Preliminary list and key of known tiger beetle larvae (Coleoptera, Cicindelidae) of the world

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Preliminary list and key of known tiger beetle larvae (Coleoptera, Cicindelidae) of the world

A.V. PUTCHKOV[1] & E. ARNDT[2]

[1]Academy of Sciences of Ukraine, Institute of Zoology, B. Hmelnitskogo, 15, 252601 Kiev-30, Ukraine.
[2]Universität Leipzig, Institut für Zoologie, AG Spezielle Zoologie, Talstr. 33, D-04103 Leipzig, Germany.

The genera of Cicindelidae (Coleoptera) are listed for which larval stages have been described and a determination key for second and third instar larvae is provided.

Keywords: Coleoptera, Cicindelidae, larval key.

INTRODUCTION

Worldwide about 2.000 species of more than 120 genera of Cicindelidae are known (WIESNER, 1992, corresponding to 35 genera sensu HORN, 1926). In contrast to an extensive knowledge of adult Cicindelidae, comparatively few papers include the biology and morphology of larvae as well as other preimaginal stages of these beetles. So far larvae of only 34 genera have been described, some of them inadequately and lacking the most important comparative character states. No general key to the larvae of the genera of the world has been published. The goal of this paper is to review the knowledge of cicindelid larvae as well as develop a larval key for second and third instar larvae. A discussion of the characters with phylogenetical conclusions is reserved to a further paper.

The studies are based mainly on the larval collection of the German Entomological Institute (D. E. I.) and of private collections of both authors. The genera of *Cicindela* (sensu auctorum) are united in the key because it is very difficult to differentiate these groups in larval stage at present. Most of the characters of this large taxon are variable, often overlapping in different groups. Moreover, the existing larval material of tropical and subtropical groups is still inadequate in the subtribe Cicindelina, and more data are need to differentiate the subgroups of *Cicindela* (s. auct.). However, preliminary studies show some possibilities for distinguishing the subgroups of *Cicindela* (s. auct.) and to test the new classification proposed by RIVALIER (1971) and WIESNER (1992).

All Figures refer to third instar larvae and are original, except 37 and 47 (after VAN EMDEN, 1935).

LIST OF TIGER BEETLE GENERA KNOWN IN LARVAL STAGE

(in parenthesis: species known in larval stage and references)

Collyrinae
Ctenostomini
– *Pogonostoma* KLUG (spec., JEANNEL, 1946)
– *Ctenostoma* KLUG (6 species, ZIKAN, 1929; VAN EMDEN, 1935)

Collyrini
– *Tricondyla* LATREILLE (*cyanea* DEJEAN, VAN EMDEN, 1935)
– *Neocollyris* HORN (3 species, GARDNER, 1930; VAN EMDEN, 1935)

Cicindelinae
Manticorini
– *Manticora* FABRICIUS (2 species, LEFFLER, 1980, and unpublished)
Megacephalini
– *Picnochile* MOTSCHULSKY (*fallaciosa* (CHEVROLAT), CEKALOVIC, 1981)
– *Amblycheila* SAY (3 species, HAMILTON, 1925; KNISLEY & PEARSON, 1984, and unpublished)
– *Omus* ESCHSCHOLTZ (7 species, HAMILTON, 1925; LEFFLER, 1985, and unpublished)
– *Megacephala* (7 species, HAMILTON, 1925; SHAROVA, 1964, and unpublished)
– *Oxycheila* DEJEAN (*tristis* (FABRICIUS), ZIKAN, 1929)
Cicindelini
Prothymina
– *Heptodonta* HOPE (*melanopyga* SCHAUM, unpublished)
– *Odontocheila* CASTELNAU (3 species, ZIKAN, 1929, and unpublished)
– *Pentacomia* BATES (6 species, ZIKAN, 1929, and unpublished)
Iresina
– *Euprosopus* DEJEAN (2 species, ZIKAN, 1929)
– *Iresia* DEJEAN (3 species, ZIKAN, 1929, and unpublished)
Theratina
– *Therates* LATREILLE (*labiatus* (FABRICIUS), BÖVING & CRAIGHEAD, 1931, and unpublished)
Cicindelina
– *Cicindela* LINNÉ (45 species, HAMILTON, 1925; VAN EMDEN, 1943; KUROSA, 1959; WILLIS, 1967, 1980; LEFFLER, 1979; KNISLEY & PEARSON, 1984; PUTCHKOV, 1990, 1991, 1993; PUTCHKOV & CASSOLA, 1994; PUTCHKOV & SHILENKOV, in press)
– *Cicindelidia* RIVALIER (13 species, HAMILTON, 1925; WILLIS, 1967; LEFFLER, 1979; BEATTY & KNISLEY, 1982; KNISLEY & PEARSON, 1984)
– *Lophyridia* JEANNEL (3 species, PUTCHKOV, 1993)
– *Lophyra* MOTSCHULSKY (4 species, ARNDT & PUTCHKOV, in press)
– *Habrodera* MOTSCHULSKY (2 species, ARNDT & PUTCHKOV, in press)
– *Neolaphyra* BEDEL (*leucosticta* (FAIRMAIRE), ARNDT & PUTCHKOV, in press)
– *Thopeutica* SCHAUM (*clara* SCHAUM, unpublished)
– *Cephalota* DOKHTOUROFF (7 species, SHAROVA, 1964; SERRANO, 1985; PUTCHKOV & CASSOLA, 1994)
– *Cassolaia* WIESNER (*maura* (LINNÉ), Serrano, 1990)
– *Cylindera* WESTWOOD (16 species, including *Plectographa* RIVALIER, 2 SPECIES, ZIKAN, 1929; CEKALOVIC & REYES, 1985; *Cicindina* ADAM & MERKl, 5 species, KUROSA, 1959; PUTCHKOV, 1990; SERRANO, 1990; PUTCHKOV & CASSOLA, 1994; and *Cylindera* s.str., 9 species, HAMILTON, 1925; LEFFLER, 1979, KNISLEY & PEARSON, 1984; PUTCHKOV, 1990; PUTCHKOV & CASSOLA, 1994, and unpublished)
– *Brasiella* RIVALIER (2 species, ZIKAN, 1929)
– *Ellipsoptera* DOKHTOUROFF (6 species, HAMILTON, 1925; WILLIS, 1967; KNISLEY & PEARSON, 1984)
– *Myriochile* MOTSCHULSKY (3 species, KUROSA, 1959; SERRANO, 1987; PUTCHKOV & CASSOLA, 1994)
– *Eunota* RIVALIER (*togata* (LAFERTE), WILLIS, 1967)
– *Habroscelimorpha* DOKHTOUROFF (4 species, HAMILTON, 1925; WILLIS, 1967; WAGENAAR-HUMMELINCK, 1983; KNISLEY & PEARSON, 1984)
– *Hypaetha* LECONTÉ (*biramosa* (FABRICIUS), HAMILTON, 1925)

The authors studied larvae of all genera listed, except for *Picnochile* MOTSCHULSKY, *Cassolaia* WIESNER, *Plectographa* RIVALIER and *Eunota* RIVALIER, which are known each with one species in larval stage.

The classification refers to WIESNER (1992), but contrary to WIESNER, *Cicindina* ADAM & MERKL should be regarded as separate genus and not be included in the genus *Cylindera* WESTWOOD, because of clear differences in larval morphology.

LARVAL KEY TO THE GENERA OF CICINDELIDAE

1(18) Gular suture Y-shaped (Fig. 4); median hooks of abdominal tergite V straight or rarely slightly curved and often spine-shaped on the top (except in Ctenostomini) (Figs 22-25).

2(9) Nasale not wider (rarely slightly wider) than diameter of stemma 1; claws fused with tarsus, no separated basal sclerite present; ridge on the caudal part of frontale not joining the ridge on the caudal part of vertex (cf. Fig. 1); elevations of pronotum usually large and raised (Figs 9, 10); basal part of mandibles only slightly shorter than apical part; hooks of abdominal tergite V pressed to the body ..... Collyrinae

3(6) Maxillae with 3 free-standing palpomeres (Fig. 38); stipes long and narrow, more than 2 times longer than wide; coronal suture absent; median hooks of the abdominal tergite V at least slightly curved in anterior part, most of their thin setae directed outwards; inner hooks with 2 symmetrical setae (Fig. 21); cephalolateral angles of pronotum very small (Fig. 10); femur of anterior legs simple .....Ctenostomini

4(5) Diameter of stemma 1 about 3 times more than diameter of stemma 2; head with distinct tubercles posterior stemmata (Fig. 5); caudolateral part of tergite V distinct sclerotized, but flattened, fused with anterior part, not hook-shaped; median hooks directed inwards, strongly curved and more than 1.5 times longer than inner hooks (Fig. 21); anterior margin of pronotum slightly concave (Fig. 10) ... *Pogonostoma* KLUG

5(4) Diameter of stemma 1 at most 1.5 times more than diameter of stemma 2; head without tubercles posterior stemmata; abdominal tergite V with 3 pairs of hooks, median hooks not more than 1,5 times longer than inner hooks (cf. Fig. 36); caudolateral part of tergite V in contact with anterior part, but not fused; anterior margin of pronotum straight ..... *Ctenostoma* KLUG

6(3) Maxillae with 2 free-standing palpomeres (Fig. 37); stipes short and wide, at most 1.6-1.7 times longer than wide; coronal suture present; median hooks of abdominal tergite V spine-shaped, not curved apically; all hooks with numerous stout setae directed upwards; anterior margin of pronotum distinctly concave (Fig. 9); femur of anterior legs enlarged with a ventroapical appendix (Fig. 45) ..... Collyrini

7(8) Apical part of mandibles not shorter than basal part; antennomere I 1.2-1.3 times wider than antennomere II; cephalolateral angles of pronotum longer and sharper (Fig. 9); anterior part of tergite V large, fused with caudolateral and partially in contact with caudal part ..... *Tricondyla* LATREILLE

8(7) Apical part of mandibles shorter than basal part; antennomere I not wider than antennomere II; cephalolateral angles of pronotum slightly rounded; anterior part of tergite V relatively small and in contact, but not fused with caudolateral part; caudal part of tergite V separated ..... *Neocollyris* HORN

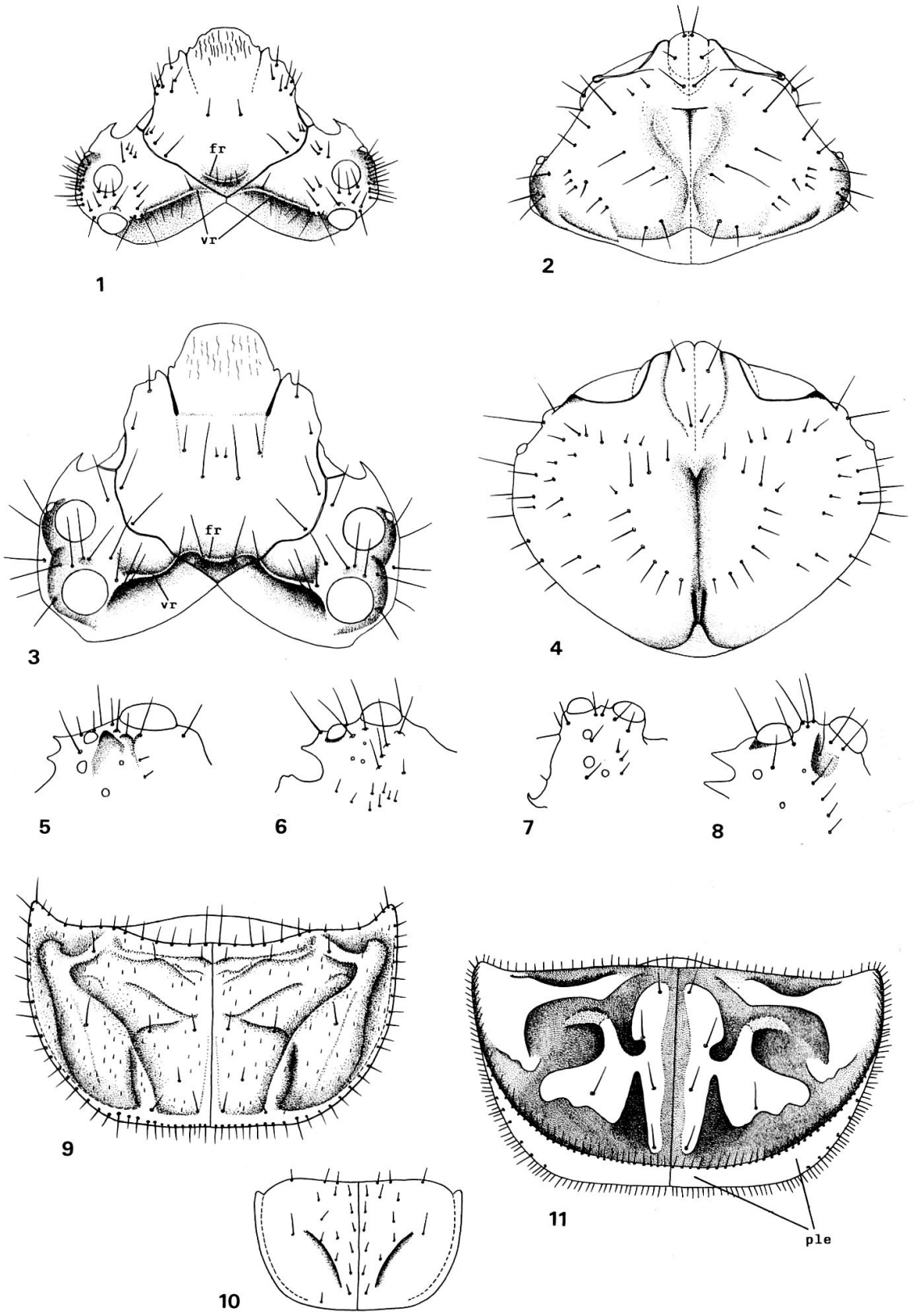
9(2) Nasale distinct wider than stemma 1; claws not fused with tarsus, a separated basal sclerite bearing 1 seta present; ridge on the caudal part of frontale transverse and joining the ridge on the caudal part of vertex (Fig. 3); elevations of pronotum indistinct or absent (Figs 11-13); basal part of mandibles distinctly shorter than apical part; abdominal tergite V domed strongly, the hooks not or slightly pressed to the body.

10(11) Antenna thin; antennomere I not more than 1.5 times wider than antennomere III (Fig. 42); antennomeres II-IV much more slender than scape; labial palpomere I with more than 10 thin setae; parietale near stemmata 1 and 2 strongly raised (Fig. 7); disc of pronotum flattened with 5 long setae per half only, elevations of pronotum absent, posterolateral edge of pronotum very wide, bearing a row of numerous black setae directed upwards (Fig. 11); tibia arched, with more than 20 thin and long setae; posterodistal margin of femur with more than 15 thin and long setae (Fig. 47); caudolateral part of tergite V very large and fused with anterior part; hooks drop-shaped (Fig. 22); nasale slightly waved; larvae very large ..... Manticorini *(Manticora* FABRICIUS)

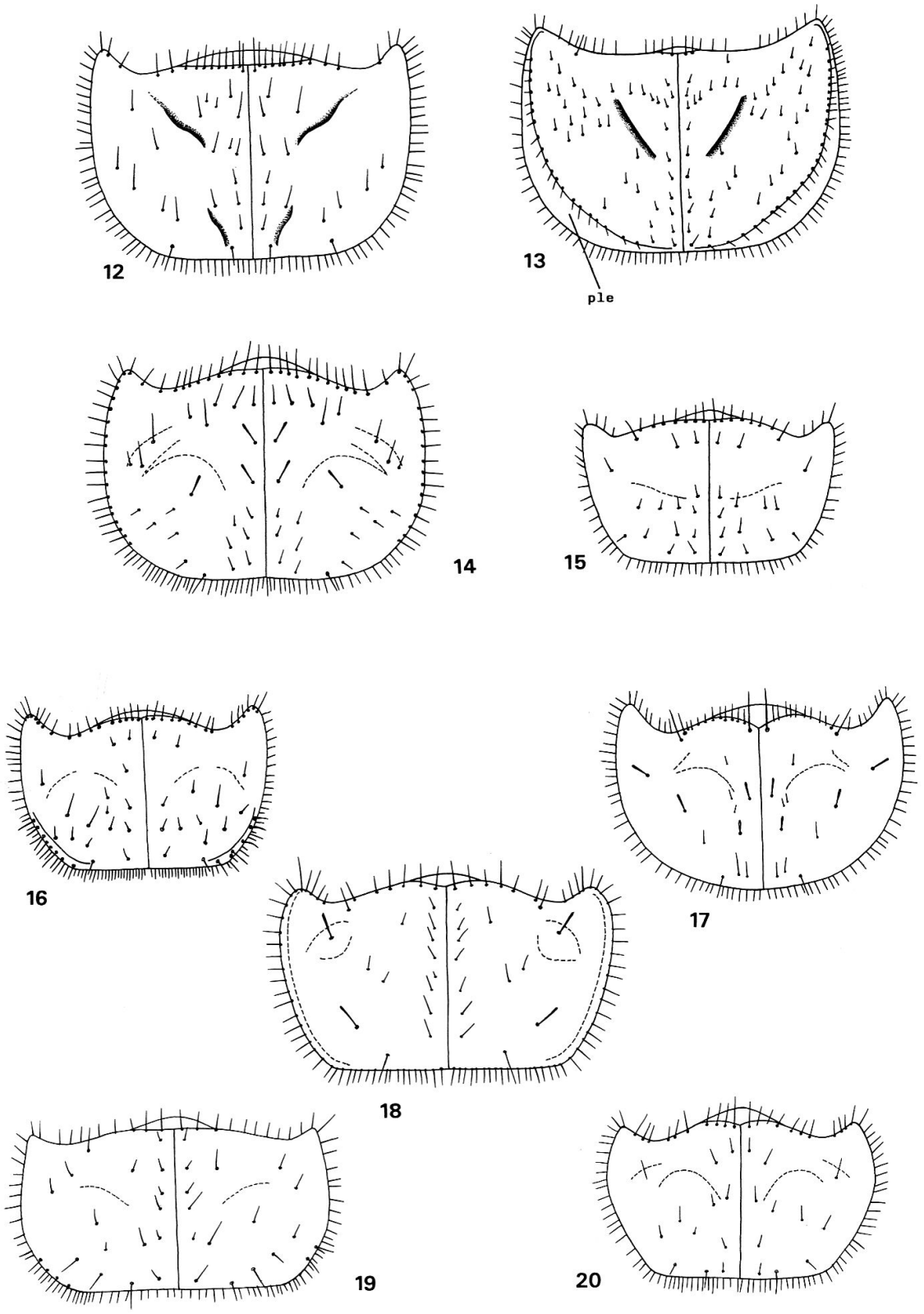
11(10) Antennomeres I and II very wide, at least 2 times wider than antennomeres III and IV (Figs 43, 44); labial palpomere I with 1-10 setae; parietale near stemmata 1 and 2 only slightly prominent (Fig. 6); disc of pronotum with more than 10 long setae per half, posterolateral edge of pronotum smaller, with setae directed outwards (Figs 12, 13); tibia not arched, with less than 20 setae; posterodistal margin of femur with less than 15 partially stout setae (Fig. 46) ..... Megacephalini

12(15) Nasale waved; median and inner hooks spine-shaped, with 2 or more setae usually in the middle part (Figs 23, 24); tergite V with 2-3 hooks; caudal frontal ridge straight.

13(14) Lacinia absent; ridge on the caudal part of vertex and frontale with more than 20 thin setae; antennomere II at least 2 times longer than antennomere III (Fig. 44); coronal suture absent; diameter of first stemma 3 times more than that of stemma 2 (Fig. 6);



Figs 1-11. – 1-4: Head (1, 3: dorsal aspect; fr: ridge on the caudal part of frontale, vr: ridge on the caudal part of vertex; 2, 4: ventral aspect; 5-8: lateral aspect). 1, 2: *Cicindela hybrida* LINNÉ, 3,4: *Megacephala euphratica* LATREILLE & DEJEAN. – 5-8: Parietale and stemmata. 5: *Pogonostoma* spec., 6: *Amblycheila schwarzi* HORN, 7: *Manticora tibialis* BOHEMAN, 8: *Heptodonta melanopyga* SCHAUM. – 9-11: Pronotum. 9: *Tricondyla cyanea* Dejean, 10: *Pogonostoma* spec., 11: *Manticora tibialis* BOHEMAN (ple: posterolateral edge).



Figs 12-20: – Pronotum. 12: *Megacephala brasiliensis* KIRBY, 13: *Amblycheila schwarzi* HORN (ple: posterolateral edge), 14: *Euprosopus quadrinotatus* LATREILLE & DEJEAN, 15: *Iresia besckei* MANNERHEIM, 16: *Pentacomia punctum* (KLUG), 17: *Heptodonta melanopyga* SCHAUM, 18: *Odontocheila* spec., 19: *Odontocheila nodicornis* (DEJEAN), 20: *Odontocheila cayennensis* (FABRICIUS).

maxillary palpomere I without spine, with thin setae on outer part only; labial palpomere I with 3-4 thin and long setae, palpomere II with 8-10 thin setae; posterolateral edge of pronotum wide (Fig. 13); anterior margin of pronotum straight in the middle; tergite V with 2 pairs of straight hooks, bearing a distinct central spine and many stout setae (Fig. 25); parts of tergite V large and fused; pygidium with numerous long and thin setae (Fig. 50) ..... *Amblycheila* SAY

14(13) Lacinia present; ridge on the caudal part of vertex and frontale with about 10 setae; antennomere II only slightly longer than antennomere III; coronal suture small, but distinct; diameter of stemma 1 only 1.5 times more than that of stemma 2; maxillary palpomere I with small spine on outer side (cf. Fig. 40); labial palpomere I with 3 setae, seta in the middle small and stout, labial palpomere II with 1 seta; posterolateral edge of pronotum smaller; anterior margin of pronotum slightly prominent in middle part; tergite V with 3 pairs of slightly arched hooks (Fig. 24); median and inner hooks with at most 3-4 stout setae; parts of tergite V only in contact on outer side, not fused; pygidium with less and in part short setae ..... *Omus* ESCHSCHOLTZ

15(12) Nasale trapezoid or slightly rounded, rarely slightly waved; median and inner hooks often drop-shaped, with 1-2 setae near the base or without setae (Fig. 25); abdominal tergite V with 2 hooks only; caudal frontal ridge in part slightly U-shaped (Fig. 3).

16(17) Maxillary palpomere I without spine on outer side; antennomeres I and II at most 2 times wider than antennomere III; labial palpomere I with 2 setae; inner side of stipes even, without elevations apically; frontal suture slightly curved in middle part (cf. Fig. 1); basal part of head not W-shaped ventrally; median hooks about 2 times longer than inner hooks ..... *Picnochile* MOTSCHULSKY

17(16) Maxillary palpomere I with strong spine on outer side (Fig. 39); antennomeres I and II very thick, 3-5 times wider than antennomere III (Fig. 43); labial palpomere I with 1-8 thin setae (Fig. 48); inner side of stipes at least with a small elevation apically (Fig. 39); frontal suture strongly curved in middle part (Fig. 3); basal part of head W-shaped ventrally (Fig. 4); median hooks not more than 1.5-1.8 times longer than inner hooks; parts of tergite V fused usually (Fig. 25) ..... *Megacephala* LATREILLE

18(1) Gular suture T-shaped, basal part of head W-shaped ventrally (Fig. 2); median hooks of abdominal tergite V arched apically; inner hooks often spine-shaped (Figs 26-36); elevations and ridges of cephalolateral angles of pronotum more ore less distinct (Figs 14-20).

19(20) Maxillary palpomere I with a small spine on outer side (Fig. 40); ridge on the caudal part of vertex not distinctly separated from ridge on the caudal part of frontale, which is slightly U-shaped; abdominal tergite V with 3 stout hooks (Fig. 26); stipes with numerous thin and long setae on inner side and dorsally (Fig. 40) ... *Oxycheila* DEJEAN

20(19) Maxillary palpomere I without spine and setae (Fig. 41); ridge on the caudal part of frontale U-shaped and distinctly separated from the ridge on the caudal part of vertex (Fig. 1); stipes with less setae, especially on dorsal side (Fig. 41); abdominal segment V with 2-3 pairs of hooks (Figs 28-36) ..... Cicindelini

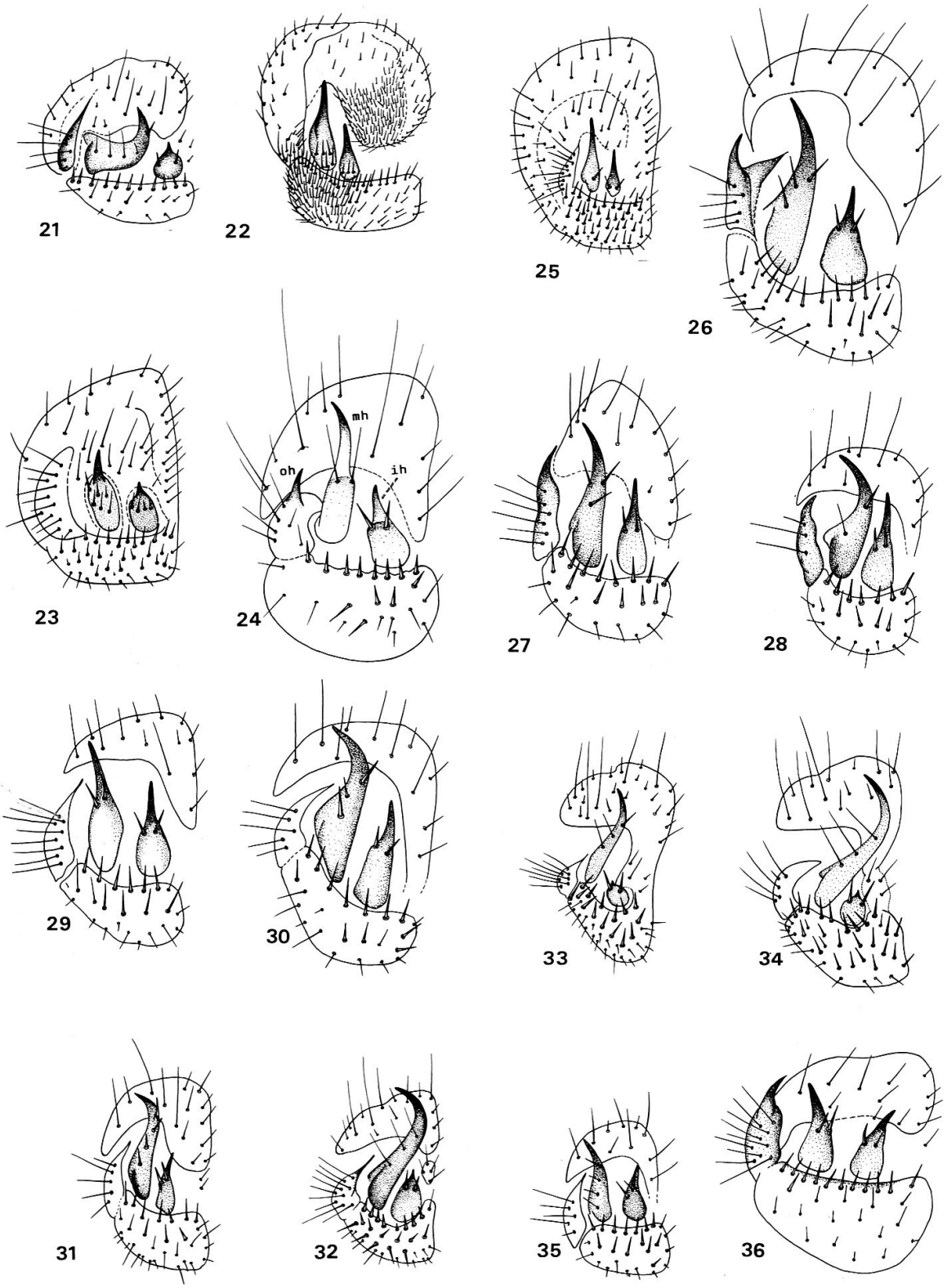
21(22) Nasale step-shaped, not or little wider than diameter of stemma 1; tergite V with 3 pairs of hooks of similar length usually (Fig. 36); setae on the hooks stout; caudolateral part of tergite V fused with anterior part (Fig. 36) ..... Theratina *(Therates* LATREILLE)

22(21) Nasale flattened, usually trapezoid, and always more than 2 times wider than diameter of stemma 1 (Fig. 1); median hooks at least 1.3 times longer than inner hooks; caudolateral part of tergite V very rarely fused with anterior part, often separated (Figs 27-35) ..... Prothymina, Cicindelina, Iresina

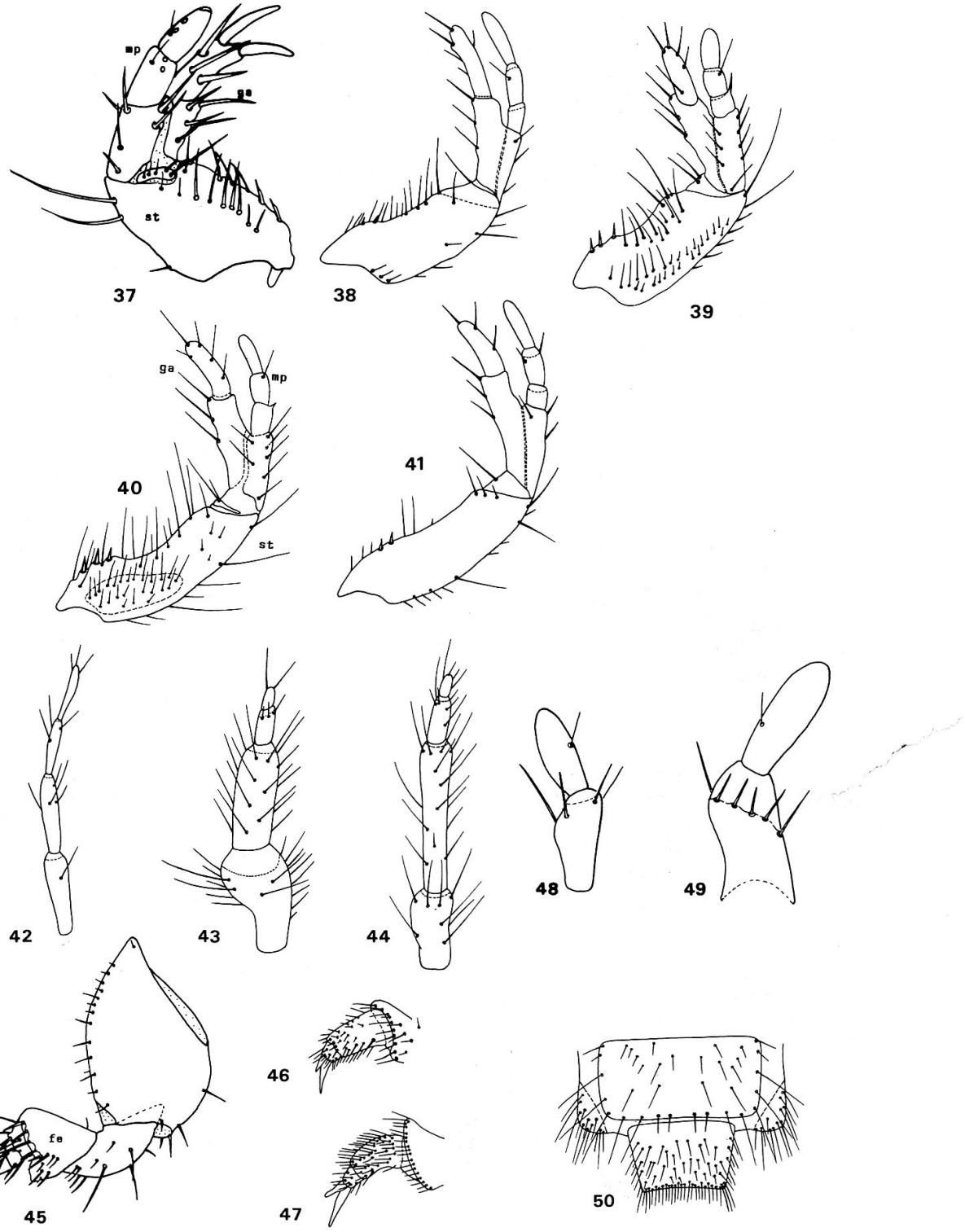
23(26) Abdominal tergite V with 3 hooks (Figs 27, 28); coronal suture distinct and only slightly shorter than last antennomere; antennomeres I-III of about equal length; antennomeres I and II 1.5-2.0 times wider than antennomere III and 2.0-2.5 times wider than last antennomere ..... Iresina

24(25) Labial palpomere I with 7 setae, palpomere II with 1 seta slightly below the middle (Fig. 49); cephalolateral angles of pronotum directed forwards (Fig. 14); pronotum with more than 20 setae per half, setae in part flattened; caudolateral part of tergite V with 6-7 setae; hooks long, partially reaching the middle of anterior part of tergite V (Fig. 27); all setae on median hooks stout; frontal suture slightly curved in anterior part ..... *Euprosopus* DEJEAN

25(24) Labial palpomere I with 5 setae, palpomere II with 1 seta near the base; cephalola-



Figs 21-36: – Abdominal segment V, left half, dorsal aspect. 21: *Pogonostoma* spec., 22: *Manticora tibialis* BOHEMAN, 23: *Amblycheila schwarzi* HORN, 24: *Omus* spec. (ih: inner hook, mh: median hook, oh: outer hook), 25: *Megacephala australis* (CHAUDOIR), 26: *Oxycheila tristis* (FABRICIUS), 27: *Euprosopus quadrinotatus* LATREILLE & DEJEAN, 28: *Iresia besckei* MANNERHEIM, 29: *Odontocheila nodicornis* (DEJEAN), 30: *Odontocheila cayennensis* (FABRICIUS), 31: *Heptodonta melanopyga* SCHAUM, 32: *Cicindela altaica* GEBLER, 33: *Cephalota besseri* (DEJEAN), 34: *Lophyridia sturmi* (MENETRIES), 35: *Pentacomia punctum* (KLUG), 36: *Therates labiatus* (FABRICIUS).



Figs 37-50. – 37-41: Maxilla (37, 40: dorsal view; 38, 39, 41: ventral view). 37: *Collyris* spec. (ga: galea, mp: maxillary palpus, st: stipes), 38: *Pogonostoma* spec., 39: *Megacephala australis* (CHAUDOIR), 40: *Oxycheila tristis* (FABRICIUS) (ga: galea, mp: maxillary palpus, st: stipes), 41: *Euprosopus quadrinotatus* LATREILLE & DEJEAN. – 42-44: Antenna. 42: *Mantichora tibialis* BOHEMAN, 43: *Megacephala* spec., 44: *Amblycheila schwarzi* HORN. – 45-47: Anterior legs (45: all segments; 46, 47: tarsus, tibia and distal part of femur). 45: *Collyris* spec., 46: *Amblycheila schwarzi* HORN, 47: *Manticora tibialis* BOHEMAN. – 48, 49: Labial palpus. 48: *Megacephala australis* (CHAUDOIR), 49: *Euprosopus quadrinotatus* LATREILLE & DEJEAN. – 50: Tergite IX and pygidium (dorsal aspect), *Amblycheila schwarzi* HORN. (37 and 47 after VAN EMDEN, 1935).

teral angles of pronotum directed slightly outwards (Fig. 15); pronotum with about 15 setae per half, most of them flattened; caudolateral part of tergite V with 3-4 setae; hooks shorter and only reaching the posterior margin of anterior part of tergite V (Fig. 28); only apical setae of the median hook stout; frontal suture nearly straight .... *Iresia* DEJEAN

26(23) Abdominal tergite V with 2 hooks; coronal suture very short or absent; antennomeres I and II slightly longer and at least 2 times wider than antennomere III.

27(30) Coronal suture very short, only 0.33 times as long as antennomere IV, or absent; all setae on median hooks stout; central spine of inner hooks long, in part slightly curved downwards (Fig 29-31); a tubercle with 2-3 often flattend setae present between stemmata 1 and 2 (Fig. 8); last antennomere 0.4-0.5 times as long as antennomere II; labial palpomere II with 1 seta near the base.

28(29) Cephalolateral angles of pronotum very large and distinct rise above the waved anterior margin of pronotum (Fig. 17); posterior margin of pronotum half-rounded; median hooks slender, arched in last third and with a row of 4 short stout setae; inner hooks about 0.6 times as long as median hooks (Fig. 31) ..... *Heptodonta* HOPE

29(28) Cephalolateral angles of pronotum short and not rise above the straight or slightly waved anterior margin; (Figs 18-20); posterior margin of pronotum straight; median hooks nearly straight or arched in last third, but distinct wider on base and with 2-3 stout setae only (Figs 29, 30); inner hooks 0.6-0.8 times as long as median hooks .... *Odontocheila* CASTELNAU

30(27) Coronal suture distinct and usually 0.5 times as long as antennomere IV (Fig. 1); most of setae of median hooks thin; central spine of inner hooks usually straight and shorter than lateral setae (Figs 32-35); labial palpomere II with 1 seta near the middle (cf. Fig. 49).

31(32) Abdominal tergites very small, bearing 5-8 setae only; antennomere IV 0.4 times as long as antennomere II; median hooks not more than 1.5-1.6 times longer than inner hooks; the most apical seta of median hooks stout, but placed only slightly asymmetrically to the rest of setae (Fig. 35); most of the setae on pronotum flattened (Fig. 16); head light brown with bright shade; sclerites of abdomen very slightly sclerotized; very small larvae ..... *Pentacomia* BATES

32(31) Abdominal tergites larger, always with 10 setae or more; antennomere IV at least 0.43 times as long as antennomere II; median hooks at least 2 times longer than inner hooks (Figs 32-34); setae on median hooks often thin and directed outwards (Figs 32, 34); in part the most apical seta stout, but always displaced asymmetrically to the rest of the setae (Fig. 33); larvae of variable size ..... Cicindelina *(Cicindela* LINNÉ s. auct.)

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ZUSAMMENFASSUNG

Bisher sind 35 Gattungen der Cicindelidae im Larvenstadium bekannt. Die Gattungen werden mit ihrer Literatur aufgelistet und ein Bestimmungsschlüssel für das zweite und dritte Larvenstadium wird gegeben.

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