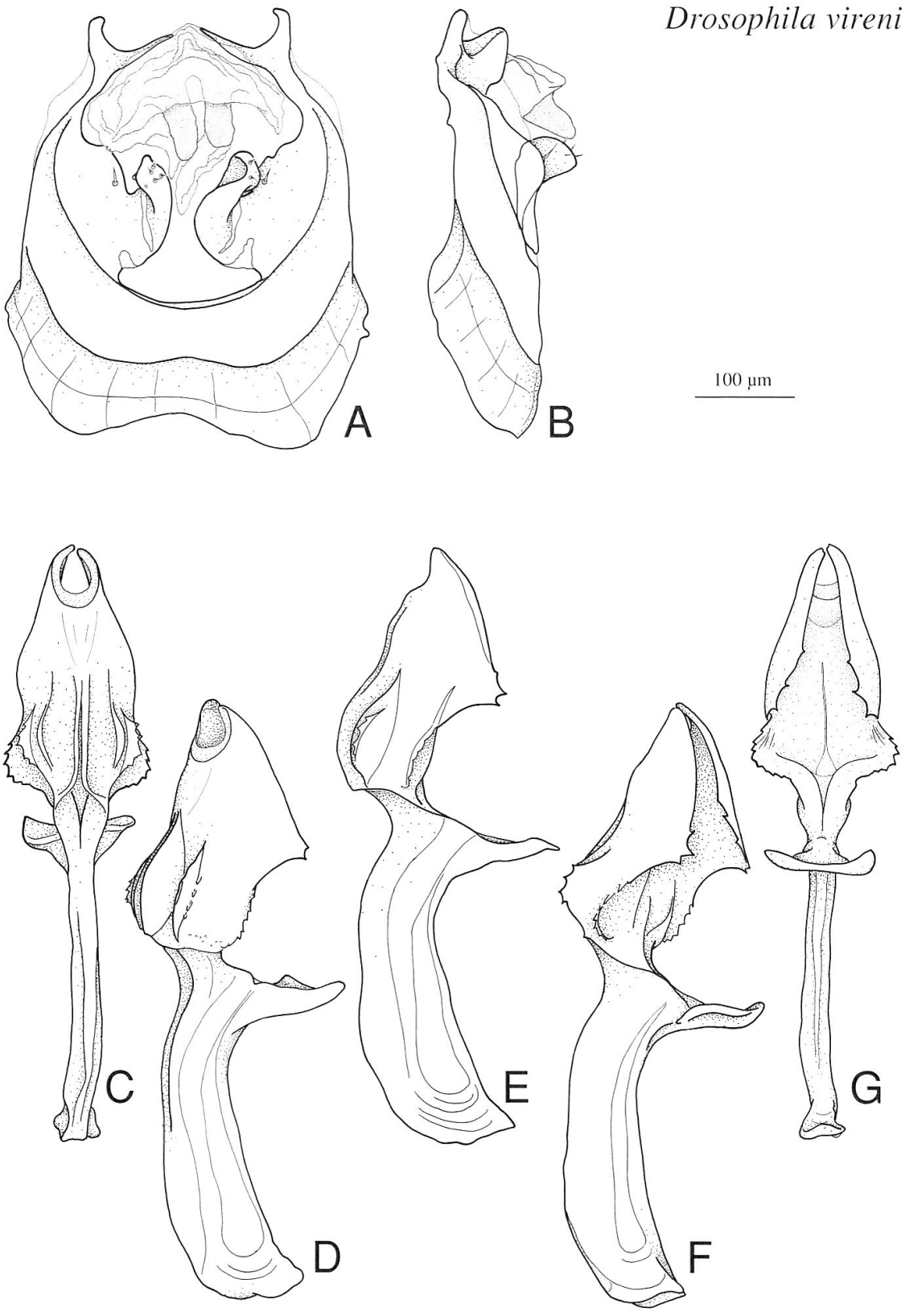

Fig. 11. *Drosophila vireni* sp. nov., holotype ♂. A, hypandrium, paraphysis and gonopods, posterior view. B, idem, left lateral view. C–G, aedeagus and aedeagal apodeme, several views from dorsal through ventral.

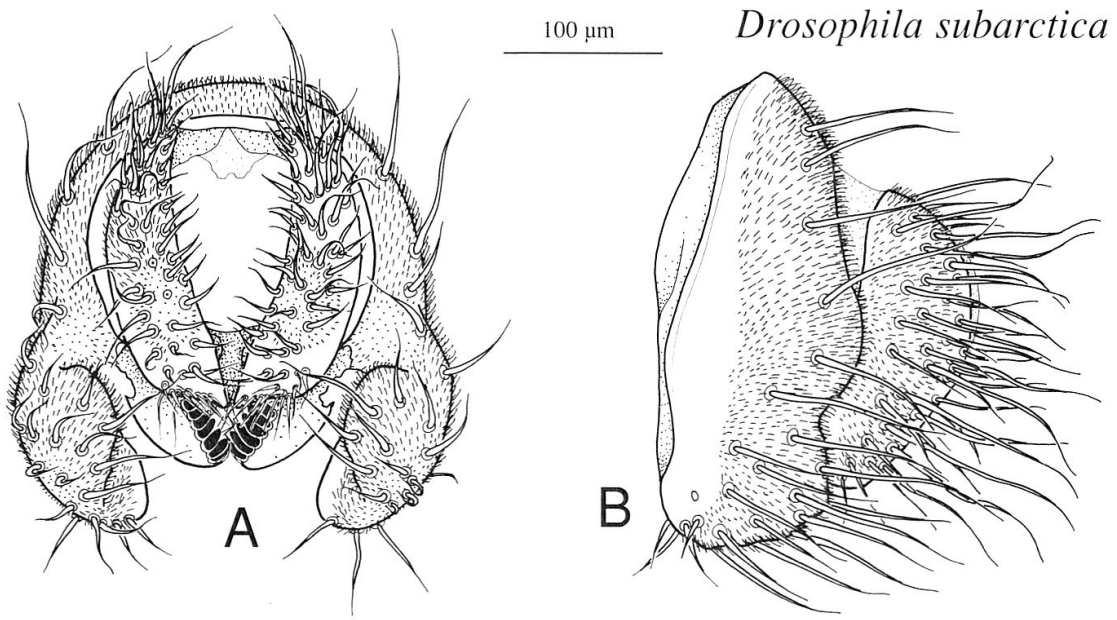

Fig. 12. *Drosophila subarctica* HACKMAN, holotype ♂. A, epandrium, cerci, surstyli and decasternum, posterior view. B, idem, left lateral view.

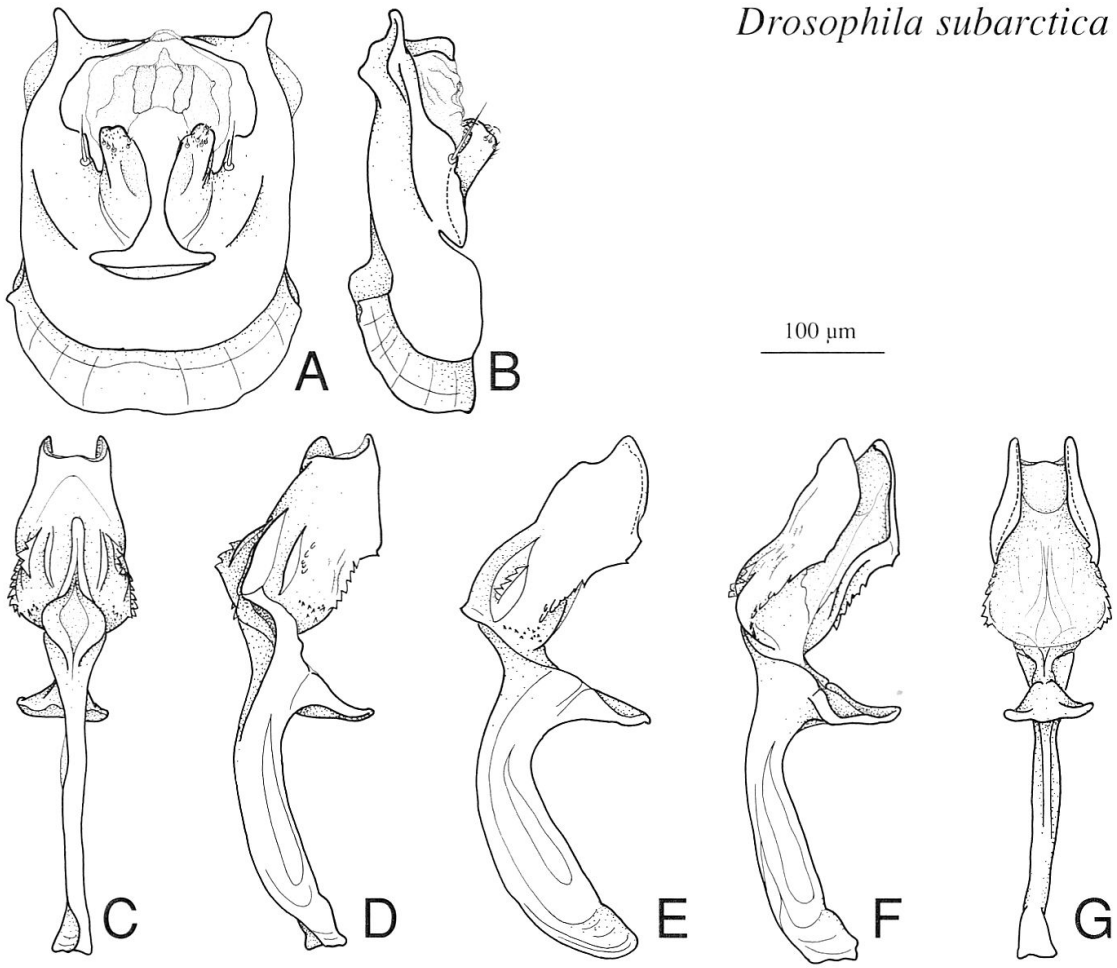

Fig. 13. *Drosophila subarctica* HACKMAN, holotype ♂. A, hypandrium, paraphyses and gonopods, posterior view. B, idem, left lateral view. C–G aedeagus and aedeagal apodeme, several views from dorsal through ventral.

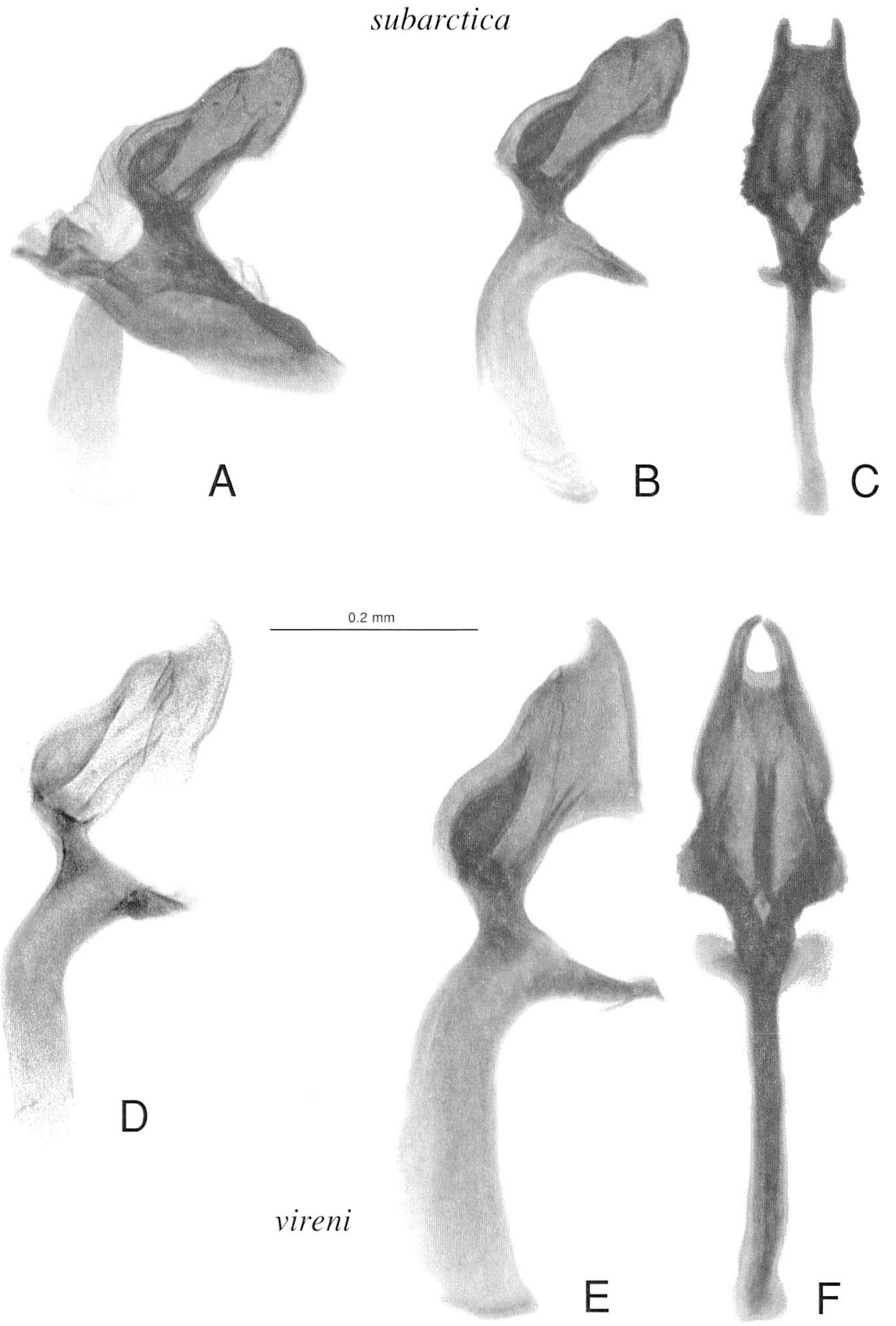

Fig. 14. *Drosophila subarctica* HACKMAN. A, paratype, internal male terminalia, left lateral view. B, C, holotype ♂, B, aedeagus and aedeagal apodeme, left lateral view. C, idem, dorsal view. – *Drosophila vireni* sp. nov.. D, teneral ordinary specimen, aedeagus and aedeagal apodeme, left lateral view. E, F, holotype ♂. E. idem, left lateral view, F, idem, dorsal view.

ventral and about 7–8 short inner branches, plus terminal fork. Proboscis yellow. Palpi apically with 2 black setae and several fine setulae along the lower border.

Thorax. Length about 1.32 (1.22–1.38) mm. Scutum dark yellowish, medially with a diffuse brown stripe. 8 rows of acrostichal setae. h index 0.71. Transverse distance of dorsocentral setae 162–200% of longitudinal distance; dc index 0.60 (0.59–0.61). Scutellum yellowish, with some diffuse darker areas; distance between apical scutellar setae about 100–108% of that of the apical to the basal one; scut index 1.11. Pleura pale yellow, slightly shiny, sterno index 0.60 (0.57–0.64), mid katepisternal seta about 41–71% of the anterior one. Halteres yellow. Legs yellow, preapical setae on all tibiae, ventral apical setae on mid tibia.

Wing hyaline, veins yellow, but both crossveins brown and distinctly shadowed, also R_1 diffusely brownish; length 3.07 (2.90–3.15) mm, length to width ratio 2.33 (2.26–2.37). Indices: C, 3.32 (3.11–3.53), ac, 2.30 (2.13–2.43), hb, 0.54 (0.53–0.56), 4c, 0.71 (0.65–0.76), 4v, 1.52 (1.46–1.61), 5x, 1.12 (1.00–1.25), M, 0.40 (0.35–0.44), prox. x, 0.59 (0.58–0.61).

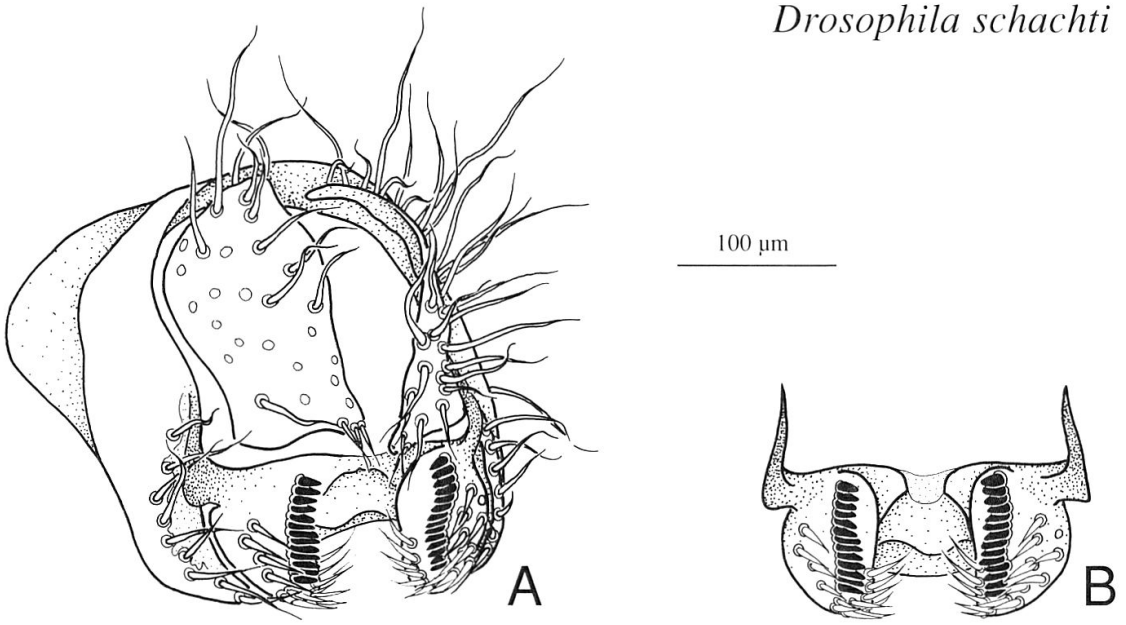

Fig. 15. *Drosophila schachti* sp. nov., holotype ♂. A, epandrium, cerci, surstyli and decasternum, oblique posterior view. B, surstyli and decasternum posterior view.

Abdomen yellow, shiny; tergites 2–5 each with 2 brown, medially not widely interrupted marginal bands which show a tendency to be split in roundish spots, particularly on tergites 4 and 5; tergite 6 with large, medially more or less confluent paramedian spots and no lateral ones.

♂ *Terminalia* (Figs 15, 16, 23C–E). Epandrium not microtrichose with about 9 lower setae, and no upper setae; ventral lobe not covering surstylus. Cerci linked to hypandrium by membranous tissue, not microtrichose. Surstylus not microtrichose, with ca. 13 cone-shaped prensisetae roundish at tip, about 8 outer long setae and ca. 6 long inner setae. Decasternum as in Fig. 15B. Hypandrium slightly longer than epandrium, dorsal arch absent, gonopod fused to paraphysis, bearing one seta near posterior inner margin. Aedeagus subapically bearing two lateral expansions posteriorly slightly serrated, slightly invaginated at tip; ventrally bearing a pair of long and downwards pointed spurs, which almost reach the ventral rod. Aedeagal

apodeme as long as aedeagus, rod-shaped. Ventral rod absent. Paraphysis rectangle-shaped, longer than wide, linked to distal margin of aedeagal apodeme by membranous tissue, distally straight, bearing two setulae.

♀. *Measurements*: Frontal length 0.34 mm; frontal index = 0.70, top to bottom width ratio = 1.30. Frontal triangle about 75% of frontal length; ocellar triangle about 35% of frontal length. Orbital plates about 80% of frontal length. Distance of or3 to or1 = 55% of or3 to vtm, or1 / or3 ratio = 0.70, or2 / or1 ratio = 0.40, postvertical setae = 70%, ocellar setae = 100% of frontal length; vibrissal index = 0.60. Cheek index about 4. Eye index = 1.10. Thorax length 1.41 mm. h index = 0.70. Transverse distance of dorsocentral setae about 170% of longitudinal distance; dc index = 0.70. Distance between apical scutellar setae about 90% of that of the

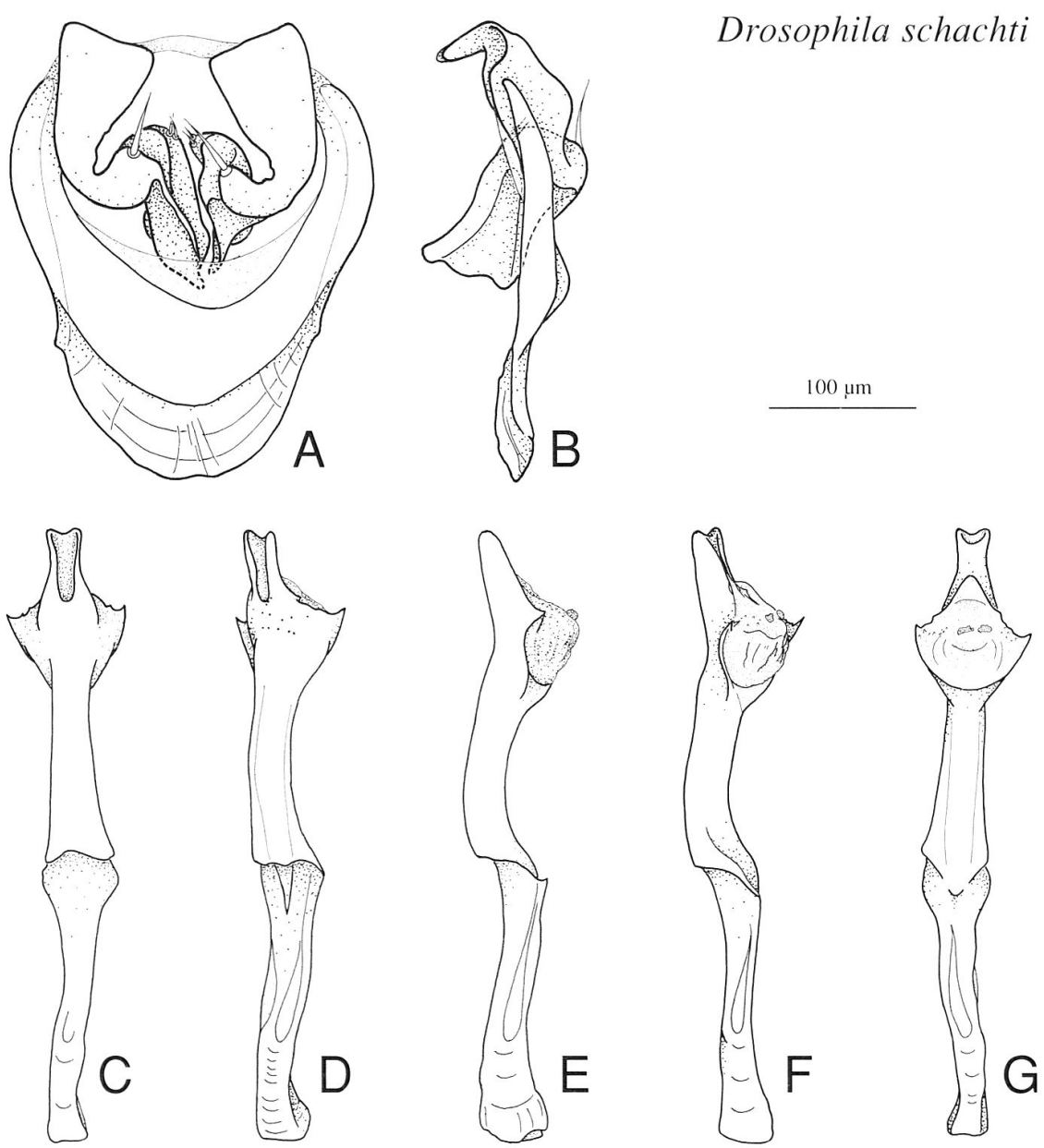

Fig. 16. *Drosophila schachti* sp. nov., holotype ♂. A, hypandrium, paraphyses and gonopods, posterior view. B, idem, left lateral view. C–G, aedeagus and aedeagal apodeme, several views from dorsal through ventral.

apical to the basal one; scut index = 0.40. sterno index = 0.80, mid katepisternal seta about 50% of the anterior one. Wing length 3.22 mm, length to width ratio = 2.30. Indices: C = 3.70, ac = 2.40, hb = 0.60, 4C = 0.70, 4v = 1.70, 5x = 1.00, M = 0.40, prox. x = 0.60.

Etymology. Named after Wolfgang SCHACHT, collector of the type series.

Relationship. Although according to the external morphology and terminalia this species is clearly a member of the *quinaria* species group, its aedeagus has no similarity with any of the species so far described in that group.

Distribution: Turkey.

Note. Recently, a species of the *quinaria* species group has been collected in Switzerland which differs from the four widespread European species by the abdominal pattern as well as by the male and female terminalia. As there were some doubts regarding its identity, a morphological comparison was made with three species which are morphologically very similar: *Drosophila unispina* OKADA, 1956 and *D. curvispina* WATABE & TODA, 1984, both from Japan, and *D. natasha* GORNOSTAYEV, 1992 from Turkmenistan (of which only the original description was available). In addition, a molecular phylogenetic analysis has been made by one of us (E. HARING).

Drosophila unispina OKADA, 1956

(Figs 17, 18, 23A)

Drosophila (Drosophila) unispina OKADA, 1956: 129 (description, distribution, affinities); KIM 1962: 132, fig. 32 (male external terminalia); WATABE & TODA 1984: 240 ff. (comparison with *D. curvispina*); LEE & CHOI 1985: 23 ff. (description. illustrations, male terminalia, phylogeny).

Material examined. 5 ♂ (one dissected), labelled «Japan: Sapporo IX.2000 M.J. TODA leg.»; 2 ♂, 2 ♀, labelled: «Japan: Tomakomai 7.–14.VIII.1999 M.J. TODA leg.»

Type locality. Daisetsuzan, Hokkaido, Japan.

Diagnosis. Generally yellowish flies; tergites with four dark brown spots, each lateral pair is usually partially confluent along the hind margin; wing with both crossveins shadowed; aedeagus slightly bent, apically bearing one long, straight, anteriorly pointed spur, which in turn subapically bears two tiny lateral spines.

Redescription. ♂. Head. Frons brownish-yellow, somewhat dull, frontal length 0.32 (0.27–0.34) mm, frontal index = 0.81 (0.71–0.87), top to bottom width ratio = 1.22 (1.13–1.30). Frontal triangle paler yellow, 65–84% of frontal length; ocellar triangle slightly darker, brownish on the inner sides of the ocelli, somewhat prominent, 35–45% of frontal length. Frontal vittae somewhat darker brownish. Orbital plates narrow, greyish-brown, shiny, slightly diverging from eye border, 80–84% of frontal length. Orbital setae blackish, almost in a line, distance of or3 to or1 = 57–75% of or3 to vtm, or1 / or3 ratio = 0.66 (0.61–0.71), or2 / or1 ratio = 0.48 (0.27–0.63), postvertical setae = 71 (65–76) %, ocellar setae = 90 (85–95) % of frontal length; vibrissal index = 0.49 (0.33–0.64). Face brownish. Carina prominent, noselike, distinctly broader downwards. Cheek index about 5–7. Eye index = 1.18 (1.13–1.21). Occiput brown with yellowish border. Antennae brownish-yellow. Arista with 4–5 dorsal, 2–3 ventral and about 7–10 short inner branches, plus terminal fork. Proboscis yellow. Palpi with about 3 fine, black setae and several fine setulae.

Thorax. Length 1.20 (1.03–1.33) mm. Scutum brownish-yellow, shiny, 6(–8) rows of acrostichal setae. h index = 0.98 (0.92–1.04). Transverse distance of dorsocentral setae 191–250% of longitudinal distance; dc index = 0.62 (0.57–0.66). Scut-

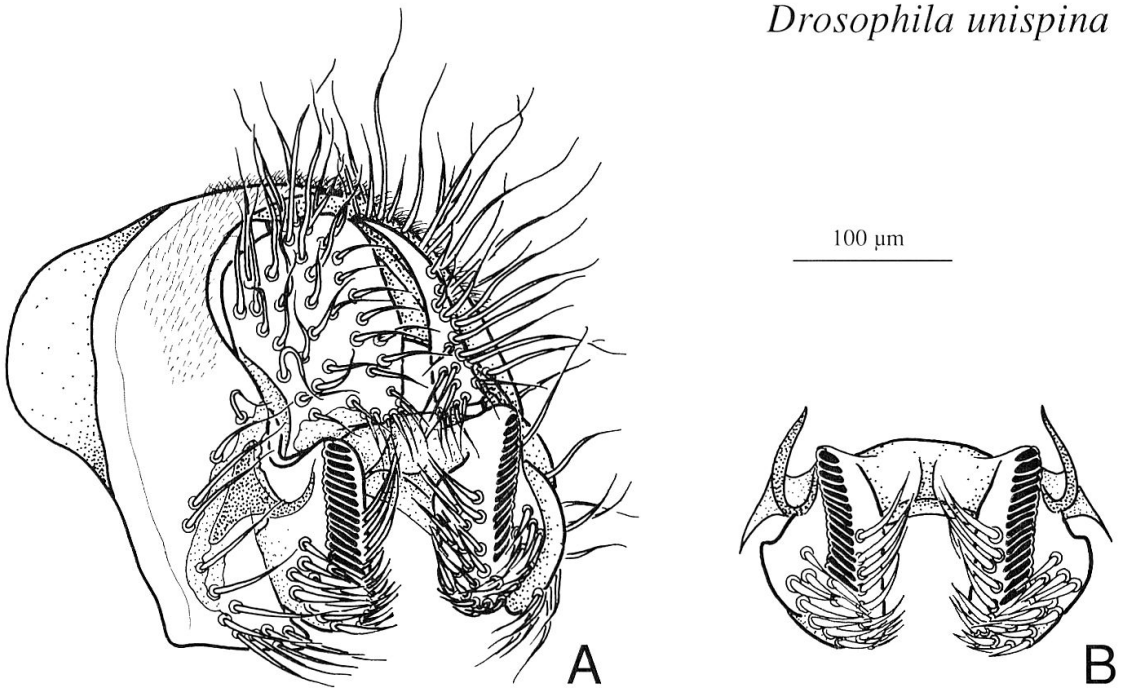

Fig. 17. *Drosophila unispina* OKADA (Sapporo, Japan, IX.2000). A, epandrium, cerci, surstyli and decasternum, oblique posterior view. B, surstyli and decasternum posterior view.

ellum pale brownish, laterally slightly yellowish, less shiny than scutum, distance between apical scutellar setae about 90–109% of that of the apical to the basal one; basal ones slightly divergent; scut index = 0.87 (0.80–0.94). Pleura pale yellow, slightly shiny, sterno index 0.59 (0.56–0.64), mid katepisternal seta 54–87% of the anterior one. Halteres yellow. Legs yellow, preapical setae on all tibiae, ventral apical setae on mid tibia.

Wing hyaline or slightly brownish, veins yellow, but both crossveins brown and distinctly shadowed, length 2.45 (2.27–2.56) mm, length to width ratio = 2.14 (2.06–2.24). Indices: C = 3.20 (2.81–3.38), ac = 2.04 (1.86–2.29), hb = 0.42 (0.38–0.47), 4C = 0.71 (0.65–0.84), 4v = 1.41 (1.30–1.53), 5x = 1.17 (1.14–1.29), M = 0.39 (0.35–0.42), prox. x = 0.51 (0.47–0.55).

Abdomen yellow, shiny; tergites 2–5 each with 4 blackish-brown, more or less triangular spots with a narrow median gap, isolated, but the spots on tergite 3 usually laterally confluent along the hind margin, the paramedian spots slightly larger than the lateral ones; in some specimens, the lateral ones may be faded; tergite 6 with large, medially more or less confluent paramedian spots and no lateral ones.

♂ *Terminalia* (Figs 17, 18, 23A). Epandrium dorsoposteriorly microtrichose with about 13 lower setae, and no upper setae; ventral lobe not covering surstylus. Cerci linked to hypandrium by membranous tissue, not microtrichose. Surstylus not microtrichose, with ca. 15 cone-shaped prensisetae roundish at tip, about 11 outer long setae and ca. 12 long inner setae. Decasternum as in Fig. 17B. Hypandrium longer than epandrium, dorsal arch absent, gonopod fused to paraphysis, bearing one seta near posterior inner margin. Aedeagus subapically bearing two tiny, lateral, rod-shaped expansions, apically bearing one long, ventral, anteriorly pointed spur, which bears two tiny lateral spines subapically. Aedeagal apodeme shorter than aedeagus, laterally flattened. Ventral rod absent. Paraphysis longer than wide, linked to distal margin of aedeagal apodeme by membranous tissue, bearing two setulae.

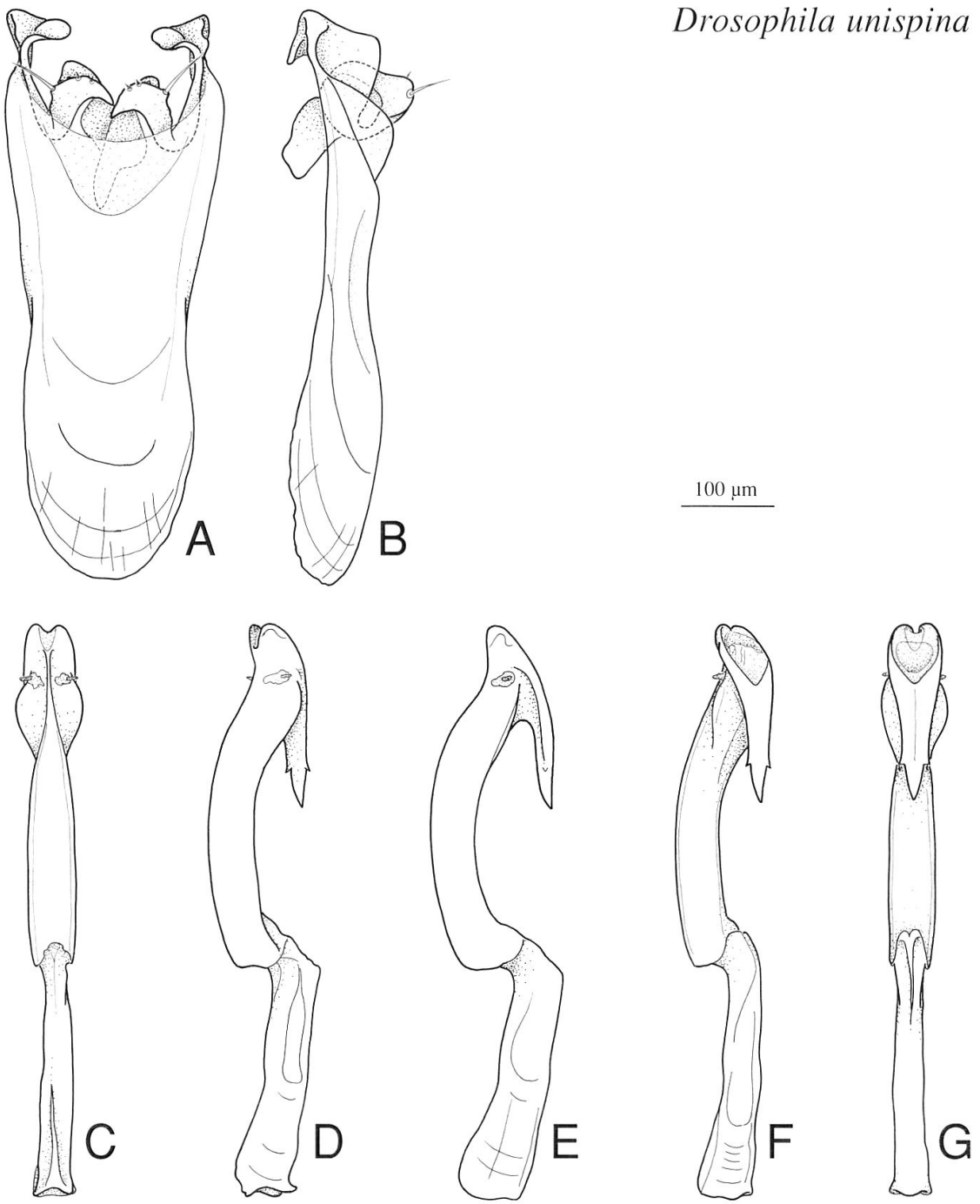

Fig. 18. *Drosophila unispina* OKADA (Sapporo, Japan, IX.2000). A, hypandrium, paraphyses and gonopods, posterior view. B, idem, left lateral view. C–G, aedeagus and aedeagal apodeme, several views from dorsal through ventral.

♀. *Measurements*: frontal length 0.34 (0.30–0.36) mm, frontal index = 0.76 (0.64–0.81), top to bottom width ratio = 1.25 (1.19–1.29). Frontal triangle 78–86% of frontal length; ocellar triangle 38–48% of frontal length. Orbital plates 71–89% of frontal length. Distance of or3 to or1 = 62–87% of or3 to vtm, or1 / or3 ratio = 0.62 (0.61–0.63), or2 / or1 ratio = 0.49 (0.42–0.55), postvertical setae = 77 (67–89) %, ocellar setae = 96 (90–111) % of frontal length; vibrissal index = 0.40 (0.35–0.50). Cheek index 5–7. Eye index = 1.22 (1.21–1.25). Thorax length 1.39 (1.36–

1.45) mm. h index = 1.00 (0.94–1.04). Transverse distance of dorsocentral setae 208–227% of longitudinal distance; dc index = 0.66 (0.64–0.69), distance between apical scutellar setae 93–108% of that of the apical to the basal one; scut index = 0.83 (0.71–1.00), sterno index = 0.66 (0.59–0.71), mid katepisternal seta 56–72% of the anterior one. Wing length 2.95 (2.87–3.12) mm, length to width ratio = 2.20 (2.15–2.22). Indices: C = 3.15 (2.79–3.39), ac = 2.00 (1.89–2.11), hb = 0.41 (0.39–0.44), 4C = 0.75 (0.67–0.86), 4v = 1.51 (1.41–1.64), 5x = 1.19 (1.00–1.25). M = 0.41 (0.37–0.45), prox. x = 0.57 (0.52–0.64).

Distribution. Japan, North Korea, South Korea, Russia (East Siberia).

Drosophila curvispina Watabe & Toda, 1984

(Figs 19–22, 23B)

Drosophila (Drosophila) curvispina Watabe & Toda, 1984: 238 (description, terminalia, type material); Okada 1988: 25 ff. (key, illustration); Lee & Song 1991a: 94 ff. (illustrations, phylogeny); Lee & Song 1991b: 111 ff. (phylogeny).

Material examined. 5 ♂ (1 dissected), 5 ♀, labelled « CH: Biasca TI 7.–11.VIII.1997 G. Bächli leg. »; 1 ♂ (dissected), 1 ♀, labelled: « Japan: Sapporo 10.X.1997 M.J. Toda leg. ».

Type locality. Sapporo, Hokkaido, Japan.

Diagnosis. Generally yellowish flies; tergites with four usually isolated, dark brown, triangular spots, on tergite 3, each lateral pair is partially confluent along the hind margin; wing with both crossveins shadowed; aedeagus medially expanded in profile view, apically bearing one long, strongly curved, anteriorly pointed spur.

Description. ♂. Head. Frons brownish-yellow, somewhat dull, frontal length 0.29 (0.27–0.32) mm, frontal index = 0.77 (0.75–0.80), top to bottom width ratio = 1.27 (1.21–1.33). Frontal triangle paler yellow, 74–83% of frontal length; ocellar triangle slightly darker, brownish on the inner sides of the ocelli, somewhat prominent, 41–56% of frontal length. Frontal vittae somewhat darker brownish. Orbital plates narrow, greyish-brown, shiny, slightly diverging from eye border, 81–87% of frontal length. Orbital setae blackish, distance of or3 to or1 = 57–75% of or3 to vtm, or1 / or3 ratio = 0.61 (0.50–0.69), or2 / or1 ratio = 0.41 (0.30–0.50), postvertical setae = 69 (63–81) %, ocellar setae = 85 (79–89) % of frontal length; vibrissal index = 0.52 (0.38–0.64). Face brownish. Carina prominent, noselike, narrow, slightly broader downwards. Cheek index about 5–8. Eye index = 1.16 (1.09–1.21). Occiput brown with yellowish border. Antennae yellowish. Arista with 4–5 dorsal, 2–3 ventral and about 7–8 inner branches, plus terminal fork. Proboscis yellow. Palpi with about 3 fine, black setae and several fine setulae.

Thorax. Length 1.15 (1.04–1.27) mm. Scutum brownish-yellow, shiny, with a diffuse, dark brown medial stripe which is darker in front of the scutellum, 6 rows of acrostichal setae. h index = 0.82 (0.73–0.93). Transverse distance of dorsocentral setae 200–244% of longitudinal distance; dc index = 0.64 (0.58–0.71). Scutellum brownish, laterally slightly yellowish, less shiny than scutum, distance between apical scutellar setae about 91–100% of that of the apical to the basal one; basal ones slightly divergent; scut index = 1.01 (0.97–1.04). Pleura pale yellow, slightly shiny, sterno index 0.60 (0.58–0.63), mid katepisternal seta 41–54% of the anterior one. Halteres yellow. Legs yellow, preapical setae on all tibiae, ventral apical setae on mid tibia.

Wing hyaline, veins yellow, but both crossveins brown and distinctly shadowed, length 2.68 (2.41–2.94) mm, length to width ratio = 2.13 (2.09–2.16). Indices: C = 3.01 (2.82–3.44), ac = 2.19 (2.00–2.43), hb = 0.42 (0.38–0.50), 4C = 0.76

(0.70–0.80), 4v = 1.56 (1.44–1.70), 5x = 1.24 (1.11–1.38), M = 0.43 (0.40–0.48), prox. x = 0.48 (0.45–0.50).

Abdomen yellow, shiny; tergites 2–5 each with 4 brown, more or less triangular spots with a narrow median gap, isolated, but the spots on tergite 3 usually laterally confluent, the paramedian spots slightly larger than the lateral ones, in some specimens, the lateral ones may be faded; tergit 6 with large, medially more or less confluent paramedian spots and no lateral ones.

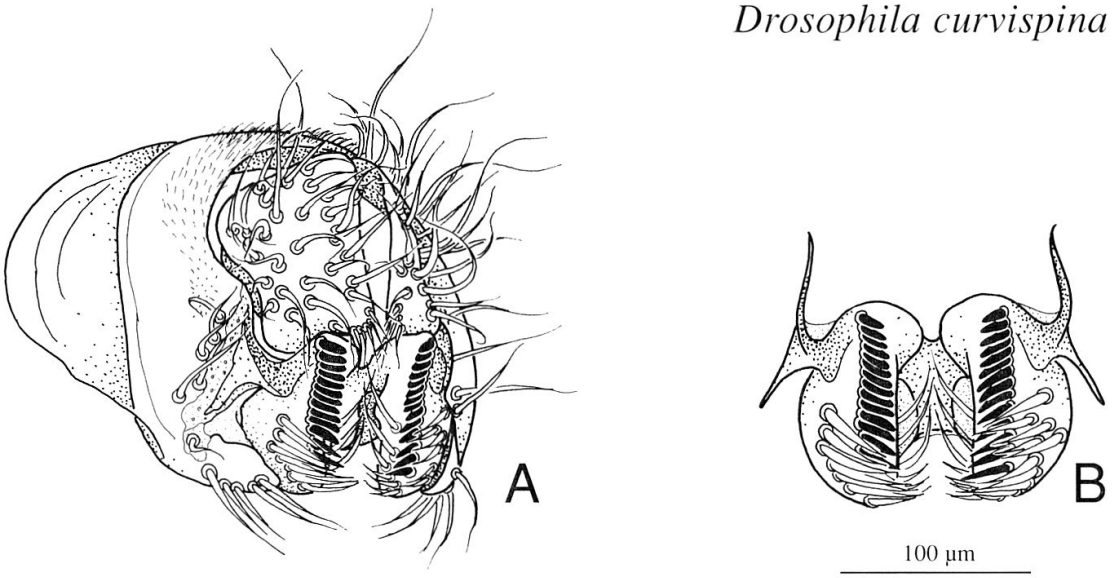

Fig. 19. *Drosophila curvispina* WATABE & TODA (Biasca, Switzerland, 7–11.VIII.1997). A, epandrium, cerci, surstyli and decasternum, oblique posterior view. B, surstyli and decasternum posterior view.

♂ *Terminalia* (Figs 19–22, 23B). Epandrium dorsoposteriorly microtrichose with about 11 lower setae, and no upper setae; ventral lobe not covering surstylus. Cerci linked to hypandrium by membranous tissue, not microtrichose. Surstylus not microtrichose, with ca. 13 cone-shaped prensisetae roundish at tip, about 8 outer long setae and ca. 7 long inner setae. Decasternum as in Figs 19B, 21B. Hypandrium longer than epandrium, dorsal arch absent, gonopod fused to paraphysis, bearing one seta near anterior inner margin. Aedeagus subapically slightly serrated dorsally, apically bearing one long, curved, ventral, anteriorly pointed spur. Aedeagal apodeme shorter than aedeagus, rod-shaped. Ventral rod absent. Paraphysis longer than wide, linked to distal margin of aedeagal apodeme by membranous tissue, bearing two setulae.

♀. *Differences to male*: Abdominal spots getting smaller towards tip of the abdomen; tergite 6 with small lateral spots.

Measurements: frontal length 0.30 (0.27–0.32) mm, frontal index = 0.76 (0.74–0.77), top to bottom width ratio = 1.24 (1.21–1.29). Frontal triangle 71–84% of frontal length; ocellar triangle 39–47% of frontal length. Orbital plates 55–76% of frontal length. Distance of or3 to or1 = 50–67% of or3 to vtm, or1 / or3 ratio = 0.69 (0.64–0.71), or2 / or1 ratio = 0.42 (0.40–0.45), postvertical setae = 68 (59–79) %, ocellar setae = 92 (82–100) % of frontal length; vibrissal index = 0.39 (0.33–0.50). Cheek index 5–7. Eye index = 1.15 (1.13–1.19). Arista with 4–6 dorsal, 2–3 ventral and about 7–8 small inner branches, plus terminal fork. Thorax length 1.26 (1.19–1.34) mm. h index = 0.74 (0.67–0.79). Transverse distance of dorsocentral

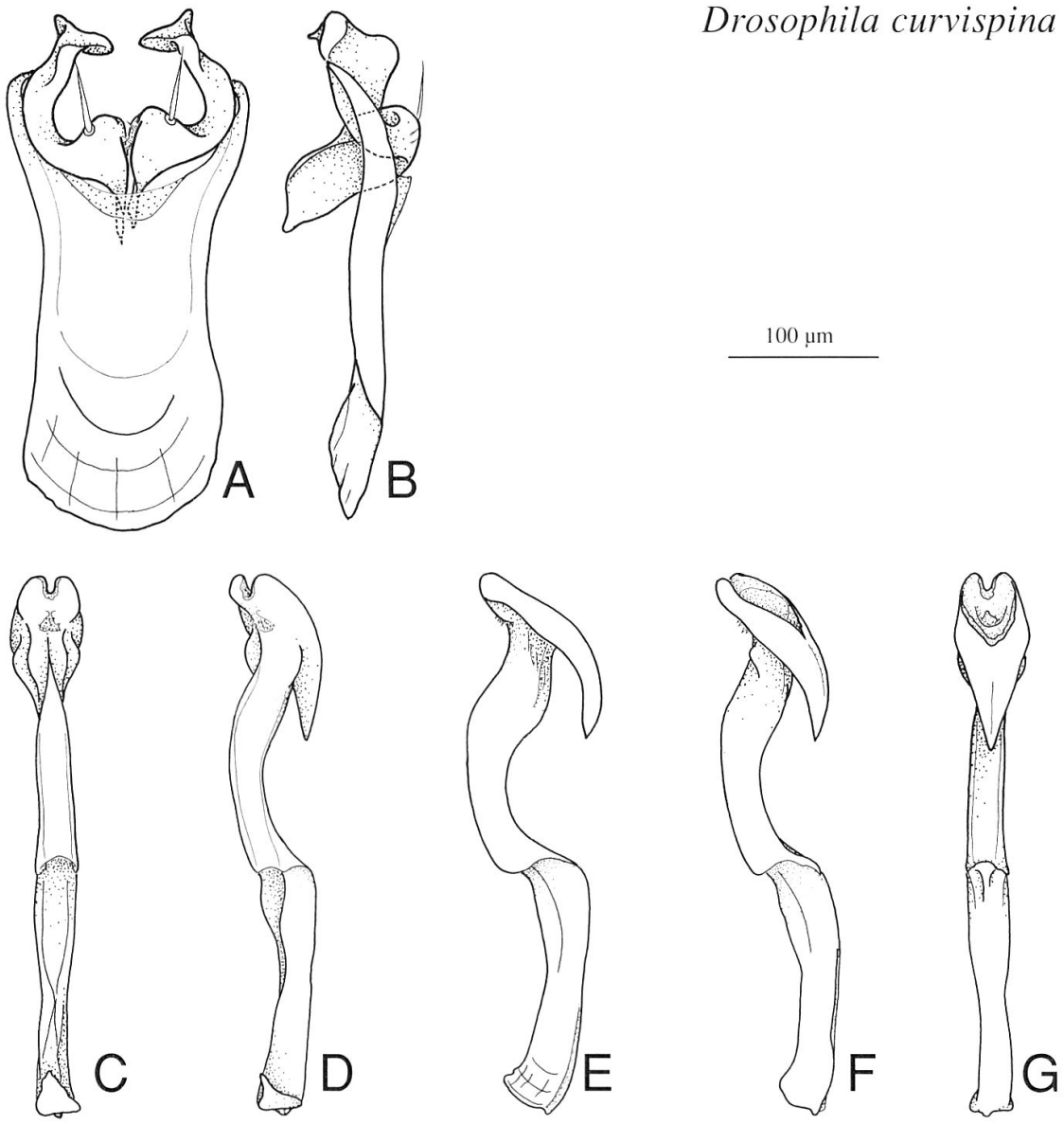

Fig. 20. *Drosophila curvispina* WATABE & TODA (Biasca, Switzerland, 7–11.VIII.1997). A, hypandrium, paraphyses and gonopods, posterior view. B, idem, left lateral view. C–G, aedeagus and aedeagal apodeme, several views from dorsal through ventral.

setae 200–260% of longitudinal distance; dc index = 0.61 (0.59–0.64), distance between apical scutellar setae 91–100% of that of the apical to the basal one; scut index = 1.00, sterno index = 0.62 (0.58–0.67), mid katepisternal seta 40–63% of the anterior one. Wing length 2.92 (2.69–3.15) mm, length to width ratio = 2.25 (2.17–2.31). Indices: C = 3.03 (2.67–3.33), ac = 2.49 (1.89–3.00), hb = 0.42 (0.40–0.44), 4C = 0.78 (0.71–0.88), 4v = 1.55 (1.32–1.64), 5x = 1.30 (1.11–1.57). M = 0.42 (0.36–0.46), prox. x = 0.48 (0.46–0.52).

Distribution. Japan, South Korea, Russia (East Siberia), Switzerland (new record).

Comments. The specimens found in Switzerland were first tentatively identified either as *D. unispina* or as an undescribed species. However, the male terminalia, which are illustrated and compared with those from specimens collected in Japan

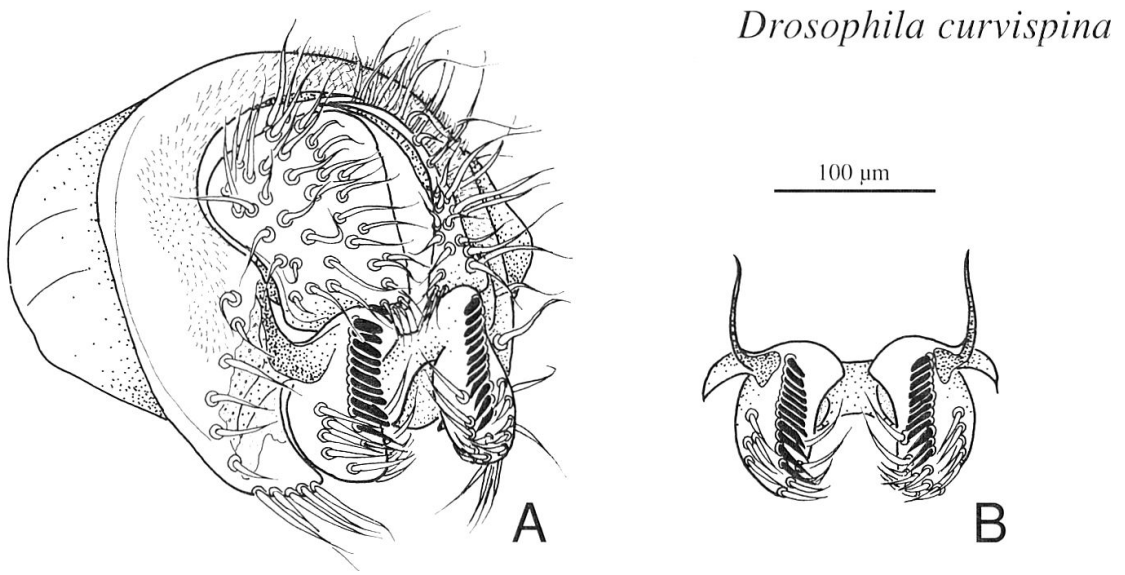

Fig. 21. *Drosophila curvispina* WATABE & TODA (Sapporo, Japan, 10.X.1997). A, epandrium, cerci, surstyli and decasternum, oblique posterior view. B, surstyli and decasternum posterior view.

(Figs 19–22), clearly show that they belong to *D. curvispina*. In spite of some minor differences, we consider them as being conspecific, a decision corroborated by molecular analysis (see below).

The occurrence of *D. curvispina* in Switzerland, as an unkown species, was first recognized in large numbers while analyzing specimens of Drosophilidae collected in 1995 at Bolle di Magadino and later on, in 1997, at Biasca, two localities in the Swiss canton Ticino. We supposed that this species was overlooked in earlier collections made in Switzerland, and could have been misidentified as *D. phalerata* or *D. transversa*, with which it could be confused with respect to the external morphology. To test this hypothesis, all specimens previously identified as belonging to these two species and stored in the ZMUZ were reanalyzed and a small number of specimens of *D. curvispina* collected at Bex VD in 1957, and at Aigle VD in 1970 were found indeed, corroborating the suspicion. Both localities are in the lower Valais/Vaud area and not close to the localities in Ticino. No additional specimens were found among all collections made in Ticino during the years 1970–1998. We therefore do not have any indications of how and when this putatively East Asian species was introduced in Switzerland and if the introduction has occurred more than once.

Molecular identification of the recent invader D. curvispina *by DNA sequence analysis*

To clarify whether the specimens of the *quinaria* group recently collected in Switzerland were conspecific with either *D. unispina* or *D. curvispina* or even represent an undescribed species, a section of the *Adh* gene was sequenced, which has already been successfully employed to assess the relationships among closely related drosophilid taxa (HARING *et al.* 1998). In addition to three specimens of the taxon in question, specimens belonging to the East Asian species *D. unispina* and *D. curvispina* as well as to the four widespread European species *D. kuntzei* DUDA, *D. limbata* VON ROSER, *D. phalerata* MEIGEN and *D. transversa* ZETTERSTEDT were analyzed for comparison (altogether 17 specimens, Tab. 1). The intron sequences could not be aligned unambiguously, therefore the intron was excluded from the phylogenetic

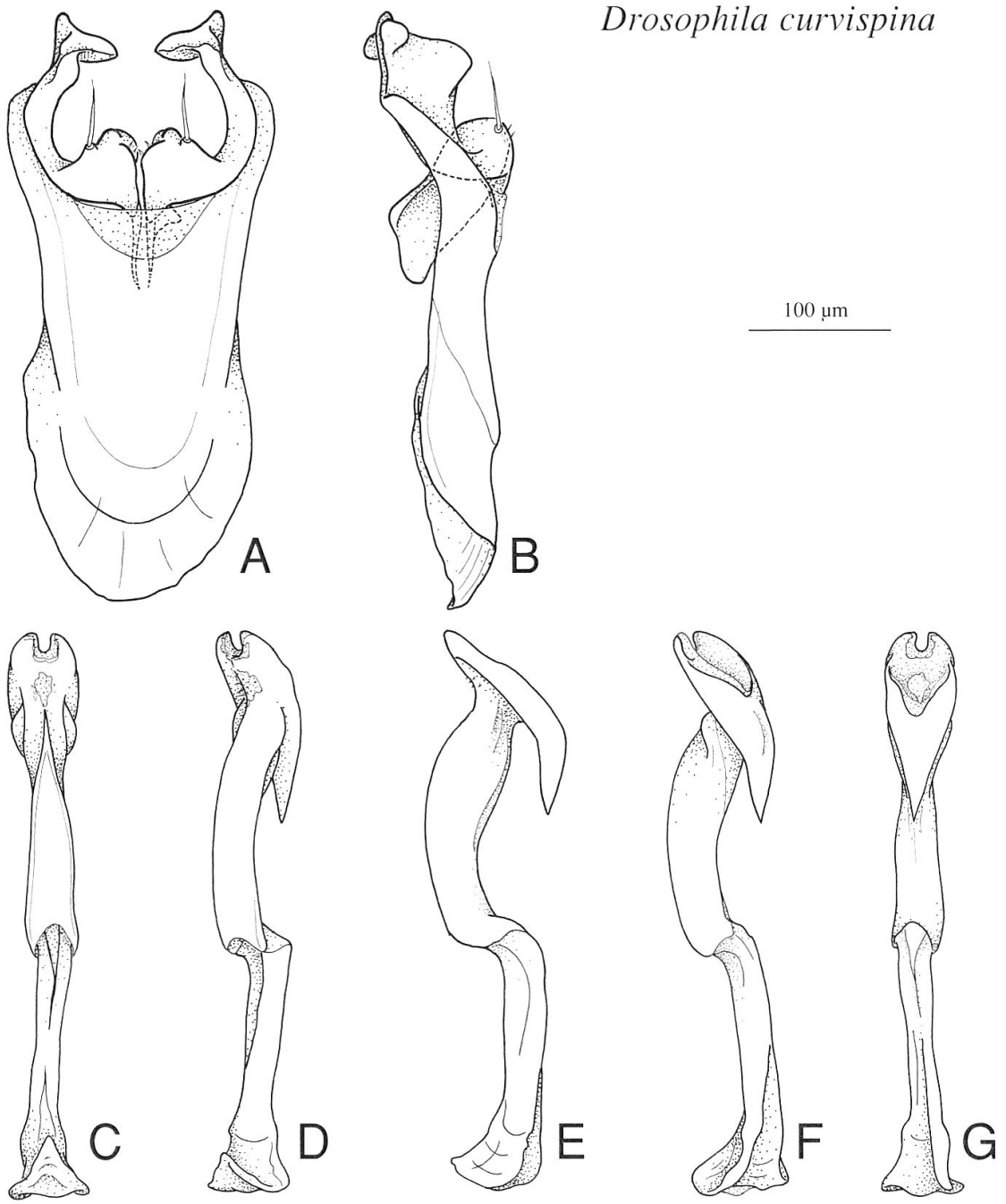

Fig. 22. *Drosophila curvispina* WATABE & TODA (Sapporo, Japan, 10.X.1997). A, hypandrium, paraphyses and gonopods, posterior view. B, idem, left lateral view. C–G, aedeagus and aedeagal apodeme, several views from dorsal through ventral.

analysis. The alignment of the 17 sequences plus the outgroup sequence of *D. immigrans* (ALBALAT & GONZALEZ-DUARTE 1993) has a length of 370 bp. The dendrogram shown in Fig. 24 is one of 16 equally parsimonious trees. The Japanese specimen of *D. curvispina* (cur1) lies within the cluster of the three Swiss specimens (cur2–cur4). These results indicate that the questionable taxon is indeed *D. curvispina*.

To assess inter- and intraspecific variability, average distances were calculated (Tab. 2). Whereas distances among the European species are quite high (5.18–

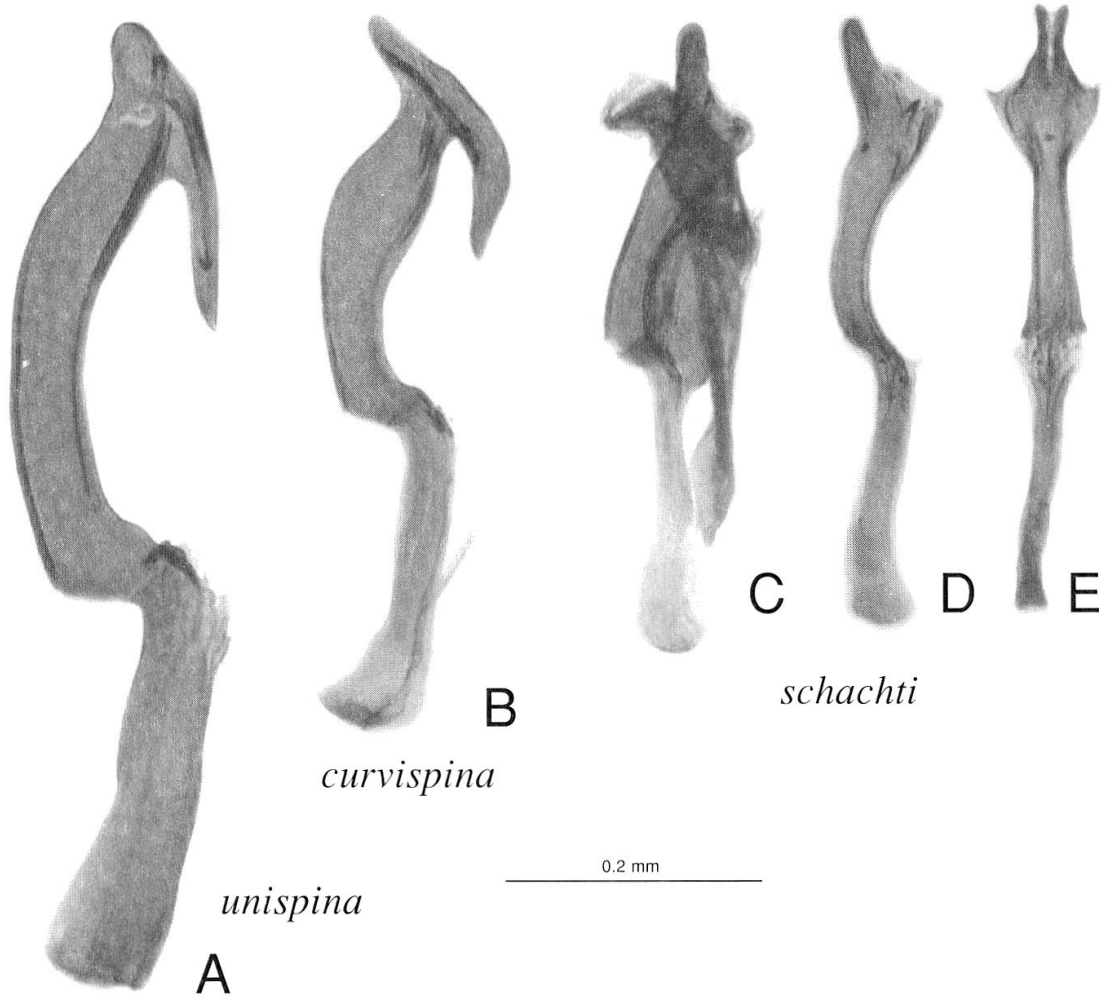

Fig. 23. A, *Drosophila unispina* OKADA (Sapporo, Japan, IX.2000), aedeagus and aedeagal, lateral view. B, *Drosophila curvispina* WATABE & TODA (Sapporo, Japan, 10.X.1997), idem apodeme. – *Drosophila schachti* sp. nov., C, paratype, inner terminalia and aedegal apodeme, lateral view. D, holotype, aedeagus, lateral view. E, idem, ventral view.

Tab. 1. Specimens used in the molecular analysis.

Species	Locality	Collecting date	Code
D. curvispina	Sapporo, Japan	6/2001	cur1
D. curvispina	Biasca, Ticino, Switzerland	8/1997	cur2
D. curvispina	Bolle di Magadino, Ticino, Switzerland	6/1995	cur3
D. curvispina	Biasca, Ticino, Switzerland	8/1997	cur4
D. kuntzei	Pfynwald, Wallis, Switzerland	7/1999	kun1
D. kuntzei	Dietikon, Zürich, Switzerland	8/1997	kun2
D. kuntzei	Leutschach, Austria	8/2001	kun3
D. limbata	Dietikon, Zürich, Switzerland	8/1997	lim1
D. limbata	Pfynwald, Zürich, Switzerland	7/1999	lim2
D. phalerata	Leutschach, Austria	8/2001	pha1
D. phalerata	Vienna, Austria	8/2001	pha2
D. phalerata	Leutschach, Austria	8/2001	pha3
D. transversa	Dietikon, Zürich, Switzerland	8/1997	tra1
D. transversa	Someo, Ticino, Switzerland	7/1997	tra2
D. transversa	Zürich-Hönggerberg, Zürich, Switzerland	7/1999	tra3
D. unispina	Kanegi/Shimane, Japan	5/1995	uni1
D. unispina	Kanegi/Shimane, Japan	5/1995	uni1

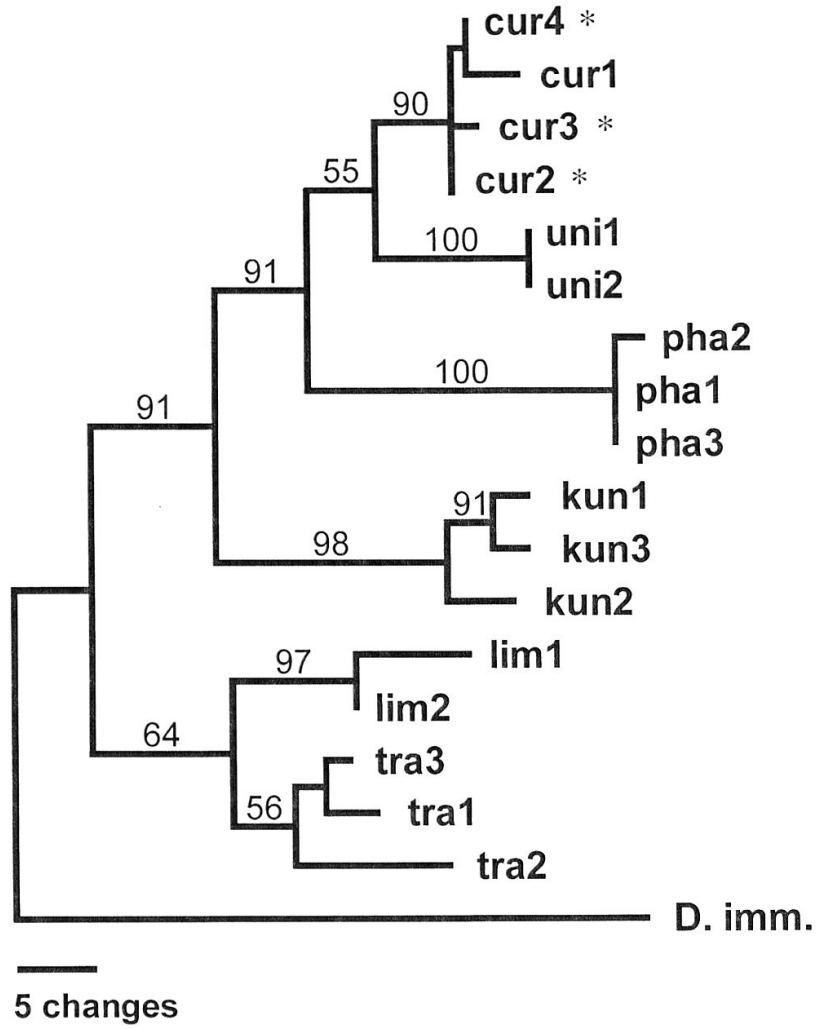

Fig. 24. Molecular phylogeny of European and Japanese species of the *Drosophila quinaria* species group based on a 370 bp section of the *Adh* gene. One of 16 most parsimonious trees (tree length = 177, consistency index CI = 0.780, retention index RI = 0.858). Bootstrap values (1000 replicates) >50 % are given above branches. Codes for species are given in Tab. 1. D. imm. = *D. immigrans* (outgroup). Swiss specimens of *D. curvispina* are marked with asterisks.

Tab. 2. Average p-distances (%, exon sequences only) within and between 6 species of *Drosophila* belonging the *quinaria* group.

	D. curvispina	*D. unispina*	*D. phalerata*	*D. kuntzei*	*D. transversa*	*D. limbata*
D. curvispina	0.59	3.99	7.14	9.30	10.34	9.93
D. unispina		0.00	7.75	9.82	11.44	11.76
D. phalerata			0.36	10.18	12.88	12.48
D. kuntzei				1.98	9.94	10.23
D. transversa					3.06	5.18
D. limbata						1.89

12.88%), the two Japanese species *D. curvispina* and *D. unispina* appear to be closely related (3.99%). Intraspecific variability in *D. curvispina* is rather low (0.59%) compared to *D. kuntzei* (1.98%), *D. limbata* (1.89%), and *D. transversa* (3.06%). This finding suggests a genetic bottleneck in the course of the introduction of *D. curvispina* to Switzerland. The topology of the MP dendrogram is identical to the

NJ tree (not shown), except the positions of the specimens within the *D. curvispina* cluster. Differences among the 16 MP trees are found concerning the position of *D. unispina*, which clusters either with *D. curvispina* or *D. phalerata*. Further differences in tree topology are found within the *D. curvispina* clade. These ambiguities are also reflected by weak bootstrap values. The main topology of all dendrograms, i.e. the relationships among the European species is supported by high bootstrap values.

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