

**Diplopoda from the Nepal Himalaya:
Towards the clarification of the genus *Anaulaciulus* POCK 1895
(Diplopoda, Julida, Julidae, Brachyiulini)¹⁾**

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Abstract

The millipede genus *Anaulaciulus* POCK 1895 is characterized; its systematic position is discussed, together with a preliminary definition to the tribe Brachyiulini. A well defined species-group of *Anaulaciulus* from the Himalayan Range is reviewed. The group consists of the following species: *A. inaequipes* ENGHOFF 1986, *A. acaudatus* n. sp., *bilineatus* n. sp., *enghoffi* n. sp., *kashmirensis* n. sp., *nepalensis* n. sp., *niger* n. sp., *pakistanus* n. sp., *tibetanus* n. sp., *tigris* n. sp. and *topali* n. sp. A character analysis (i.e., size relationships, leg polymorphism, distribution of gnathochilarial and vulval setae) of the group together with an identification key to the species is provided. Remarks with regards to the ecology and distribution of the species in Nepal are made. A new combination is published: *Anaulaciulus tonggosanensis* PAIK 1976, comb. nov.

Introduction

In spite of a possible first-glance expectation, the high mountainous regions of the southern Himalaya situated in Pakistan, Nepal, India, China and Burma seem to support a highly diverse millipede fauna, as it has already been shown in the case of the oncoiuline genus *Nepalmatoiulus* MAURIÈS 1983 (ENGHOFF 1987). This paper analyses the *inaequipes*-group (characterized by a beaklike process on the gonopod opisthomerite) of the only other julid genus, *Anaulaciulus* POCK 1895, which occurs, similarly to *Nepalmatoiulus*, in high numbers amongst the millipedes of this region. Although all the species but one presented here are new, there can be no doubt, or perhaps even this indicates, that many other species may exist and still await collecting and a description.

Material and methods

Material for study was loaned from the following institutions:

Forschungsinstitut und Natur-Museum Senckenberg, Frankfurt am Main (SMF); Zoological Museum, University of Copen-

hagen, Copenhagen (ZMUC); The Natural History Museum (formerly British Museum (Natural History)), London (BMNH); Museum d'Histoire Naturelle, Genève (MHNG); Zoological Institute, St. Petersburg (ZISP); Hungarian Natural History Museum, Budapest (TMB); National Science Museum, Tokyo (NSMT); Zoological Museum of the Moscow State University, Moscow (ZMMU).

For details on the material examined see the species descriptions below. In the case of available material, paratypes were shared between the institutions mentioned above; depository details are also given in the species descriptions.

For every species from each sample some selected specimens (males and females, separately) were examined. Of those which were analysed, temporary glycerin slides (gonopods), permanent slides mounted in Euparal (gnathochilarium, left antenna, first legpair, second legpair, penis, anterior and posterior legpairs of a midbody segment, and limb), and permanent slides in Faure-Berlese medium (vulvae) were made.

On analysed specimens, in addition to measuring total length and midbody (maximum) vertical diameter (= height), measurements (length and width) of antenno- and podomeres were taken (in the case of the latter: mean of anterior and posterior legpairs of a midbody segment), the number of podous segments (n.p.s.), ocelli in one eye (where possible), gnathochilarial and vulval setae were counted. Calculations for relative length of antennae and

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legs (total length/midbody vertical diameter), and leg slenderness (sum of length/width ratios of prefemur, femur, postfemur and tibia) were also made.

Scanning electron micrographs (Jeol JSM-840) were taken and mounts are deposited in the Zoological Museum, University of Copenhagen.

Acknowledgements

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Systematic position of *Anaulaciulus*

Anaulaciulus has traditionally been placed in the tribe Brachyiulini VERHOEFF 1909, subfamily Brachyulininae. However, definitions of both these groups are unsatisfactory. Brachyulininae, in the sense of VERHOEFF (1932), are characterized by having a flagellum; being devoid of a free mesomerite; mesomerital process (if any) of the (in SCHUBART 1934: anterior!) gonopod attached to the opisthomerite, i.e., the posterior gonopod is not divided by a deep incision to its base; males having or rarely lacking expanded cheek lobes; ozopores lying in or closely behind the suture. The genera *Oncoiulus* VERHOEFF 1893 (= *Unciger* BRANDT 1841), *Fusiulus* ATTEMS 1909 (= *Anaulaciulus* POCKOCK 1895), *Microbrachyiulus* VERHOEFF 1897 (= *Brachyiulus* BERLESE 1884), *Brachyiulus* sensu VERHOEFF (1932) nec BERLESE (1884) (= *Chromatoiulus* sensu auct., nec VERHOEFF 1894; = *Megaphyllum* VERHOEFF 1894), and a few others were listed as belonging to this subfamily. The definition of the tribe Brachyiulini in the sense of VERHOEFF (1909, 1910, 1932), as opposed to Oncoiulini (with *Unciger* and *Chaitoiulus* VERHOEFF 1895), is based on the lack of a division of the posterior gonopod into an opisthomerite and a mesomerite, where the latter together with the promerite would give the forceps-like arrangement characteristic of most other tribes of the Julidae (SCHUBART 1934). ATTEMS (1939), following that consideration, already grouped *Unciger* and allies in Uncigerini LOHMANDER 1936 (= Oncoiulini VERHOEFF 1909), and placed this tribe in the subfamily Julinae.

The rather confusing systematic puzzle outlined above, with *Unciger*, *Brachyiulus* and *Megaphyllum* as key genera, can be explained mainly by seeking the answer for the theoretical (and apparently insoluble) question whether any part of the opisthomerite is homologous to the free mesomerite of higher julids or not (ATTEMS 1939). The result is a set of "mesomerital processes", as the amazingly "variable" parts (even posteriorly) of the opisthomerite were termed by various authors (e.g., VERHOEFF 1910, SCHUBART 1934, STRASSER 1976). The question is indifferent, and it is recommended to restrict using the term "mesomerite" for the posterior

member of the forceps-like arrangement of the advanced julids.

In more modern literature, the subfamily Brachyulininae is either disregarded (HOFFMAN 1979, READ 1990), or, as an extreme example, its VERHOEFFian concept is transferred to the Brachyiulini (BLOWER 1986). It seems well-based and can be accepted, however, that the two oncoiulinine genera (*Unciger* and *Chaitoiulus*) together with other members of Oncoiulinae (in Leucogeorgiini, ENGHOFF 1987) show close relation to the "higher julids", having the promerite and the mesomerite acting as a pincer, although the latter is still connected to the opisthomerite by a "velum" (READ 1990). Hence the remaining Brachyiulini (s. str., nec BLOWER 1986) can be defined as:

- Julidae having no mesomerite on the posterior gonopod, but provided with a usually well-developed flagellum; gonopods rather compressed ("flattened") and/or not particularly developed in the longitudinal direction.

This definition is quite weak and far from a list of strong apomorphic characters found in every member of the tribe. According to HOFFMAN (1979), Brachyiulini comprise 24 genera, of which all except 5 are monotypic; this alone suggests an immature systematic arrangement within the tribe. Three genera containing numerous species seem to emerge from the mess: two of them (*Brachyiulus* BERLESE 1884 and *Anaulaciulus* POCKOCK 1895) have in common a conspicuously short promerite, but differ in other characters. *Megaphyllum* VERHOEFF 1894, the third, is again obviously a "waste-paper basket", there can hardly be found any synapomorphy which keeps this genus together. The whole situation is well represented by the character table of READ (1990: Table 2), where Brachyiulini show plesiomorphic states at each of the ten characters studied except one: the expanded male cheek lobes. This again, however, can be disregarded at a closer examination, since, e.g., species of *Anaulaciulus* do not have it. It should also be mentioned here that in some other characters, which otherwise are considered as typical though primitive to Brachyiulini, *Anaulaciulus* differs from the other members of the tribe (cf. READ

1990 and below). All this suggests that a thorough revision of the genera of the whole tribe may well result in splitting it to smaller but more likely monophyletic groups.

Genus *Anaulaciulus* Pocock 1895

- 1895 *Anaulaciulus* Pocock: Annals and Magazine of Natural History, Ser. 6, 15: 366. Type species: *Anaulaciulus paludicola* Pocock 1895 (by monotypy).
 1909 *Fusiulus* Attems, Arkiv för Zoologi, 5: 59 (synonymized by Causey 1966). Type species: *Fusiulus pinetorum* Attems 1909 (designation by Jeekele 1970).
 1968 *Anaulaciulus* – Murakami & Paik, Bulletin of the National Science Museum, 11: 383.
 1970 *Anaulaciulus* – Jeekele, Nomenclator: 149.
 1979 *Anaulaciulus* – Hoffman, Classification of Diplopoda: 112.
 1986 *Anaulaciulus* – Enghoff, Steenstrupia, 12: 117.

Diagnosis: Member of the tribe Brachyiulini as defined above by the male gonopod, but differs from all other genera in:

- having short, flattened, scale-like promerites, and long, bifurcate penis;
- lacking both metazonal setae and expanded cheek lobes in males.

Characterization of the genus

Body size: small to medium sized species, body length varies from 13–40 mm (males), 17–60 mm (females); mid-body vertical diameter 1.0–2.9 mm (males), 1.2–3.5 mm (females); number of podous segments 40–58 (males), 40–67 (females).

Colouration: usually the common primitive julid pattern (see, e.g., Enghoff 1982: figs. 106–107), brownish, brown-yellowish ground colour; frequently a sharp, thin, black middorsal line present (see, e.g., Enghoff 1987: figs. 3–4); in a few species a characteristic dorsal pattern: dark middorsal line (variable in width) between two light longitudinal stripes (similarly to that of *Brachyiulus pusillus* Leach 1814 or *Megaphyllum projectum* Verhoeff 1894). Some species uniformly dark. Legs and anal valves usually lighter than body colour.

Head with 2 frontal setae, usually with 4 supralabral and a row of labral setae; antennae with 4 apical sensillae; gnathochilarium with usual julid arrangement and setosity (see, e.g., Enghoff 1992: figs. 22–23), stipites only with group of apical setae, lamellae linguales with a few setae usually evenly distributed; males without expanded cheek lobes.

Collum smooth, with short striae at the postero-lateral corner.

Body cylindrical, slightly tapering towards telson; segments not vaulted, prozonites smooth, metazonites finely striate, without setae, suture straight, ozopores lying closely behind it, sometimes touching it, at midbody height; limb straight, cellular structure hardly visible. Seventh segment with anterior and posterior projections, forming an opening for the gonopods (Fig. 1).

Preanal ring smooth, dorsal projection variable from blunt, almost naught to longer, upward turned, but rarely exceeding anal valves; telson, anal valves and subanal scale usually densely pilose.

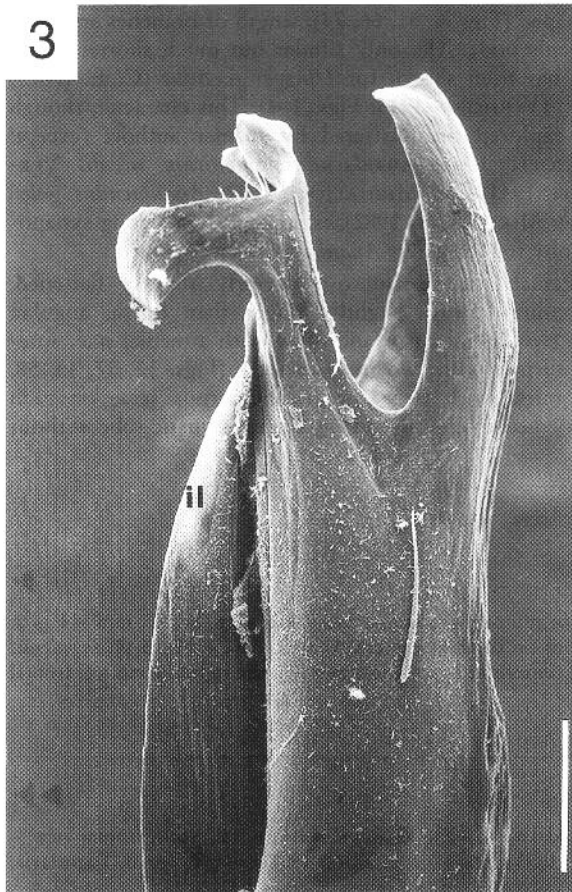
Legs slender, in females without modification. In males 1st legpair hooklike, small, 2nd without modification, adhesive pads present on postfemora (usually very weak), strongest on tibiae. In some species males with characteristic legs gradually increasing in length towards midbody (described in detail by Enghoff 1986); this phenomenon appears exclusively in *Anaulaciulus* (among Juliformia), although not featured in every species and showing even individual variation.

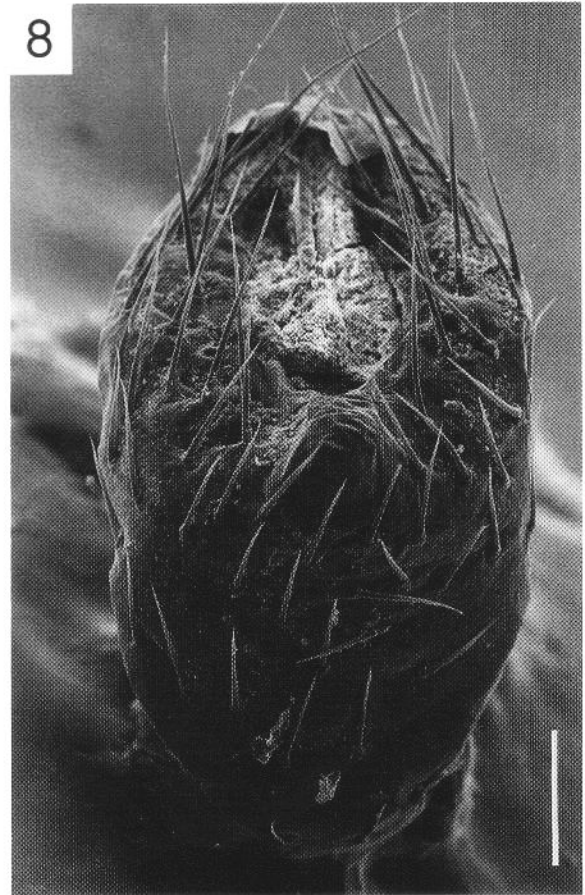
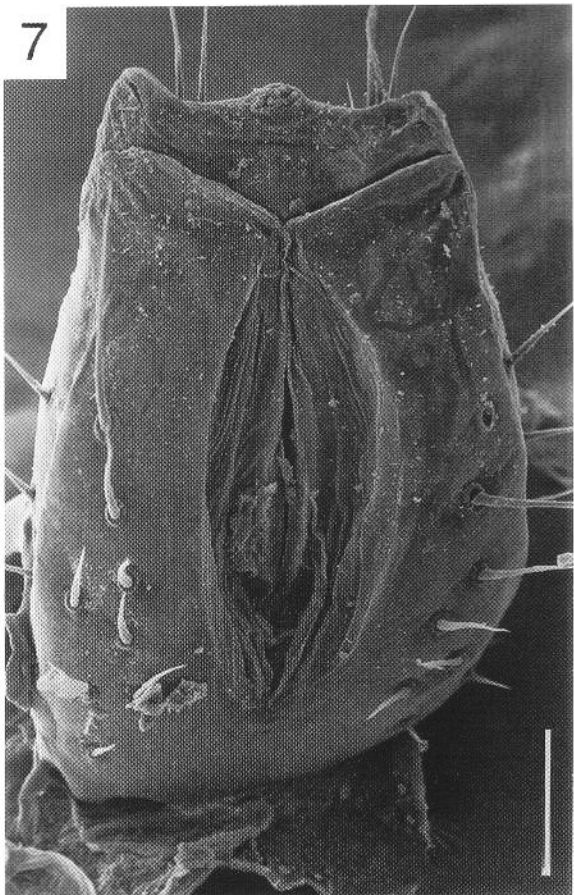
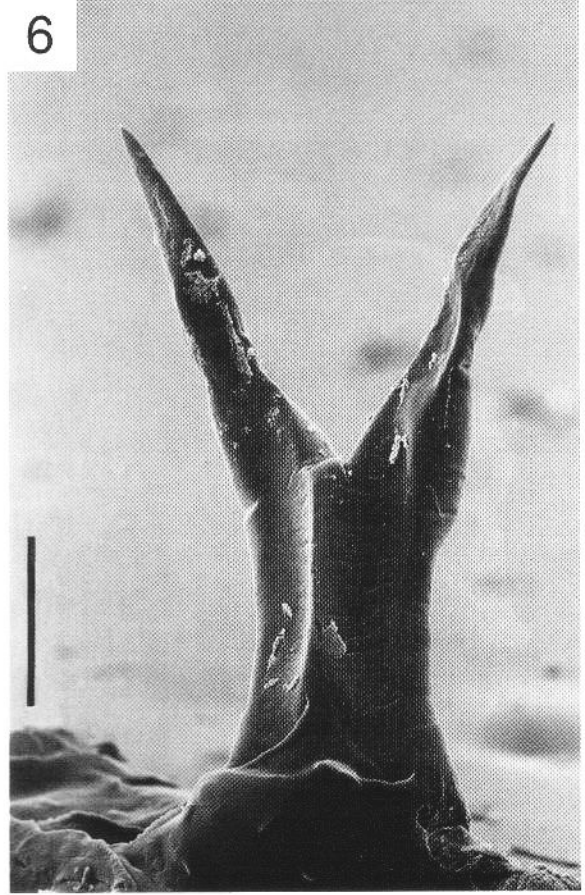
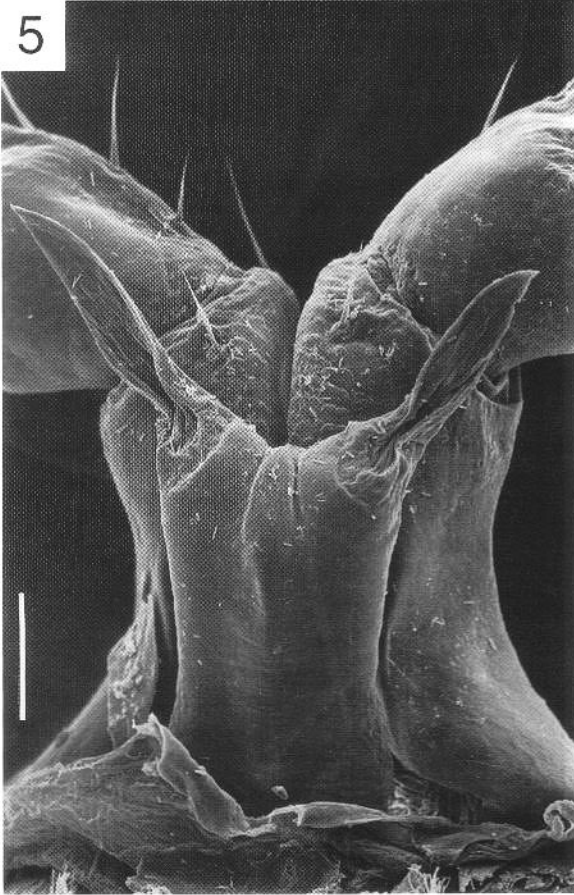
Penis closely behind 2nd legpair (Figs. 5 and 23), easily recognizable in situ in the opening formed by the 2nd and 3rd segments; conspicuously long, bifurcate, Y-shaped (Figs. 6, 51, 66, 74); length of branches subequal to penis body. The only similar but much shorter structure has been shown for *Unciger foetidus* (C. L. Koch 1838) (Verhoeff 1913: Figs. 1–4). This character, though not explored or illustrated by former authors (except: Verhoeff 1941: *Anaulaciulus pinetorum nivalis* Verhoeff 1941, and Mikhaljova 1982: *Anaulaciulus golovatchi* Mikhaljova 1982), is apparently a strong synapomorphy for the genus *Anaulaciulus*.

Female vulvae antero-posteriorly slightly flattened; operculum always slightly longer than bursa, angular, with two lateral cusps and often with a medial one, anterior surface with two rows of setae (Figs. 32, 37, 45, 58, 63); bursa with two rows of numerous setae on each valve, median cleft deep (Fig. 7); apodemetic tube without

Figs. 1–4. Fig. 1. Head, first and second legpair with penis, and gonopods in situ of *Anaulaciulus nepalensis* n. sp. Scale 1 mm. – Fig. 2. Gonopod opening of an intact male, *A. nepalensis* n. sp., note modifications on the 7th segment. Ventral view. – Fig. 3. *A. nepalensis* n. sp., left opisthomerite, caudal view. il = intermediate lamella. – Fig. 4. *A. bilineatus* n. sp., coxal pore on the right second leg, frontal view. – All SEM, scales in Figs. 2–4: 100 µm.

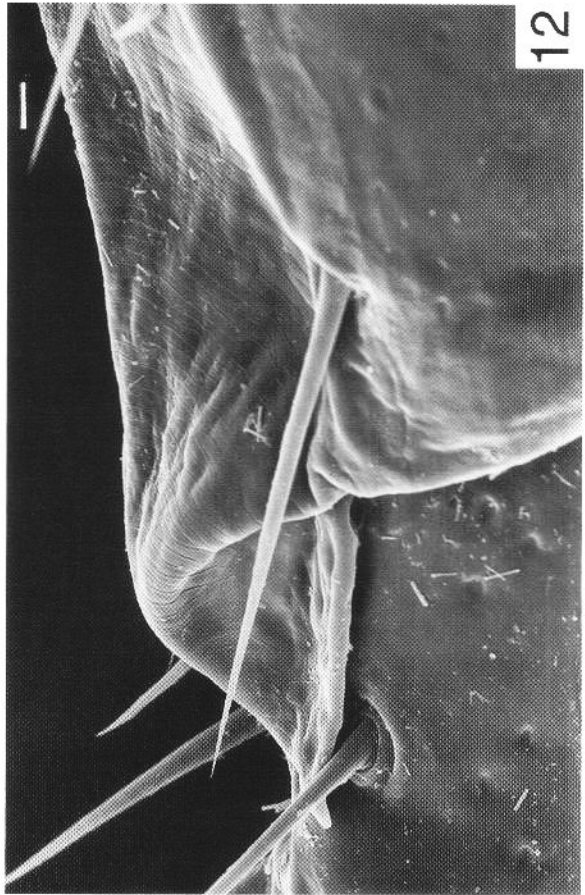
Figs. 5–8. Fig. 5. *Anaulaciulus tigris* n. sp., penis behind second legpair, caudal view. – Fig. 6. *A. bilineatus* n. sp., penis, frontal view. – Fig. 7. *A. nepalensis* n. sp., right vulva, caudal view. – Fig. 8. *Megaphyllum unilineatum* (C. L. Koch 1838) from Beograd, Yugoslavia, right vulva, caudal view. – All SEM, scales 100 µm.



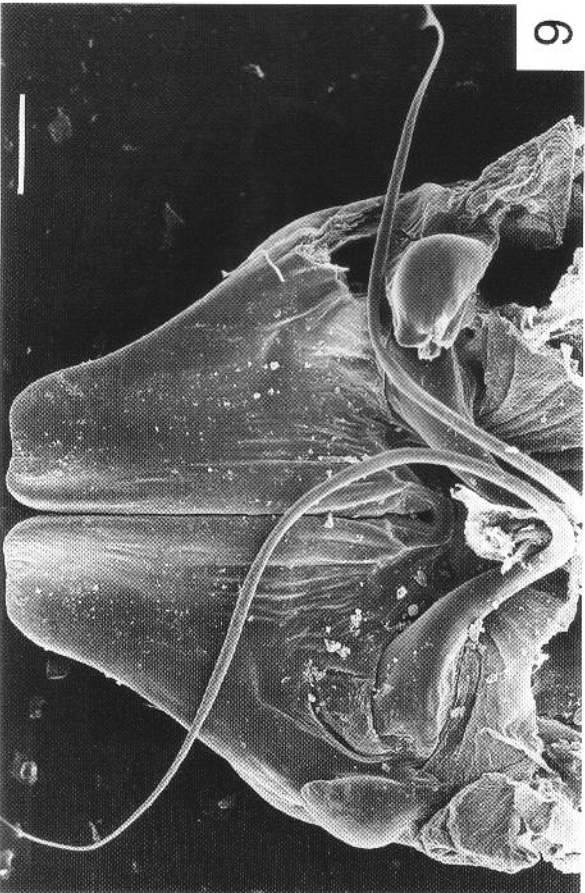




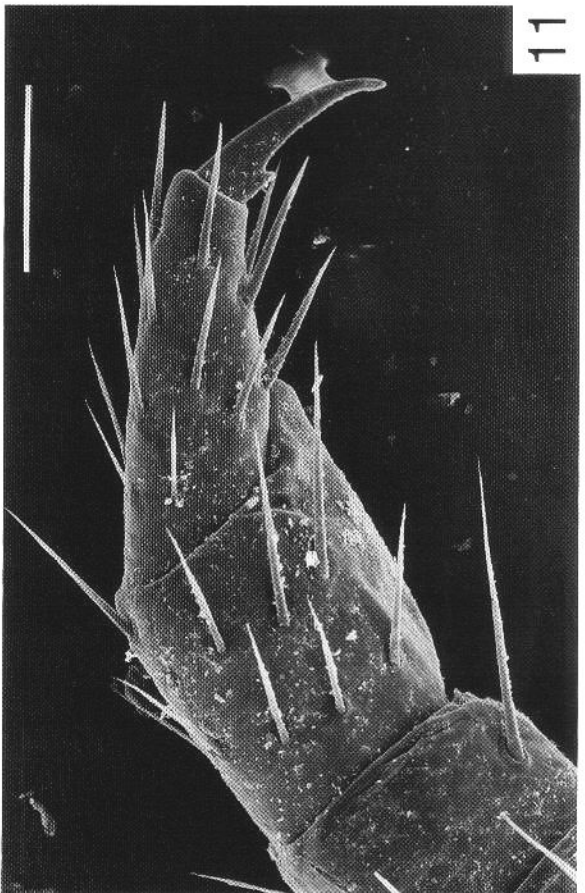
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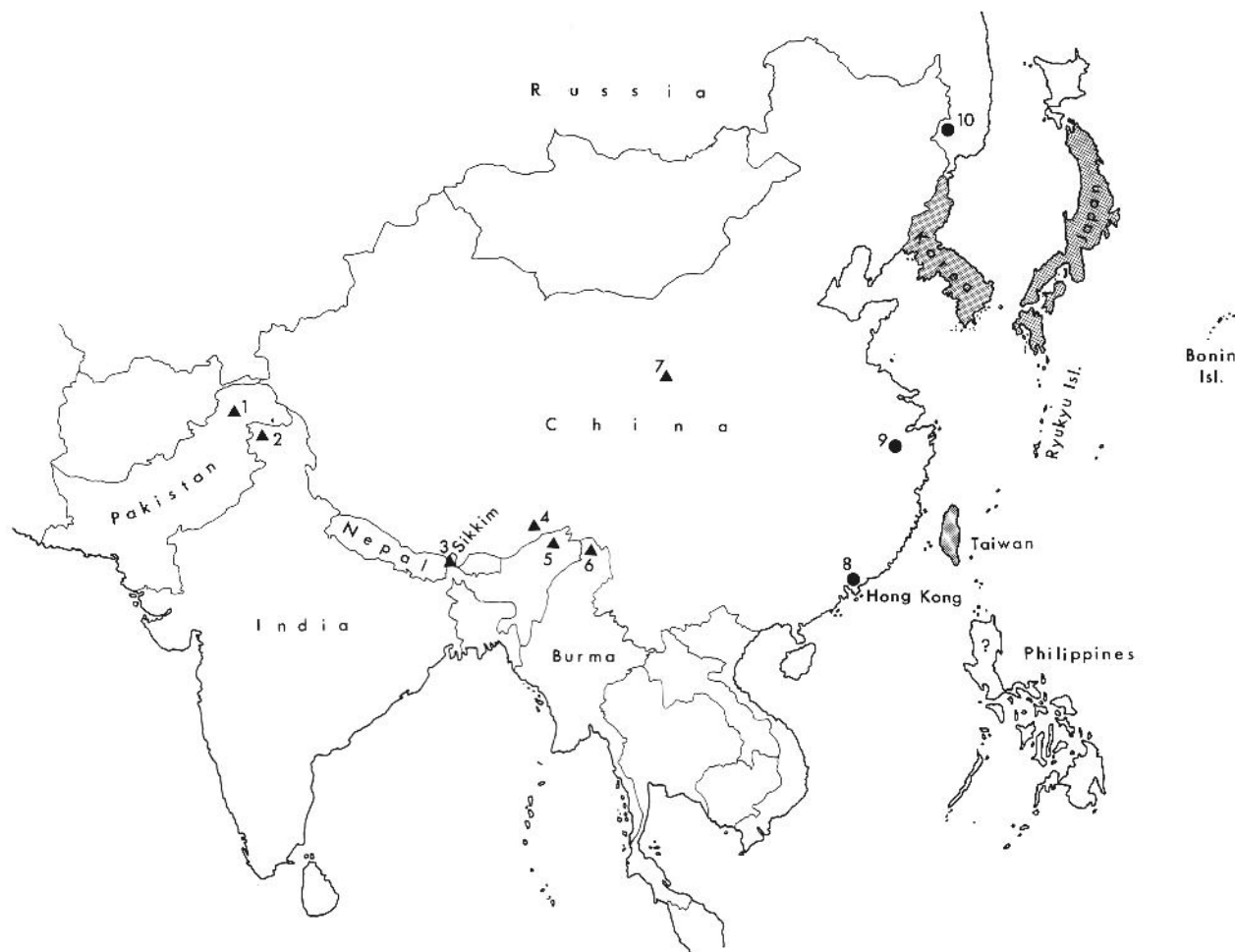
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Map 1. Distribution of the genus *Anaulaciulus*. Shaded areas (i.e., Korea, Japan excl. Hokkaido, incl. Ryukyu and Bonin Islands, and Taiwan) are inhabited by numerous forms; numbered localities are as follows: 1. Pakistan: District Swat (*pakistanus*, *tigris*); 2. India: Kashmir (*kashmirensis*, *topali*); 3. India: Sikkim (*acaudatus*); 4. China: Tibet (*tibetanus*); 5. India: Assam (*tibetanus*); 6. Burma: Adung Valley (*inaequipes* ENGHOFF); 7. China: Kansu (*enghoffi*); 8. Hong Kong (*tonginus* KARSCH 1881); 9. China: Chekiang District (*paludicola* POCCOCK 1895, *vallicola* (POCCOCK 1895)); 10. Russia: Ussuriysky District (*golovatchi* MIKHAJLOVA 1982). Triangles = members of the *inaequipes*-group. For more locality details see text. Occurrence in the Philippines is doubtful. For distribution in Nepal, see Map 2.

secondary branch, usually straight, ampulla sphaerical or elongated, with or without appendix (Figs. 31, 36, 44, 57, 62). As a comparison to the vulvae of two other representatives of Brachyiulini (*Megaphyllum unilineatum* (C. L. KOCH 1838), Fig. 8, and *Brachyiulus pusillus* (LEACH 1814), Fig. 13) indicates, the general appearance of the *Anaulaciulus* vulva is strongly different and characteristic within the tribe. The differences include (as it is described above): the shape of the operculum, the general shape and spinulation of the bursa, and the structure of the apodemetic tube. Other members of the Brachyiulini (Figs. 8,

13, and also LOHMÄNDER 1936: figs. 83–84 in his taxa *Megaphyllum* (= *Chromatoiulus*) *spatulatus*, or figs. 114–115 in *M.* (= *Chr.*) *macrourus abchasicus* and *divaricatus*, all from the western Caucasus) seem to have the vulvae of a rather cylindrical shape, generally thick, compact, with a short, round opening at the top, forming no deep median cleft; operculum of the same length and closely attached to bursa, hardly ready to separate; entire vulva densely setose, setae scattered irregularly on the surface; apodemetic tube two-branched, ending in two, more-or-less elongated ampullae.

Figs. 9–12. Fig. 9. *Anaulaciulus bilineatus* n. sp., promerites, caudal view. – Fig. 10. *A. nepalensis* n. sp., gonopods in situ, ventral view. – Fig. 11. *A. bilineatus* n. sp., left second leg, note adhesive pad on tibia, frontal view. – Fig. 12. *A. tigris* n. sp., adhesive pad on tibia of right second leg, caudal view. – All SEM, scales in Figs. 9–11: 100 μ m, in Fig. 12: 10 μ m.

Male gonopods: promerite unusually short, less than a half as long as opisthomerite, flattened, scale-like (Fig. 9), in situ covering the anterior part of the gonopodal opening of the 7th segment (Fig. 10); usually rounded at tip, sometimes angular, with a long, slender flagellum; laterally with a definite rudiment of telopodite on the caudal side. Opisthomerites partly protruding from beneath the covering promerites (Fig. 10); long, slender, not particularly developed sagittally, generally simple; without mesomerite or mesomerital process; with several longitudinal lamellae parallel to the axis of opisthomerite; one of them characteristically arched and present in every species (Fig. 3, and ENGHOF 1986: fig. 3, "intermediate lamella"), usually with a row of fine marginal hairs. Apical end of opisthomerite variable; in a coherent group of species it carries a beak-like process (the *inaequipes*-group, described below). The importance of the shape of the posterior gonopod is discussed below together with intrageneric relationships.

Distribution: The members of the genus are quite widespread in eastern Asia (Map 1). They do not penetrate as far south to tropical areas as it is the case in *Nepalmatoiulus* MAURIÈS 1983 (ENGHOFF 1987), with which they overlap in the Himalaya Mts. Instead, *Anaulaciulus* is distributed further to the east, and seems to be confined to the temperate zone (or to higher altitudes): species occur quite abundantly on the continent in Korea and the Russian Far East, possibly also in northeastern China; and numerous forms (TAKAKUWA 1941, MIYOSI 1959, SHINOHARA 1990) seem to represent a species swarm on the islands of Japan, south of Hokkaido. Various forms have also been reported from Taiwan (WANG 1955, 1963), and the genus probably occurs also on the Philippines (ENGHOFF 1986).

A recent account of the species belonging to *Anaulaciulus* has been presented by ENGHOF (1986). He enlisted 34 forms (30 species and 4 subspecies) known at that time, one additional was overlooked (*Anaulaciulus tonggosanensis* PAIK 1976, comb. nov.) from Korea. Since then further 4 species were described (*Anaulaciulus okinawaensis*, *ryugadensis* and *takanoi*, all by SHINOHARA 1990 from Japan, and *A. otigonopus* by ZHANG 1993 from China), and an addition of 10 new is given below. One species, *crassus* ATTEMS 1938, from Vietnam (see also GOLOVATCH 1983), was originally assigned to *Fusiulus*, but has recently been removed to *Nepalmatoiulus* (ENGHOFF 1987). Apart of the 10 new, the 38 names obviously represent a combination of valid species and forms of yet unclear relationships (see KORSÓS 1996). Moreover, there may certainly still be new species awaiting a description, as such notes as "sp. 1" and "sp. 2" or data on female specimens indicate (LIM 1988, GOLOVATCH 1980, MURAKAMI & PAIK 1968).

The *inequipes*-group

Characters of the group

This species-group of the genus *Anaulaciulus* is recognized here for the first time, based on the numerous specimens of 11 species (10 of which are new and described below) from the southern regions of the Himalaya Mts. The most important – and strongly synapomorphic – character shared by all members of the group is a sub-

apical beak-like process on the opisthomerite of the male gonopods. This process was first described and illustrated in *Anaulaciulus inaequipes* (ENGHOFF 1986, hence the groupname). Other characters for the group include: the arrangement of adhesive pads on male legs (absent or very weakly developed on postfemur, very strong on tibia, proceeding over the ventral side of tarsus as well: Figs. 11–12); always short, sometimes slightly downward pointed epiproct (Figs. 41, 75), never turned upwards; and an occasional – but unique amongst juliformian millipedes – occurrence of male leg polymorphism (characteristic lengthening towards midbody legs) which was analysed in detail by ENGHOF (1986). Female vulva usually with a simple or slightly coiled apodemetic tube, always with a nearly spherical ampulla.

Morphology

Body size: small to medium sized species, body length varies from 13–41 mm (males), 12–49 mm (females); midbody vertical diameter 1.2–2.4 mm (males), 1.2–2.6 (females); number of podous segments 36–59 (males), 34–58 (females).

Colouration: basically the common primitive julid pattern, with brownish, brown-yellowish or grey-brownish ground colour and darker or brighter spots; in several cases this pattern superimposed by species-characteristic pattern, e.g., two pale yellowish parallel dorsal stripes, or uniformly dark blackish-brown colour (for details see species descriptions); often with a sharp, thin, black middorsal line. Legs and anal valves brownish, in females usually lighter, fade brown or whitish.

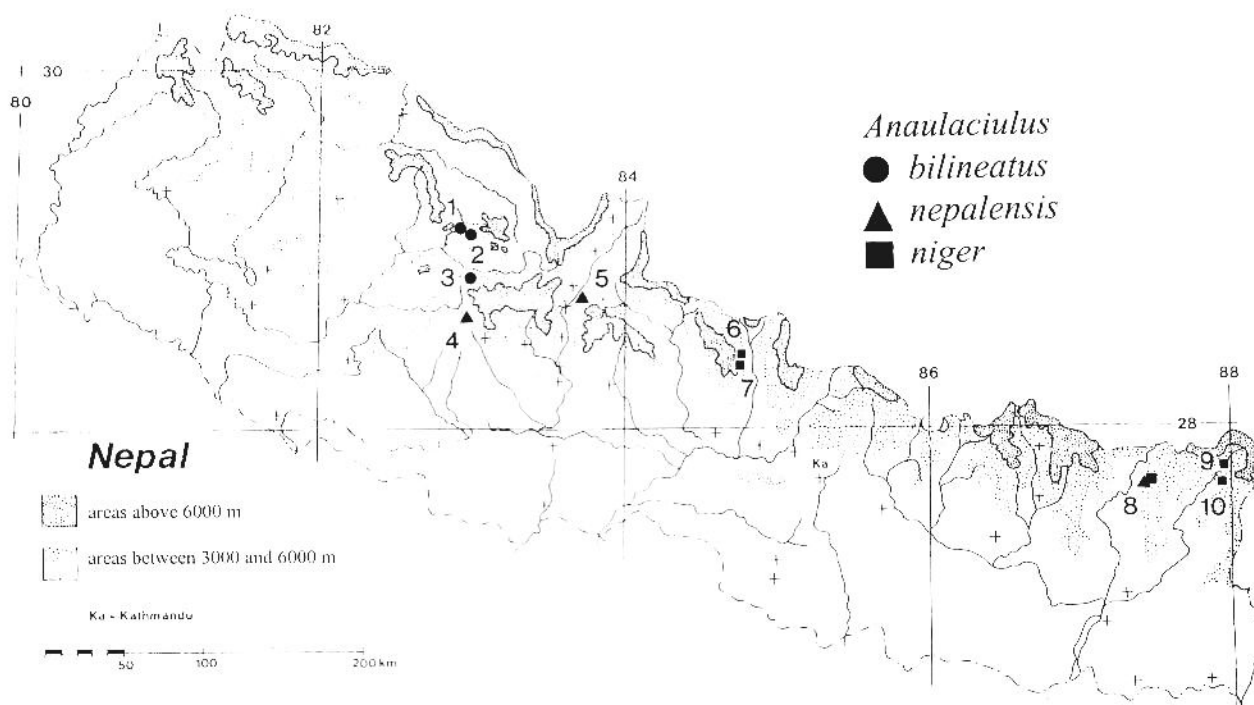
Head with 2 frontal setae, usually with 4 supralabral and a row of numerous labral setae; antennae with 4 apical sensillae; gnathochilarium with usual julid arrangement, promentum small, triangular, stipites mostly with 3+3 (1–4+2–4) setae on their apical corner, lamellae linguales with a few evenly distributed setae (their number varies between 2–6+2–5); males without expanded cheek lobes.

Collum smooth, with short striae at the postero-lateral corner.

Body cylindrical, slightly attenuated towards telson, segments not vaulted; prozonites smooth, metazonites finely striate, number of striae varies between 8 and 18 in the upper quarter of a midbody segment height, metazonites without setae, suture straight, ozopores lying closely behind, sometimes touching it, at midbody height; limbus straight (Fig. 2), cellular structure hardly visible. Second and third segments forming an opening for penis; 7th segment with characteristic projections, forming an opening for the gonopods, which is, however, almost entirely covered by scale-like promerites.

Preanal ring smooth, with a few setae at least at the dorsal and ventral margin, sometimes (in *nepalensis*, *niger*, *topali*) along its entire margin; dorsal projection small, never exceeding anal valves, straight, in one species (*acaudatus*) almost missing, in others (*enghoffi*, *tigris*, *topali*) slightly downwards pointed, setose, in males usually a bit longer than in females; anal valves very densely, subanal scale moderately pilose.

Legs slender, in females without modification. In males 1st legpair hooklike, small (Fig. 67), 2nd without



Map 2. Distribution of three species of the *Anaulaciulus inaequipes* group in Nepal. – 1) Dolpo district, northern Dhaulagiri Himal, Ringmo on Phoksumdo Lake (*A. bilineatus* n. sp.); 2) Dolpo district, ascent to pass Bagar La via Manduwa (*A. bilineatus* n. sp.); 3) Dolpo district, Gomba near Tarakot (*A. bilineatus* n. sp.); 4) Myagdi district, western Dhaulagiri Himal, Thankur (*A. nepalensis* n. sp.); 5) Mustang district, Thaksang above Tukche (*A. nepalensis* n. sp.); 6) Ghorka district, Chuling Khola (*A. niger* n. sp.); 7) Gorkha district, Tabruk Kharka NW of Rupina La (*A. niger* n. sp.); 8) Sankhua Sabha district, above Pahakhola (*A. nepalensis* n. sp., *A. niger* n. sp.); 9) Taplejung district, S of Gansa (*A. niger* n. sp.); 10) Taplejung district, pass Anda Deorali, between Simbua Khola valley and Gansa Khola valley (*A. niger* n. sp.). – According to species: *A. bilineatus* n. sp.: localities 1, 2, 3; *A. nepalensis*: localities 4, 5, 8; *A. niger* n. sp.: localities 6, 7, 8, 9, 10.

modifications, adhesive pads present from 2nd legpair onwards (Figs. 23, 68), on postfemora usually very weak or completely absent (Figs. 11–12, 46), strongest on tibiae, gradually disappearing towards body end. Coxal pores on 2nd leg in central-axial position (Fig. 4, and ENGHOFF 1987: fig. 35). Accessory claw usually present, its length 60–89 % (*bilineatus* and *enghoffi* females only) or 109–195 % (other species, no significant difference between sexes) of the length of claw. In five species (*bilineatus*, *inaequipes*, *enghoffi*, *nepalensis* and *tigris*) of the 11 members of the group, some larger males with characteristic legs gradually increasing in length towards mid-body (for a more detailed analysis see ENGHOFF 1986, and below).

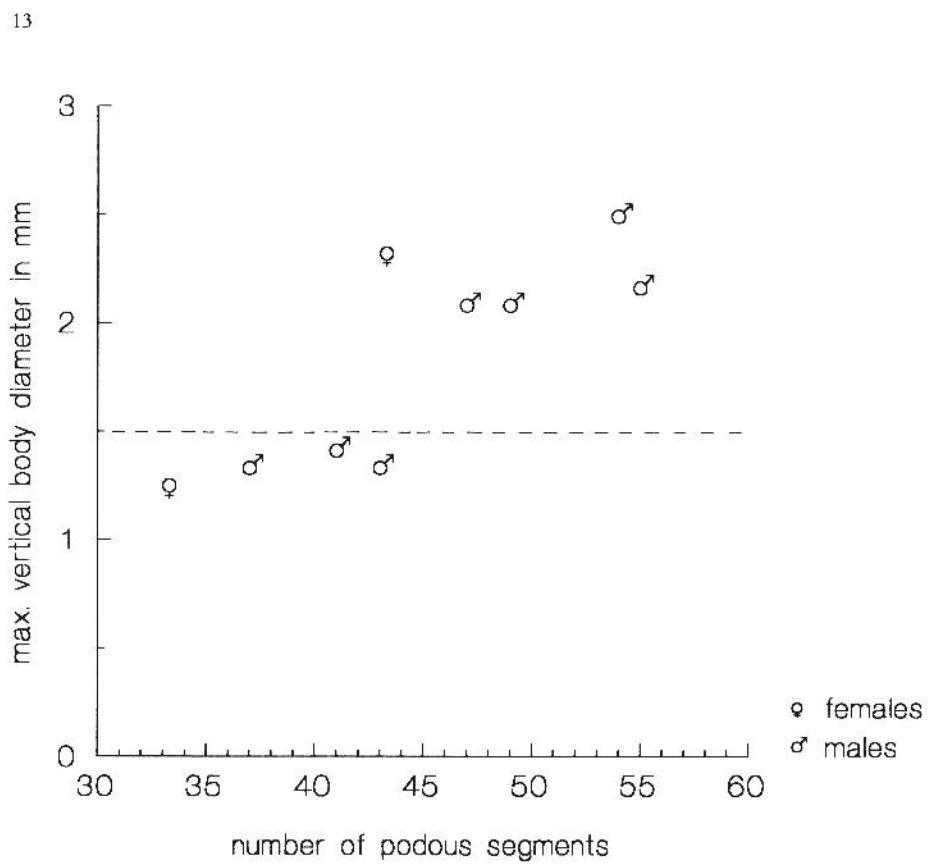
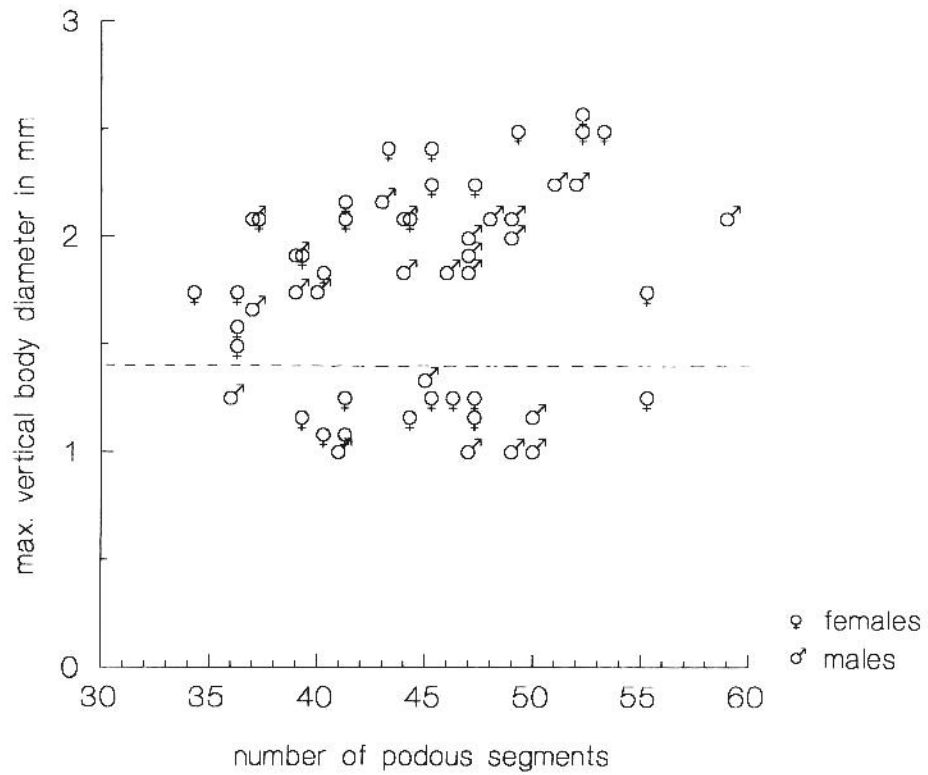
Penis long, bifurcate, Y-shaped; branches hyaline or even membranous, slightly flattened, sometimes almost leaflike. Opening of the seminal canal hardly visible, possibly at the proximal part of the branches, on the caudal side (Fig. 5).

Female vulvae as described in detail at the genus and species-group characterization. Setae on the frontal side of operculum in two rows, setae on each valve of the bursa in two rows: 1+1 on the posterior median plate, and one row on both the lateral and mesal sclerites, respectively (see, e.g., Fig. 31, following ENGHOFF's (1986) terminology).

Male gonopods: promerite as described for the genus, its shape individually variable, triangular, tip rounded,

with or without shallow incision, rudimentary telopodite present, flagellum long and slender. Posterior surface of promerite smooth (Fig. 9) though compound microscopy shows short linear shadows on more-or-less every species (illustrated only for *nepalensis*, Fig. 48), obviously an internal structure.

Each opisthomerite subapically with characteristic beaklike processes, pointed mesad, in situ touching each other (most species), or caudad, in parallel direction (*inaequipes*, *enghoffi*). Shape of the "beak" variable, short and wide, or slender and pointed, distally virtually in every species provided with fine, single, short hairs (it could not have been traced in *inaequipes* and *kashmirensis*; this character, however, is difficult to observe and have only importance as regards the other congeners, see below). Tip of opisthomerite slightly variable, ending mostly in a small thickening (i.e., "the head of the bird"), sometimes concave, with or without additional small processes. Opisthomerite strongly sclerotized along its axis, may carry several ridges, furrows and lamellae. One lamella (= "il" in ENGHOFF 1986) always present, long, thin, stretching mesally throughout from tip to base of opisthomerite, bent mesad, with a more-or-less well-developed flange at its base close to the sternal junction, in situ accommodating the flagellum. Lateral side of opisthomerite body with another lamella (= "al" in ENGHOFF 1986), bent laterad, having a strong, sclerotized support and a membranous velum (i.e., "the wing of the bird"); length



Figs. 13-14. Body size relationships in the *Anaulaciulus nepalensis* n. sp. - *A. niger* n. sp. (above), and in the *Anaulaciulus tigris* n. sp. - *A. pakistanus* n. sp. (below) species-pairs.

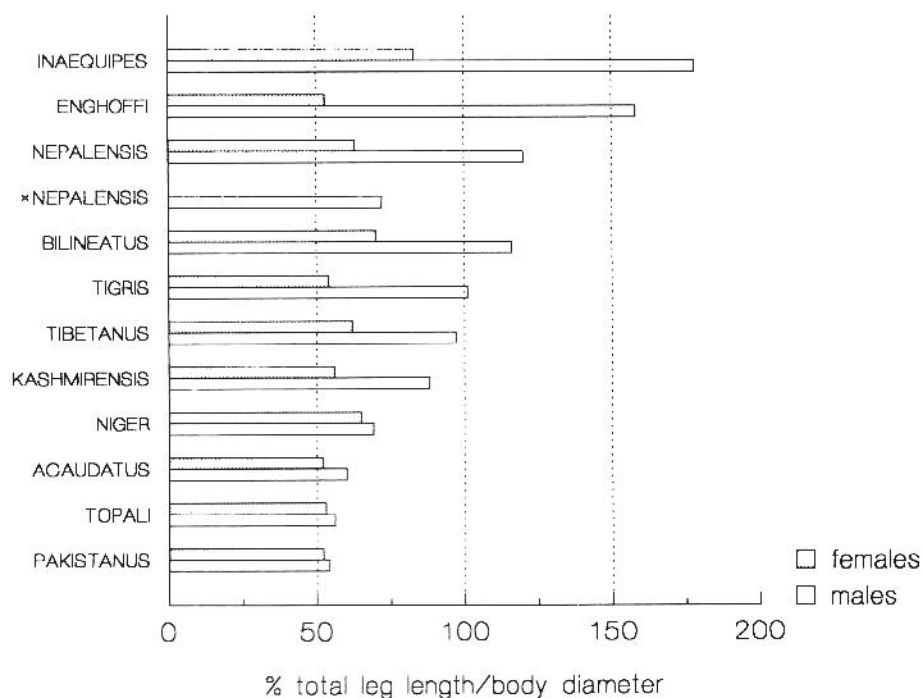


Fig. 15. Relative midbody leg length differences in males and females of the *A. inaequipipes*-group.

usually subequal to opisthomerite, in *pakistanus* and *tibetanus* conspicuously shorter, shape variable, in *bilineatus*, *enghoffi*, *kashmirensis* and *pakistanus* broad, in *acaudatus* and *niger* narrow, slender, in others intermediate, with a sharp, rounded, or undulate, slightly serrulate (*acaudatus*, *nepalensis*, *niger*) margin.

Distribution: Species belonging to the *inaequipipes*-group seem to be confined to the southern slopes of the Himalaya Mts. (Maps 1–2), except one species (*enghoffi*) which was collected more than a hundred years ago in Inner China, Kansu Province, on the expedition of the great Russian traveller, G. N. POTANIN. All the species seem to be restricted to very small areas, possibly because of the isolating habitat structure of the high mountains. This allopatric zoogeographic pattern is generally characteristic for numerous other soil-dwelling invertebrates of the region (MARTENS 1984).

Analysis of characters

Size relationship

Body length, vertical diameter and number of podous segments were found to be generally close to each other in every species, the values falling within the range characteristic for the entire genus. However, adult size diagrams of two closely related (and possibly sympatric) species-pairs show definite differences in both males and females. In *nepalensis* and *niger* (Fig. 14), the number of podous segments is more-or-less the same, however, specimens of *niger* seem hardly to exceed the maximum vertical diameter of 1.5 mm. This feature is useful for identification as well, in the otherwise very similar

species-pair. From *pakistanus* and *tigris* (Fig. 15) only relatively few specimens were at hand. Although podous segment numbers hardly overlap, midbody vertical diameter of *pakistanus* specimens does not exceed 1.5 mm and that of *tigris* starts at 2.0 mm. The two species are easy to distinguish with the help of other characters (e.g., colouration, gonopod conformation, etc.) as well.

Leg polymorphism

Length of midbody segment legs are larger in males of every species in the group (Fig. 16). In five species (*bilineatus*, *enghoffi*, *inaequipipes*, *nepalensis*, and *tigris*), however, midbody legs of some larger males were found to be characteristically longer, i.e., exceeding the maximum vertical body diameter. The phenomenon appears as a tendency for the whole group, for there is no sharp difference between the species with longer legged males (*kashmirensis* and *tibetanus* males have also somewhat longer midbody legs). For comparison, another male of *nepalensis* with normal legs is also included in the diagram, to show intraspecific differences.

The legs are gradually increasing in length towards midbody and then decreasing again, as it was shown in detail on *inaequipipes* (ENGHOFF 1986). Longer legs are mainly due to the larger length/width ratios of femora and tibiae (Fig. 17), which also appears in the tarsus length-tibia length relationship (Fig. 18). In adult julids the tarsus is generally longer than the tibia (VERHOEFF 1928, ENGHOFF 1982, 1992), but in the males of six species (*bilineatus*, *enghoffi*, *inaequipipes*, *kashmirensis*, *tibetanus*, and *tigris*) the tibia exceeds it in length (especially in *enghoffi*). The case of *kashmirensis* shows again that these characters have no sharp differences in the members of the group.

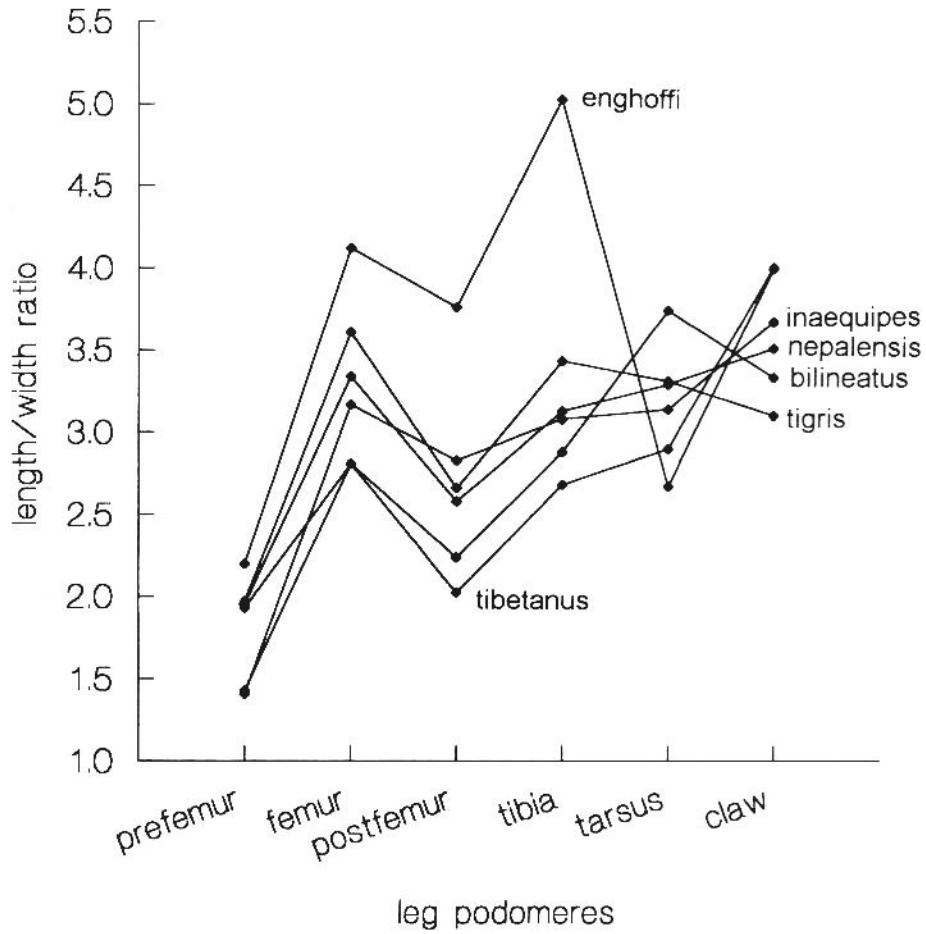


Fig. 16. Leg podomere length/width ratio ("leg slenderness") in selected species of the *inaequipes*-group.

Table 1: Number and arrangement of setae of female vulva in the species of the *Anaulacilus inaequipes*-group (extremes in parentheses)

bursa								operculum	
left valve				right valve				left	right
outer		inner		outer		inner			
lateral	median	median	mesal	lateral	median	median	mesal	outer/ inner	outer/ inner
3-4	7-9	6-9	4-5	3-4	7-9	8-10	4-7	4/4	7/6
(2-7)	(6-14)	(6-11)	(3-7)	(1-7)	(5-13)	(6-12)	(3-7)	(3-9)	2-9

Other characters

Two other characters analysed on the members of the *inaequipes*-group are summarized here. The number and distribution of setae on the gnathochilarium (with a mean of 6 on stipites, and 8 on lamellae linguales) show no interspecific differences, data pooled from the entire group are very close to each other (Fig. 19). Number and arrangement of setae on the female vulvae are summarized

in Table 1. Two groups of species at the edges of the entire range are conspicuous and hence may have characteristic value: *acaudatus*, *bilineatus*, *inaequipes* and *tigris* with a high number (30-35) of setae on bursal valves altogether, whereas *enghoffi*, *niger* and *pakistani* with fewer (17-21) setae. There seems to be no size effect in this respect.

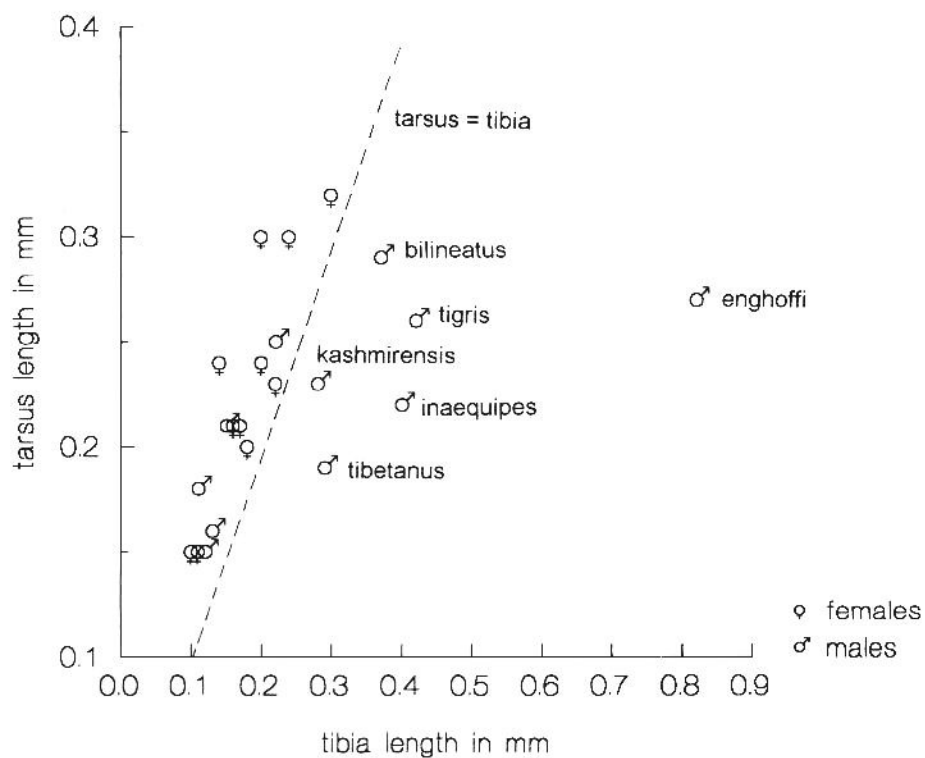


Fig. 17. Tibia and tarsus length relationship in the species of the *inaequipes*-group.

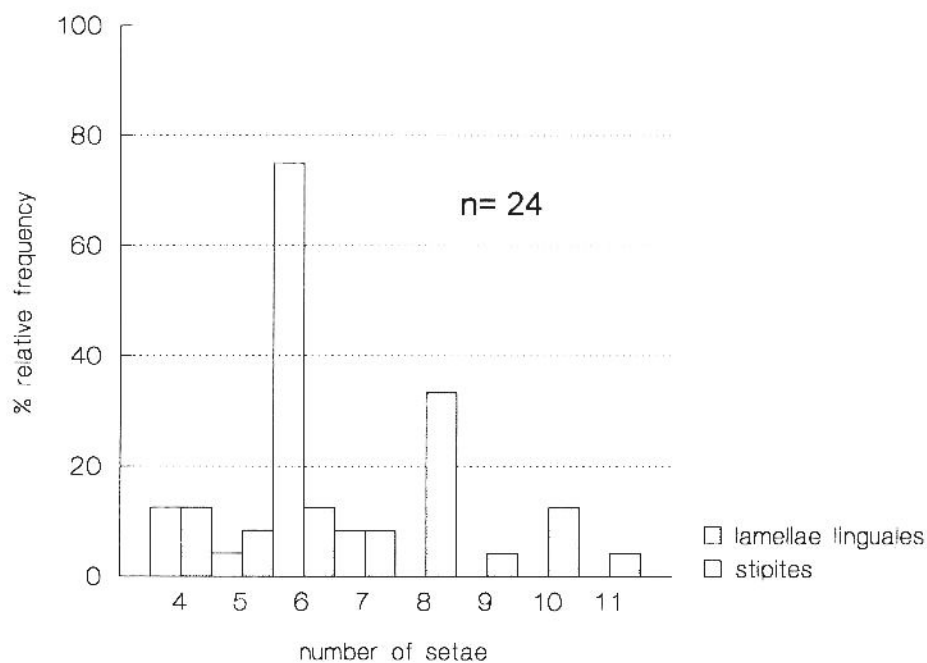


Fig. 18. Relative frequency distribution of gnathochilarial setae in the *inaequipes*-group.

Key to species of the *inaequipes*-group of *Anaulaciulus*

The following key is compiled using external characters as far as possible; gonopodal structures were only used where a closer examination of these is unavoidable

for the differentiation of the species. Because of the close relationship between the group-members, the key can only be used as a preliminary identification; for more reliable result the species descriptions detailed below should be consulted.

1. Characteristic colour pattern: dark blackish-brown middorsal stripe between two parallel pale yellowish dorsolateral stripes; sides blackish-brown. Large males with longer legs towards midbody. Nepal. *bilineatus* n. sp.
 - Colouration different. 2
2. Ground colour orange-yellow or light brown, with dark brown transverse stripes: prozonites dark, metazonites with ground colour. 3
 - Colour uniformly dark brown, greyish brown or brown, with usual primitive julid pattern. 4
3. Relatively large species, length 31–41 mm (♂♂), 49 mm (♀), max. vertical diameter 2.1–2.5 mm (♂♂), 2.4 mm (♀). Brown middorsal stripe strong, broad, continuous. Lateral lamella of posterior gonopod subequal to opisthomerite (Fig. 65). Larger males with longer legs. Pakistan. *tigris* n. sp.
 - Smaller species, vertical diameter less than 1.5 mm. Brown middorsal stripe thin and weak, present only on prozonites. Lateral lamella of posterior gonopod much shorter than opisthomerite (Fig. 57). Pakistan. *pakistanus* n. sp.
4. Preanal ring without dorsal projection (Fig. 27). India: Sikkim Prov. *acandatus* n. sp.
 - Preanal ring with short dorsal projection (e.g., Fig. 55). 5
5. Epiproct slightly downward pointed (Figs. 40, 70). 6
 - Epiproct straight (Figs. 51, 55). 7
6. Metazonital striation sharp, dense (13–18 in a quarter of vertical diameter). Lateral lamella on posterior gonopod very broad, rounded; tip of opisthomerite rounded, concave; "beak" blunt, sometimes with incisions (Fig. 34), in situ directed caudad. Large males with legs gradually increasing in length towards midbody. China: Kansu Prov. *enghoffi* n. sp.
 - Metazonital striation weak, hardly visible. Lateral lamella on posterior gonopod slender, its connection to opisthomerite through a deeper incision; tip of opisthomerite with small processes, fringes, without hollow cavity; "beak" slender, pointed (Figs. 67–68), in situ directed mesad. Males without longer legs. India: Kashmir. *topali* n. sp.
7. Lateral lamella of posterior gonopod with undulate or slightly serrulate margin (Figs. 48–49, 53–54). 8
 - Lateral lamella of posterior gonopod with straight, entire margin (Fig. 58). 9
8. Larger, thicker species, vertical midbody diameter of adults usually over 1.5 mm (Fig. 14). Body colour pale greyish-brown, legs dark brown. Epiproct sharp, pointed, longer than in *niger* (Fig. 51). Some large males with longer legs towards midbody. Nepal. *nepalensis* n. sp.
 - Smallest species in the group, with slender body, vertical diameter not exceeding 1.5 mm (Fig. 14). Body dark brown, blackish-brown, legs lighter, in females whitish. Metazonital striation strong. Epiproct shorter, tip rounded (Fig. 55). Nepal. *niger* n. sp.
9. Length of lateral lamella on posterior gonopod around two thirds of opisthomerite (Fig. 58). China: SE Tibet, India: Assam. *tibetanus* n. sp.
 - Length of lateral lamella subequal to opisthomerite. 10
10. „Beaks” of opisthomerite in situ directed caudad, parallel; shape of lateral lamella fold-like (Figs. 20–21). Large males usually with longer legs towards midbody. N. Burma. *inaequipes* ENGHOFF 1986
 - „Beaks” directed mesad, tips in situ touching each other. Lateral lamella very broad, end of opisthomerite short, "beak" heavy, broad (Fig. 42). India: Kashmir. *kashmirensis* n. sp.

Description of species

Anaulaciulus inaequipes ENGHOFF 1986

Figs. 19–24

1986 *Anaulaciulus inaequipes* ENGHOFF: *Steenstrupia* 12: 118, Figs 1–4.

Material: 2 ♂♂, 2 ♀♀, (paratypes, ZMUC), Burma: Upper Burma, Adung Valley, 28°15'N 94°40'E, 8000 ft a.s.l., 25. v.–10. vi. 1931; leg. Lord CRANBROOK & Capt. J. Kingdon WARD.

Remarks: The species was satisfactorily described (ENGHOFF 1986) except for some details, which achieved relative importance in respect of other members of the group, and are added (and illustrated) here.

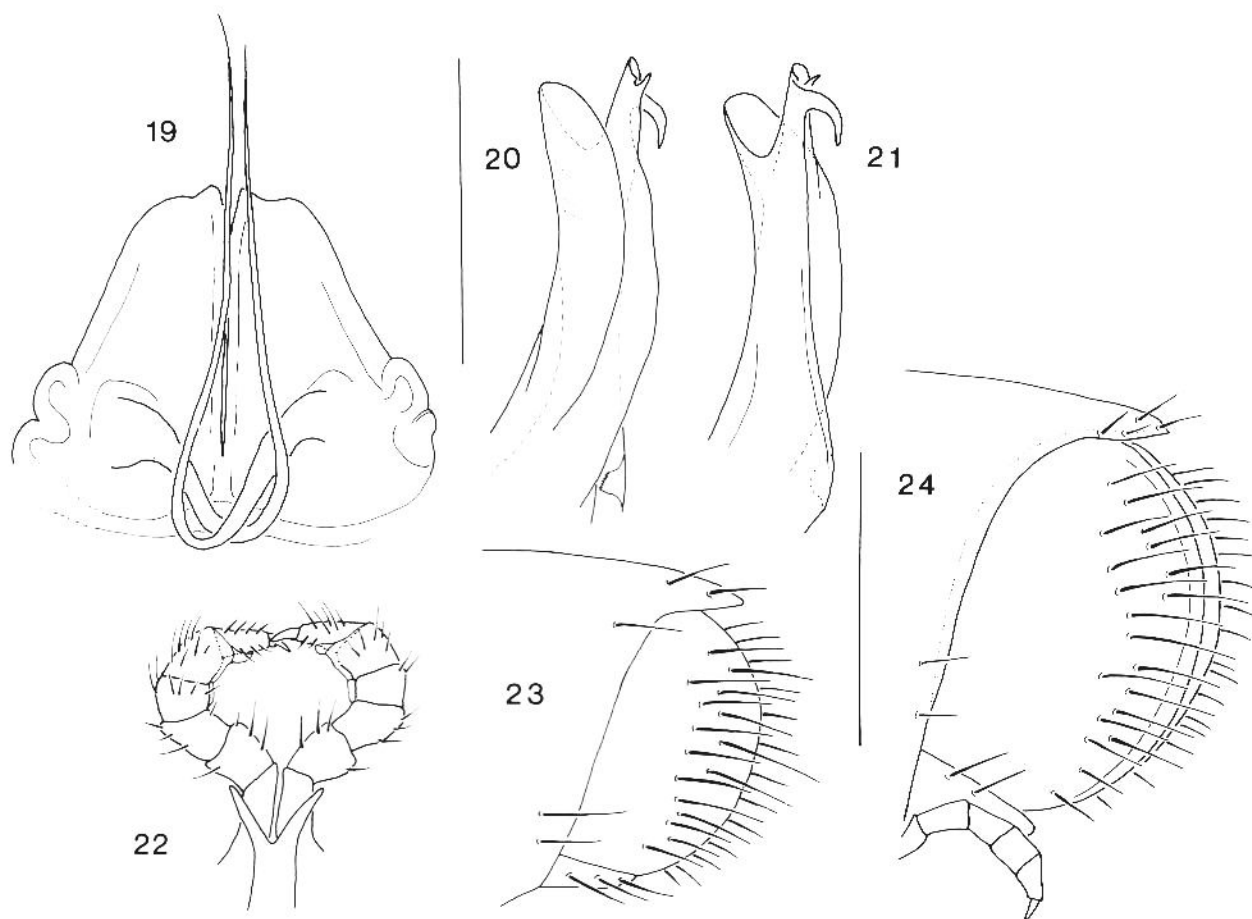
Though the shape of the promerite seems to have no specific value in the entire genus (see variations e.g., in MIKHALJOVA 1982, and also in *topali*, Figs. 65–66), an illustration of one of the paratype specimens may turn to be necessary. The strong rudiments of the telopodites (lateral side, caudal view, Fig. 19) were only mentioned as "humps" in the original description. Two different views of the left and right opisthomerites, respectively, are also given, for a better understanding of the foldlike lateral ("anterior" in ENGHOFF 1986) lamella, which is characteristically different from all the other group-members

(Figs. 20–21). The concave tip of opisthomerite provided with a small fingerlike process. The subapical pointed processes of the two opisthomerites ("beaks") in situ parallel, directed caudad; hairs on them could not have been observed in the only paratype specimen with gonopods. Penis illustrated together with the 2nd pair of legs, showing relative length of branches reaching the distal margin of 2nd coxae (Fig. 22).

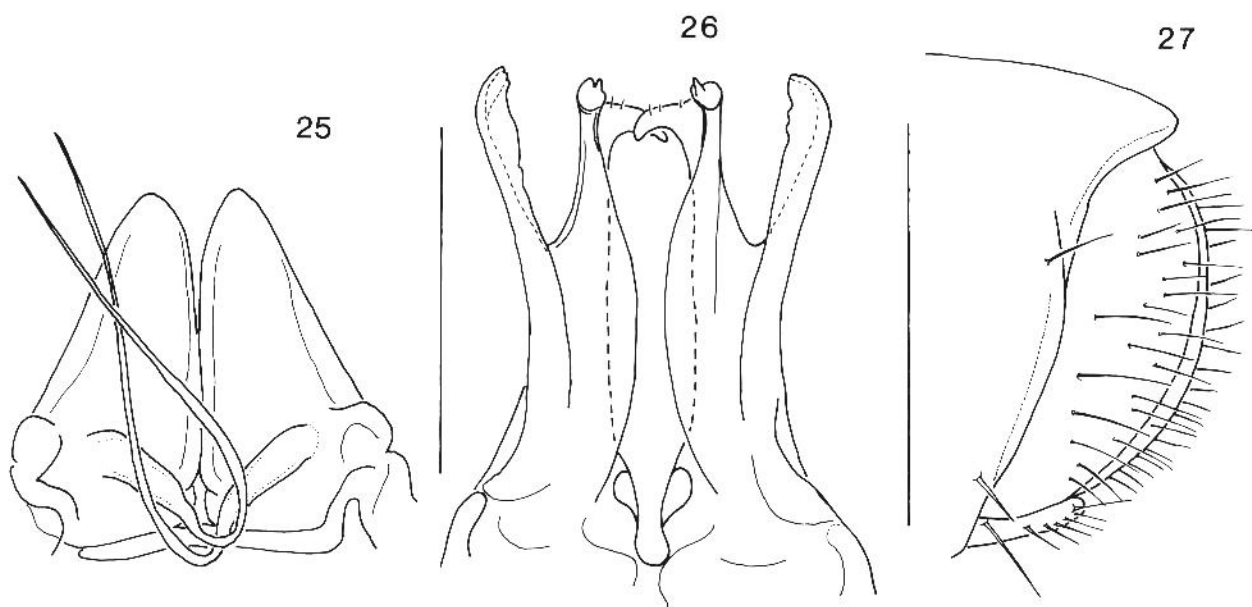
The shape of the telson is illustrated for the first time (Figs. 23–24), showing intraspecific difference between male and female: epiproct in males slightly longer and more pointed (its free length reaches one third of the length of the anal valves in male, only one fifth in female). This phenomenon seems to be present in every species of the *inaequipes*-group.

Description of new species

The species in the following are treated in alphabetical order. Features generally characterizing the entire group are not repeated here. Colouration, which seems to be an important factor in the *inaequipes*-group, is described based on specimens preserved in alcohol; hence with old samples more difficulties arose, and the characterization had to be based on other (including gonopod) structures.



Figs. 19–24. *Anaulaciulus inaequipes* ENGHOFF 1986. – 19) promerites, caudal view. – 20) left opisthomerite, frontomesal view. – 21) right opisthomerite, caudolateral view. – 22) second legpair with penis, caudal view. – 23) male body end. – 24) female body end. – Scales in Figs. 19–21: 0.5 mm, in Figs. 22–24: 1 mm.



Figs. 25–27. *Anaulaciulus acaudatus* n. sp. – 25) promerites, caudal view. – 26) opisthomerites, frontal view. – 27) male body end. – Scales in Figs. 25–26: 0.5 mm, in Fig. 27: 1 mm.

Anaulaciulus acaudatus n. sp.

Figs. 25–27

Holotype: ♂ (NSMT), India: West Sikkim, Kanchenjunga area, Dzongri, 3990 m, 17. IX. 1983; leg. S. AE, S.-I. UENO & Y. NISHIKAWA.

Paratypes: 2 ♂♂, 14 ♀♀ (1 ♂, 9 ♀♀: NSMT; 1 ♂, 1 ♀: TMB [slide prep. no. AN-111, 112, 113]; 1 ♀: ZMUC; 1 ♀: SMF 6830; 1 ♀: ZMMU; 1 ♀: MNHG), data as holotype.

Total material: 3 ♂♂, 14 ♀♀.

Derivatio nominis: The species has gained its name from the shape of the telson.

Diagnosis: The only species in the group with entirely missing epiproct. From its closest relative, *niger*, differs also by its larger size.

Description: Length 24 mm (♂♂), 18–27 mm (♀♀); height 1.6 mm (♂), 1.7–1.9 mm (♀♀); n.p.s. 49–51 (♂♂), 47–58 (♀♀).

Colouration: Body generally brown with pale traces of julid common pattern, prozonites greyish or bluish, metazonites transparent brown, head, collum, preanal ring and anal valves darker brown. Middorsal line sharp, black, present on both pro- and metazonites. Legs pale brown.

Head with 45–47 ocelli in a rounded eye field, length of antennae 98 % (♂), 90 % (♀) of body height. Meta-

zonal striation strong, ca. 8–10 striae in a quarter of vertical diameter, ozopores touching suture from behind. Preanal ring without dorsal projection, almost naught, with a few setae on epiproct and on subanal scale, anal valves densely pilose (Fig. 28). Length of legs 60 % (♂), 52 % (♀) of body height, leg slenderness 5.9 (♂) and 6.8 (♀).

Male gonopods: Promerites strongly tapering towards tip (Fig. 25). Lateral lamella of opisthomerite equal to or a bit longer than opisthomerite, without membranous “velum”, margin undulated, or slightly serrulated; “beaks” with only few hairs, broad, tips pointed (Fig. 26), in situ directed mesad, touching (or overlapping) each other.

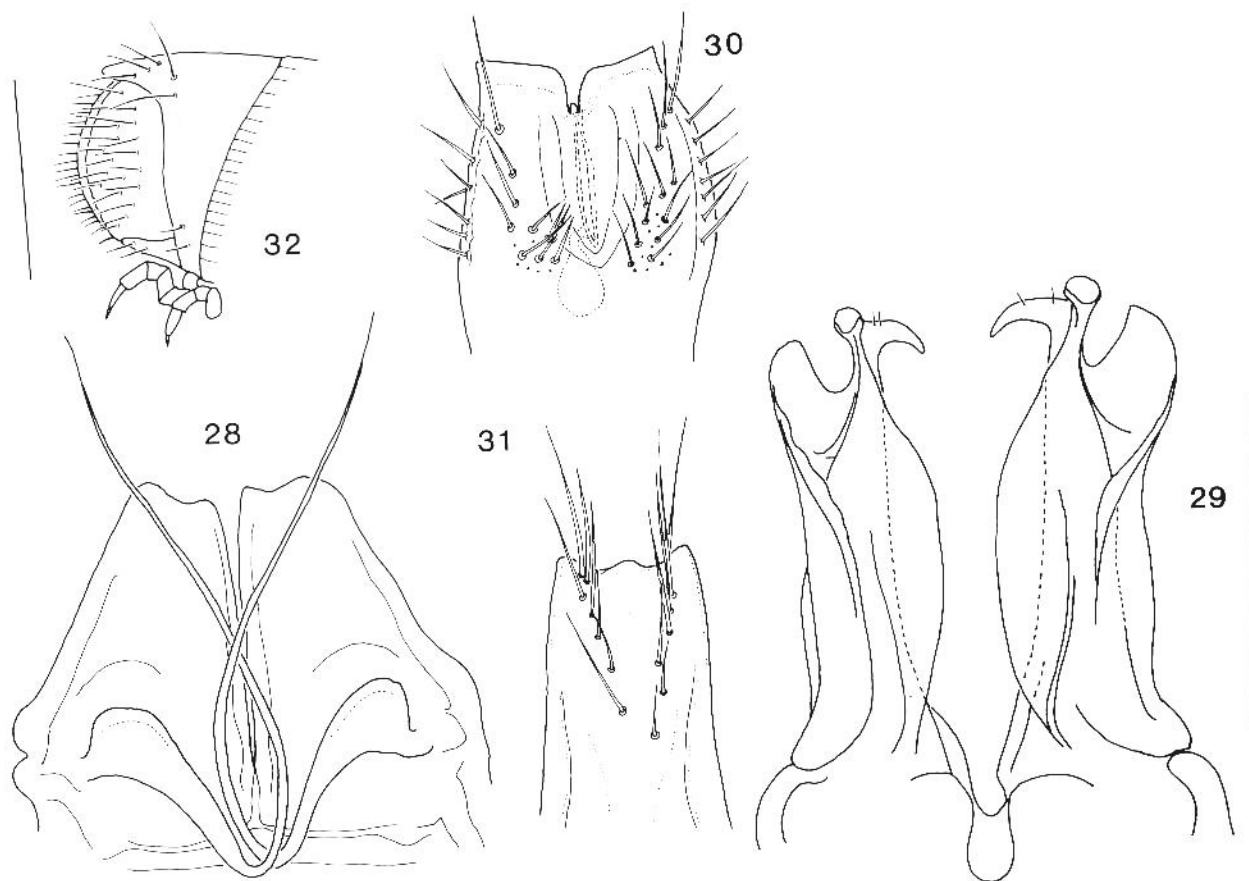
Female vulvae: Bursa with 32 setae, 7 on mesal and lateral sclerites together; ampulla sphaerical, apodematic tube long, spiralled. Operculum with a tiny median tooth, with 7–8 setae.

Distribution: India: Sikkim (Map 1).

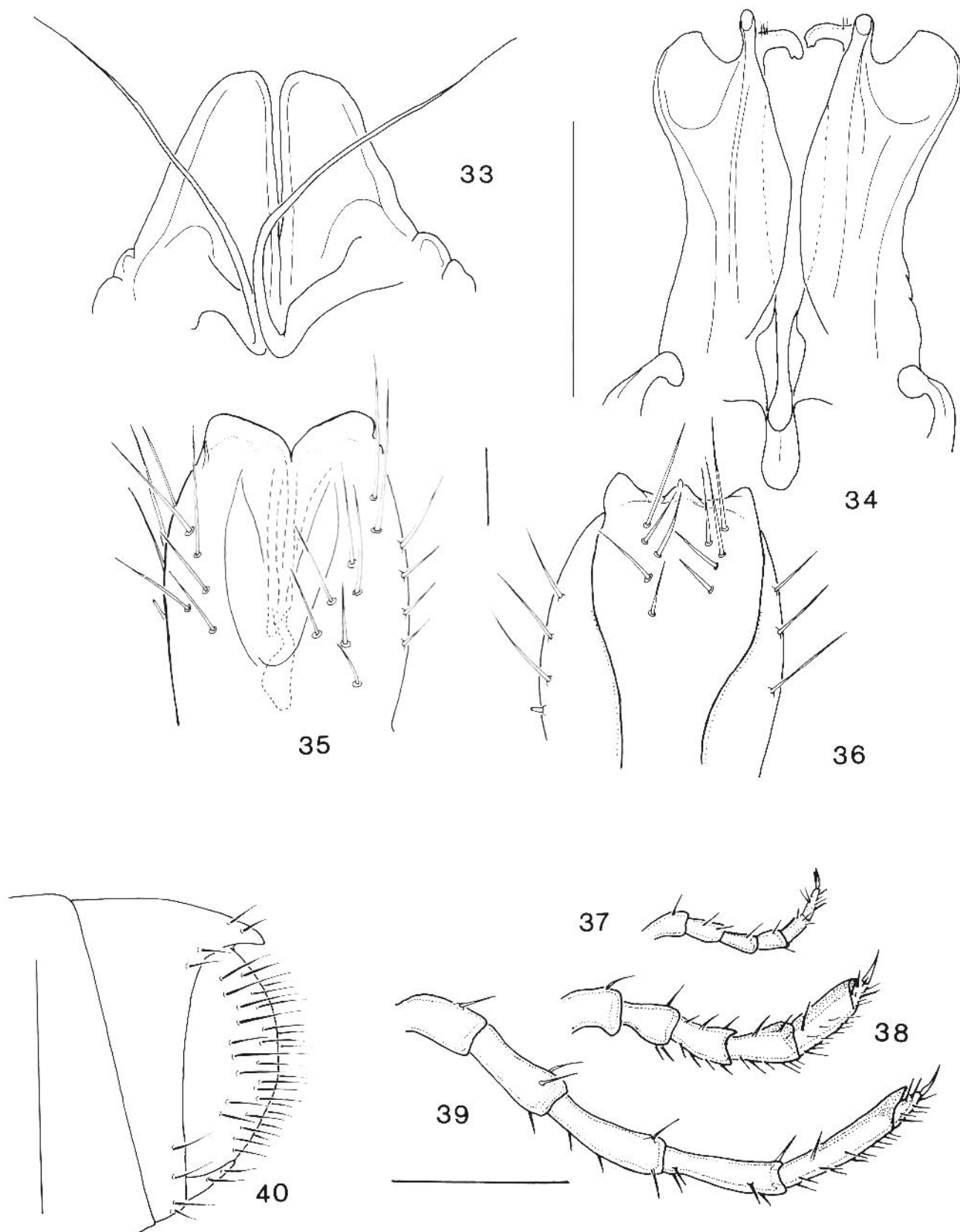
Anaulaciulus bilineatus n. sp.

Figs. 2–4, 6, 9, 11, 28–32

Holotype: ♂ (SMF 6832), Nepal: Dolpo Distr., Northern Dhaulagiri Himal, Ringmo on Lake Phoksumdo, 4000 m, forest clearing, close to timberline, 15. vi. 1973; leg. J. MARTENS.



Figs. 28–32. *Anaulaciulus bilineatus* n. sp. – 28) promerites, caudal view. – 29) opisthomerites, frontal view. – 30) right bursa, caudal view. – 31) right operculum, frontal view. – 32) male body end. – Scales in Figs. 28–31: 0.5 mm, in Fig. 32: 1 mm.



Figs. 33-40. *Anaulaciulus engboffi* n. sp. - 33) promerites, caudal view. - 34) opisthomerites, frontal view. - 35) right bursa, caudal view. - 36) left operculum + bursa, frontal view. - 37) right 17th leg of a female. - 38) right 8th leg of a male. - 39) right 25th leg of a male. - 40) female body end. - Scales in Figs. 33-34: 0.5 mm, in Figs. 35-36: 0.1 mm, in Figs. 37-40: 1 mm.

Paratypes: 1 ♂, 3 ♀♀ (1 ♂: TMB [slide prep. no. AN-51]; 3 ♀♀: SMF 6834), data as holotype. - 1 ♀ (SMF 6816), Nepal: Dolpo Distr., Ringmo on Lake Phoksumdo, 3600-3800 m, dry pine forest, v.-vi. 1970; leg. J. MARTENS. - 13 ♀♀ (9 ♀♀ SMF 6839; 1 ♀: TMB [slide prep. no. AN-52, 53]; 1 ♀: ZMUC; 1 ♀: MNIG; 1 ♀: ZMMU), same locality, 4000-4100 m, alpine meadows, 3.-4. vi. 1970; leg. J. MARTENS. - 2 ♀♀ (SMF 6841), same locality, 3700 m, 10.-15. vi. 1973; leg. J. MARTENS. - 3 ♂♂, 7 ♀♀ (2 ♂♂, 6 ♀♀: SMF 6843; 1 ♂: ZMUC [SEM prep.]; 1 ♀: TMB), Gompa near Tarakot, 3300-3400 m, *Picea-Betula* forest, 11.-16. v. 1970; leg. J. MARTENS. - 1 ♀ (SMF 6818), same locality, 2.-6. vi. 1973; leg. J. MARTENS. - 1 ♀ (SMF 6823), ascent to Pass Bagar La from Ringmo via Manduwa, 4300 m, 17. vi. 1973; leg. J. MARTENS.

Total material: 5 ♂♂, 28 ♀♀.

Derivatio nominis: The species is named after the characteristic dorsal colour pattern, i.e., a dark brown middorsal stripe between two pale yellowish stripes.

Diagnosis: Differs from other group-members by colouration.

Description: Length 21 mm (♂), 19-31 mm (♀♀); height 1.7 mm (♂), 1.7-2.2 mm (♀♀); n.p.s. 41 (♂), 44-58 (♀♀).

Colouration: Sides below ozopores dark brown, above pale greyish-yellowish, head dark brown with usual julid pattern, anterior margin of collum widely brown, preanal ring and anal valves brown. Middorsal stripe wide, dark brown, present on both pro- and metazonites, hence dorsal pattern formed by the middorsal line and two pale yellowish stripes. Legs marble brown.

Head with 28-30 ocelli in an irregular mass, length of antennae 132 % (♂), 98 % (♀) of body height. Metazonital striation strong, ca. 9 striae in a quarter of vertical diameter, ozopores behind suture. Preanal ring with very short dorsal projection, with a few setae on its margin, on epiproct and on subanal scale, anal valves densely pilose (Fig. 33). Length of legs 116 % (♂), 70 % (♀) of body height, leg slenderness 9.9 (♂) and 8.4 (♀). Large males with legs gradually increasing towards midbody.

Male gonopods: Promerites as in Fig. 28. Lateral lamella of opisthomerite subequal to opisthomerite, with broad membranous "velum", with entire margin; "head" of opisthomerite round; "beaks" with only few hairs, tips slender, pointed (Fig. 29), in situ directed mesad, touching (or overlapping) each other.

Female vulvae (Figs. 30-31): Bursa with 33-35 setae, 12-14 of which on mesal and lateral sclerites together; ampulla more-or-less spherical, apodemetic tube simple. Operculum narrow, with a small median cusp, with 12-14 setae.

Distribution: Nepal (Map 2).

Anaulaciulus engboffi n. sp.

Figs. 33-40

Holotype: ♂ (ZISP), China: Kansu, southern wall of the pass Latschi-san, Karyn Valley, 4. v. 1885; leg. G. N. POTANIN.

Paratypes: 12 ♂♂, 12 ♀♀ (8 ♂♂, 7 ♀♀: ZISP; 1 ♂, 1 ♀: TMB [slide prep. no. AN-61, 62, 63]; 1 ♂, 1 ♀: ZMMU; 1 ♂, 1 ♀: ZMUC; 1 ♂, 1 ♀: SMF 6825; 1 ♀: MNHG), data as holotype.

Total material: 13 ♂♂, 12 ♀♀.

Derivatio nominis: The species is named in honour of the outstanding diplopodologist, Dr. Henrik ENGHOFF, who described the first species of this group (*inaequipes*) and also anticipated the present one (ENGHOFF 1986).

Diagnosis: Differs from other group-members by the shape of the epiproct (pointed downward) and gonopod conformation.

Description: Length 19 mm (♂), 25 mm (♀); height 1.6-2.2 mm (♂♂), 2.1 mm (♀); n.p.s. 41 (♂), 43 (♀).

Colouration: Almost uniformly amber coloured, most probably due to 100 years preservation in alcohol. A fade, thin middorsal line can be traced both on pro- and metazonites. Legs brown.

Head with 43 (♂) ocelli in a triangular eye field, length of antenna 55 % (♀) of body height. Collum in large males especially wide, rectangular from dorsal view, antero-lateral corner with dense, short striae. Metazonital striation fine, dense, sharp, 13-18 striae in a quarter of vertical diameter, ozopores behind suture. Preanal ring with short dorsal projection pointed downward, with a few setae on its margin, on epiproct and on subanal scale, anal valves densely pilose (Fig. 40). Length of legs 158 % (♂), 53 % (♀) of body height, leg slenderness 15.1 (♂) and 7.9 (♀). Large males with legs gradually increasing in length towards midbody (Figs. 37-39).

Male gonopods: Promerites tapering towards tip (Fig. 33). Lateral lamella of posterior gonopod subequal to opisthomerite, with very broad, rounded, membranous "velum", with entire margin, connection to opisthomerite very high; "head" of opisthomerite round, concave; "beaks" with only few hairs, tips blunt, sometimes with incisions (Fig. 34), in situ directed caudad.

Female vulvae (Figs. 35-36): Bursa with 21-23 setae, only 7-8 on lateral and mesal sclerites; ampulla elongated, apodemetic tube simple. Operculum with strong median "hump" with a small tooth, with 10-12 setae.

Distribution: China, Kansu (Map 1).

Anaulaciulus kashmirensis n. sp.

Figs. 41-46

Holotype: ♂ (SMF 6842, slide prep. no. AN-31), India: Kashmir, Sonamarg, Nichinai Valley, 3100-3200 m, mixed forest, also broadleaved trees, moist, 9. vi. 1976; leg. J. MARTENS.

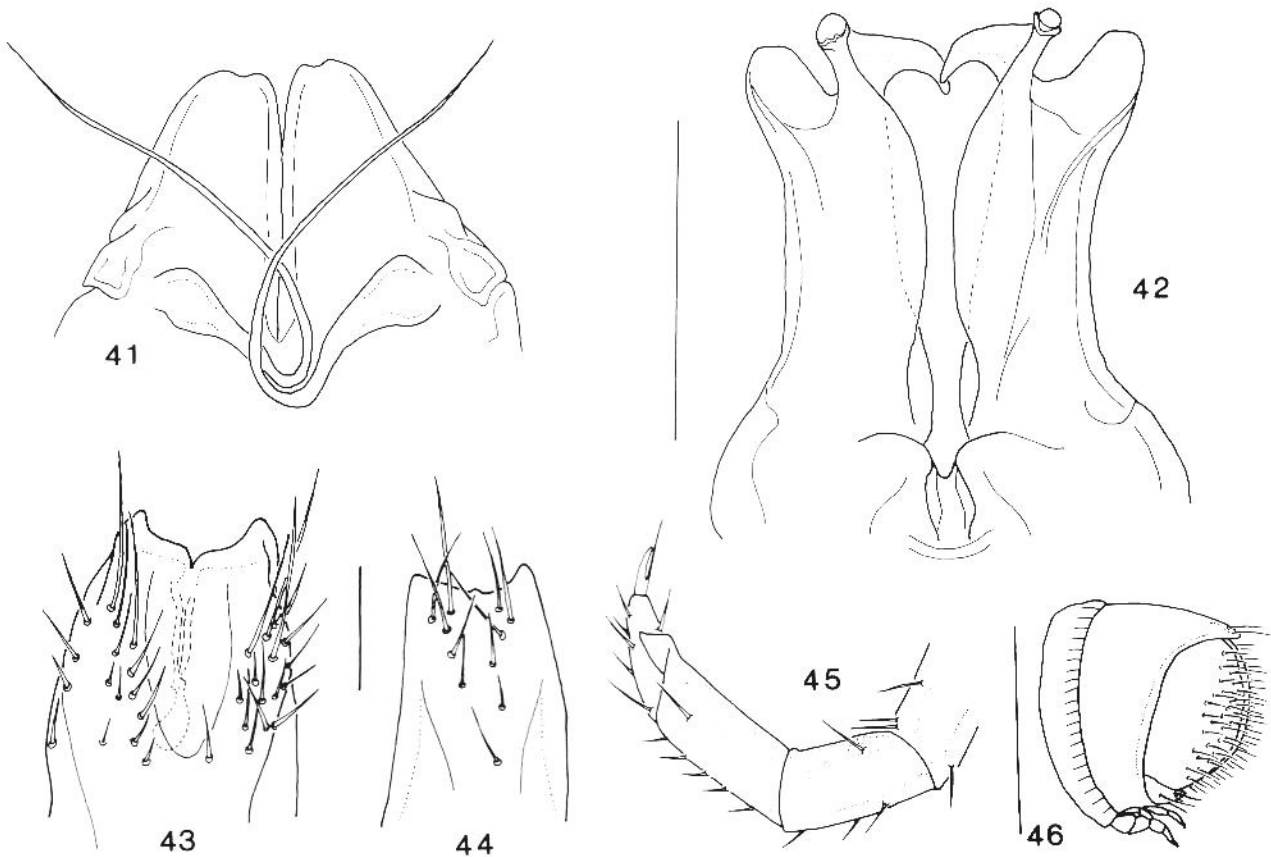
Paratypes: 2 ♀♀ (SMF 6833, slide prep. no. AN-32, 33), data as holotype.

Total material: 1 ♂, 2 ♀♀.

Derivatio nominis: The species is named after the type locality.

Diagnosis: Differs from group-members by the combination of characters: colouration, shape of epiproct, and gonopod conformation (broad lateral lamella, broad "beak").

Description: Length 27 mm (♂), 31 mm (♀); height 1.7 mm (♂), 1.8 mm (♀); n.p.s. 54 (♂), 47 (♀).



Figs. 41–46. *Anaulaciulus kashmirensis* n. sp. – 41) promerites, caudal view. – 42) opisthomerites, frontal view. – 43) right bursa, caudal view. – 44) right operculum, frontal view. – 45) left 28th leg (postfemur, tibia, tarsus) of a male. – 46) female body end. – Scales in Figs. 41–42, 45: 0.5 mm, in Figs. 43–44: 0.2 mm, in Fig. 46: 1 mm.

Colouration: Uniformly brown, greyish-brown. Collum light marble brown, anterior margin darker. Middorsal line on body segments thin, black, only on prozonites, on metazonites missing. Preanal ring dark brown, anal valves whitish. Legs marble brown.

Head with 27 (♂) ocelli in an irregular eye field, length of antennae 111 % (♂), 95 % (♀) of body height. Collum and prozonites smooth, metazonital striation in male strong, in females less visible, ca. 8 striae in a quarter of vertical diameter, ozopores just behind suture. Preanal ring with a very short dorsal projection, epiproct and sub-anal scale with only a few setae, anal valves densely pilose (Fig. 46). Length of legs 88 % (♂), 56 % (♀) of body height, leg slenderness 9.1 (♂) and 7.6 (♀).

Male gonopods: Promerites as in Fig. 41. Lateral lamella of posterior gonopod subequal to opisthomerite, with very broad, rounded, membranous “velum”, with entire margin, connection to opisthomerite high; “head” of opisthomerite round, concave; “beaks” without hairs, broad, pointed (Fig. 42).

Female vulvae (Figs. 43–44): Bursa with 27–30 setae, 9–11 on lateral and mesal sclerites; ampulla slightly elongated, apodemetic tube simple. Operculum with a weak median cusp, with 13–14 setae on frontal side.

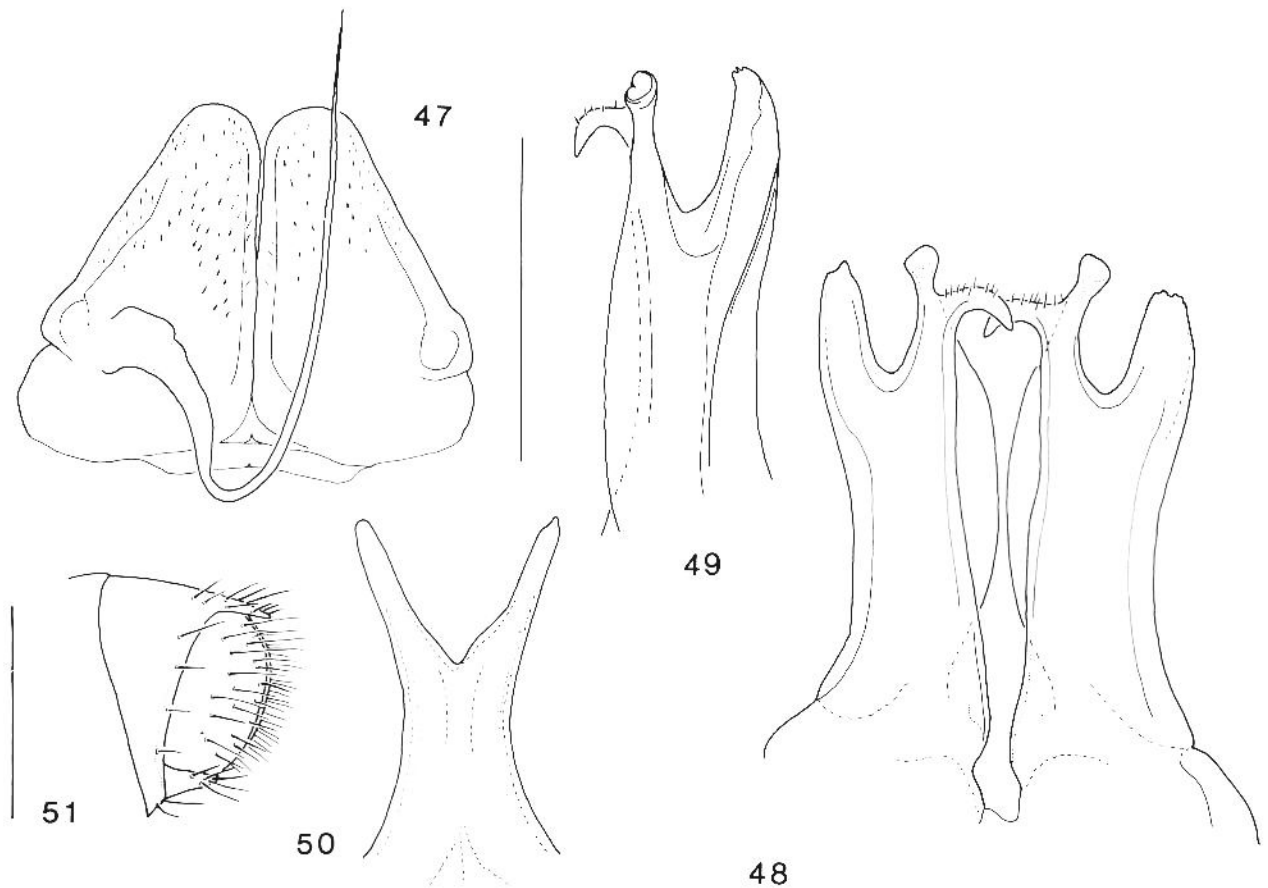
Distribution: India: Kashmir (Map 1).

Anaulaciulus nepalensis n. sp.

Figs. 1, 3, 7, 10, 47–51

Holotype: ♂ (SMF 6828), Nepal: Mustang Distr., Thaksang above Tukche, 3150 m, *Pinus excelsa*-*Abies* forest, forest clearing, BERLESE sample, 26.–29. IV. 1980; leg. J. MARTENS & A. AUSOBSKY.

Paratypes: 1 ♀, 2 juvs (1 ♀: TMB [slide prep. no. AN-71]; 2 juvs: SMF 6826), data as holotype. – 16 ♂♂, 5 ♀♀, 19 juvs (12 ♂♂, 1 ♀, 19 juvs: SMF 6844; 1 ♂, 1 ♀: TMB [slide prep. no. AN-72, 73]; 1 ♂, 1 ♀: ZMUC [SEM prep.]; 1 ♂, 1 ♀: MNHG; 1 ♂, 1 ♀: ZMMU), Nepal: Mustang Distr., Thaksang, 3150–3400 m, clearing, 26.–29. IV. 1980; leg. J. MARTENS & A. AUSOBSKY. – 1 ♀, 33 juvs (SMF 6840), same locality and date, 3150 m, *Abies-Betula* forest, BERLESE sample; leg. J. MARTENS & A. AUSOBSKY. – 1 ♂, 1 juv. ♀ (SMF 6821), Mustang Distr., on the way from Tukche to Thaksang, 2650–2950 m, *Cupressus-Pinus*, 26. IV. 1980; leg. J. MARTENS & A. AUSOBSKY. – 2 ♂♂, 1 ♀ (1 ♂, 1 ♀: SMF; 1 ♂: ZMUC), Mustang Distr., Thaksang above Tukche, clearing in pine forest, 3100 m, 17. II.–11. III. 1974; leg. J. MARTENS. – 1 ♀, 2 juvs (SMF 6817), same locality, Thaksang above Tukche, 3100 m, clearing in pine forest, XI. 1969; leg. J. MARTENS. – 3 ♀♀ (2 ♀♀: SMF; 1 ♀: ZMUC), same locality, 3100–3400 m, mixed forest, 5.–10. VIII. 1970; leg. J. MARTENS. – 1 ♀ (SMF 6819), same locality, 3150 m, 2.–4. VII. 1973; leg. J. MARTENS. – 2 ♂♂, 1 ♀ (SMF 6824), same locality, ascent to Thaksang, 2700–2900 m, 1. VII. 1973; leg. J. MARTENS. –



Figs. 47–51. *Anaulaciulus nepalensis* n. sp. – 47) promerites, caudal view. – 48) opisthomerites, caudal view. – 49) right opisthomerite, frontal view. – 50) penis, caudal view. – 51) male body end. – Scales in Figs. 47–50: 0.5 mm, in Fig. 51: 1 mm.

9 ♂♂, 8 ♀♀ (6 ♂♂, 5 ♀♀: SMF 6837; 1 ♂, 1 ♀: TMB; 1 ♂, 1 ♀: NSMT; 1 ♂, 1 ♀: BMNH), Myagdi Distr., Western Dhaulagiri Himal, Thankur, 3350 m, pine-fir forest, 26.–27. v. 1970; leg. J. MARTENS. – 2 ♀♀, 27 juvs (1 ♀, 27 juvs: SMF 6829; 1 ♀: TMB [slide prep. no. AN-94, 95]), Nepal: Sankhua Sabha Distr., above Pahakhola, 2600–2800 m, *Quercus semecarpifolia*, *Rhododendron*, 31. v.–3. vi. 1988; leg. J. MARTENS & W. SCHWALLER.

Total material: 31 ♂♂, 24 ♀♀, 65 juvs.

Derivatio nominis: The species is named after the country of its origin, from where it was the most abundant species in the present samples.

Diagnosis: Largest species in the group. Differs from others by colouration, shape of epiproct and gonopod structure.

Description: Length 22–30 mm (♂♂), 16–31 mm (♀♀); height 1.7–2.3 mm (♂♂), 1.5–2.6 mm (♀♀); n.p.s. 37–59 (♂♂), 34–55 (♀♀).

Colouration: Uniformly brownish, greyish-brown or bluish-grey, primitive julid pattern fade, hardly visible, head and preanal ring darker, anal valves light brown. Middorsal stripe very thin but sharp, black, continuous. Legs dark marble brown, in females a bit lighter.

Head with 25–27 (♂♂), 37–46 (♀♀) ocelli in a rectangular eye, length of antennae 98 % (♂♂), 88–99 % (♀♀) of body height. Metazonital striation strong, 9–12

striae in a quarter of vertical diameter, ozopores clearly visible, behind suture, which is slightly bent frontad at ozopores. Preanal ring with slender, pointed dorsal projection, with a few setae on its margin, epiproct, subanal scale and anal valves densely pilose (Fig. 51). Length of legs 72 % (♂♂), 57–68 % (♀♀) of body height, leg slenderness 7.6 (♂♂) and 7.5–7.7 (♀♀). In a few large males midbody legs longer.

Male gonopods: Promerites with tip rounded (Fig. 47). Lateral lamella of opisthomerite long, subequal to opisthomerite, its shape not very broad, with undulate margin; “head” of opisthomerite long, round; “beaks” with hairs, tips pointed (Figs. 48–49).

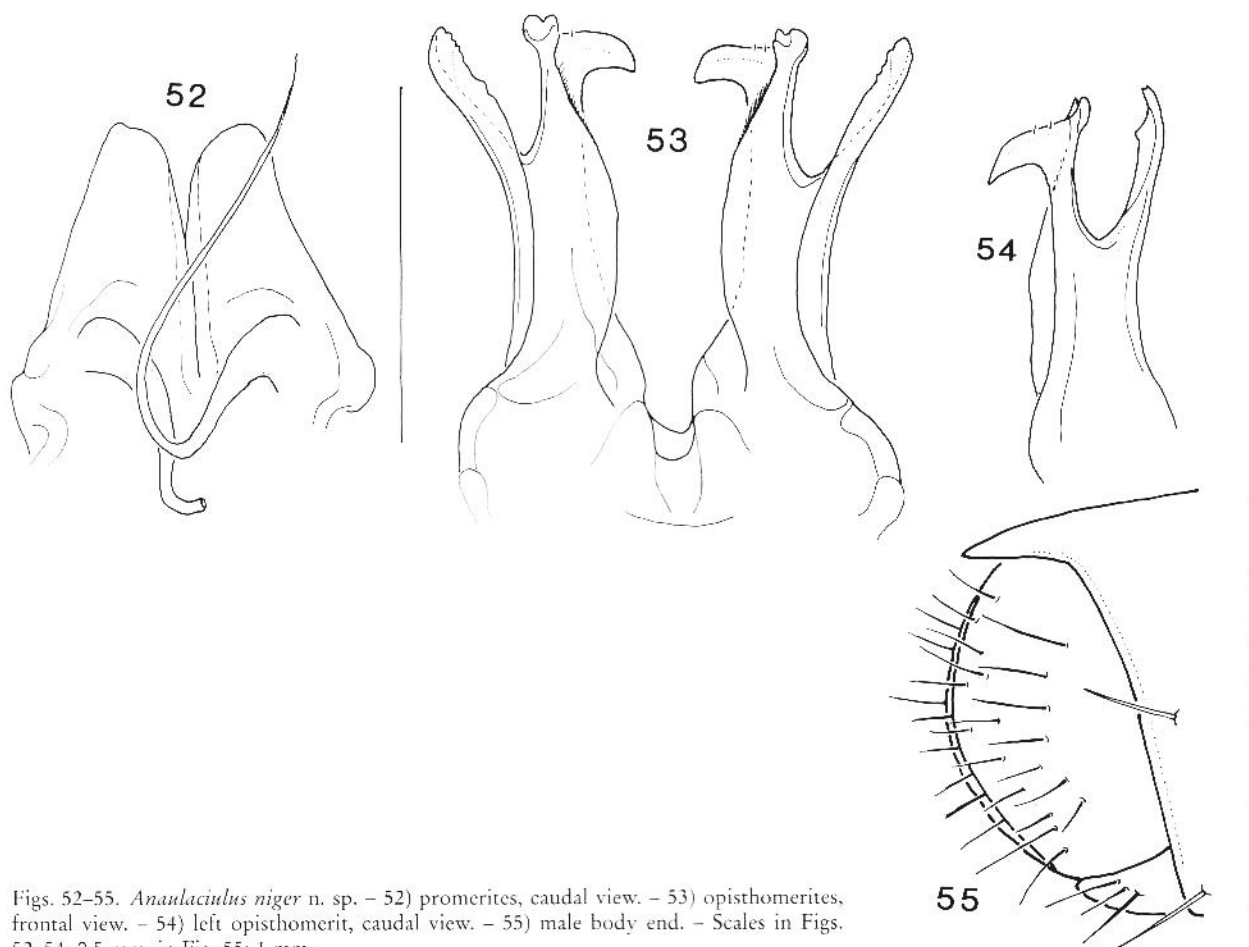
Female vulvae: Bursa with 26–27 setae, 8–9 on lateral and mesal sclerites; ampulla spherical (as in Fig. 30), apodemetic tube short, simple. Operculum with a median cusp, with 13 setae on frontal side.

Distribution: Nepal (Map 2).

Anaulaciulus niger n. sp.

Figs. 52–55

Holotype: ♂ (SMF 6835), Nepal: Taplejung Distr., Pass Anda Deorali, between Simbua Khola and Gunsua Khola, 4250–4500 m, alpine meadows, 9. ix. 1983; leg. J. MARTENS & B. DAAMS.



Figs. 52–55. *Anaulaculius niger* n. sp. – 52) promerites, caudal view. – 53) opisthomerites, frontal view. – 54) left opisthomerite, caudal view. – 55) male body end. – Scales in Figs. 52–54: 0.5 mm, in Fig. 55: 1 mm.

Paratypes: 1 ♂, 9 ♀♀, 2 juvs (1 ♂, 7 ♀♀, 2 juvs: SMF 6831; 1 ♀: TMB [slide prep. no. AN-82, 83]; 1 ♀: MNHG), data as holotype. – 1 ♂, 1 ♀ (1 ♂: TMB [slide prep. no. AN-81]; 1 ♀: SMF 6836), Taplejung Distr., S Gunsa, 4270 m, alpine meadows, dwarf bushes, rock debris, 10. ix. 1983; leg. J. MARTENS & B. DAAMS. – 1 ♂ (SMF 6822), Gorkha Distr., Chuling Khola, 3000–3400 m, *Abies-Quercus*, 3. viii. 1983; leg. J. MARTENS & W. SCHAWALLER. – 2 ♂♂, 2 ♀♀ (1 ♂, 1 ♀: SMF 6827; 1 ♂: ZMUC; 1 ♀: ZMMU), Gorkha Distr., SW Rupina La, Tabruk Kharka, 4000 m, 7.–8. viii. 1983; leg. J. MARTENS & W. SCHAWALLER. – 1 ♂, 1 ♀, (SMF 6838, slide prep. no. AN-91, 92, 93), Nepal: Sankhua Sabha Distr., above Pahakhola, 2600–2800 m, *Quercus semecarpifolia*, *Rhododendron*, 31. v.–3. vi. 1988; leg. J. MARTENS & W. SCHAWALLER.

Total material: 7 ♂♂, 13 ♀♀, 2 juvs.

Derivatio nominis: The species is named after its uniform blackish body colour.

Diagnosis: Smallest species in the group. Differs from others by colouration and gonopod structure (lateral lamella of opisthomerite very slender).

Description: Length 16–18 mm (♂♂), 13–23 mm (♀♀); height 1.0–1.3 mm (♂♂), 1.1–1.5 mm (♀♀); n.p.s. 36–50 (♂♂), 39–55 (♀♀).

Colouration: Uniformly dark brownish, blackish-brown, primitive julid pattern very dark. Middorsal stripe

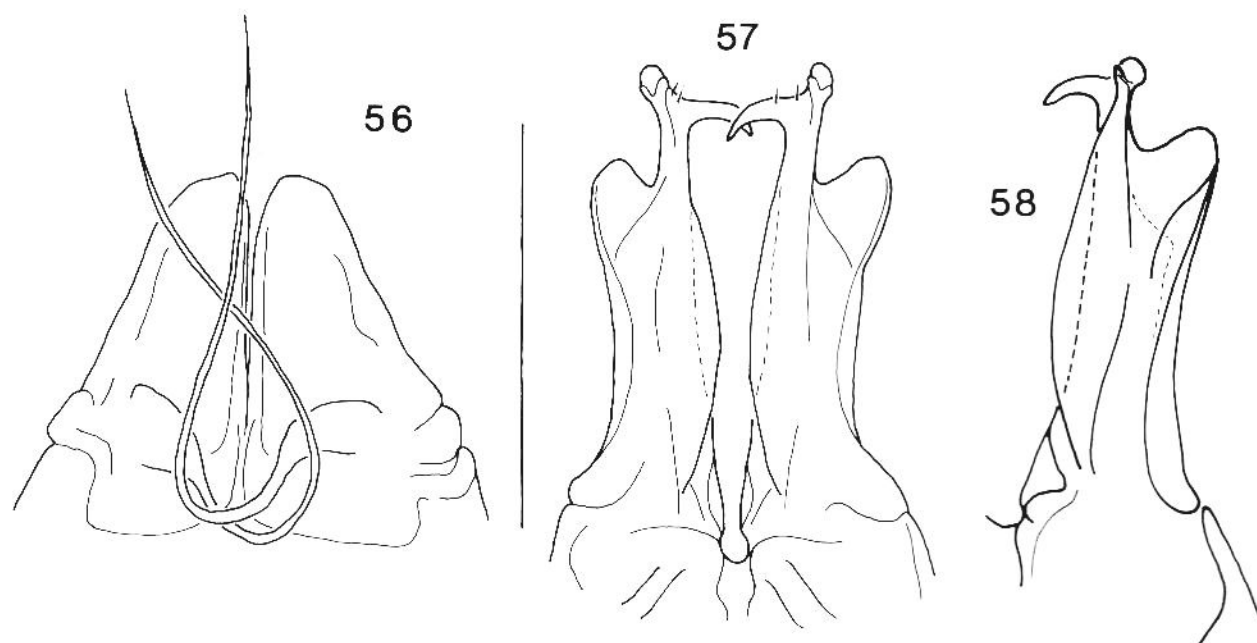
very thin, black, sometimes weak. Legs light marble brown, in females whitish.

Head with 22–29 (♂♂), 30–37 (♀♀) ocelli in a rounded-triangular eye, length of antennae 101–110 % (♂♂), 106 % (♀♀) of body height. Metazonal striation strong, 9–10 striae in a quarter of vertical diameter, ozopores behind suture. Preanal ring with short dorsal projection, with several setae on its margin; epiproct, subanal scale moderately, anal valves densely pilose (Fig. 55). Length of legs 59–79 % (♂♂), 53–78 % (♀♀) of body height, leg slenderness 6.0–6.2 (♂♂) and 5.7–6.8 (♀♀).

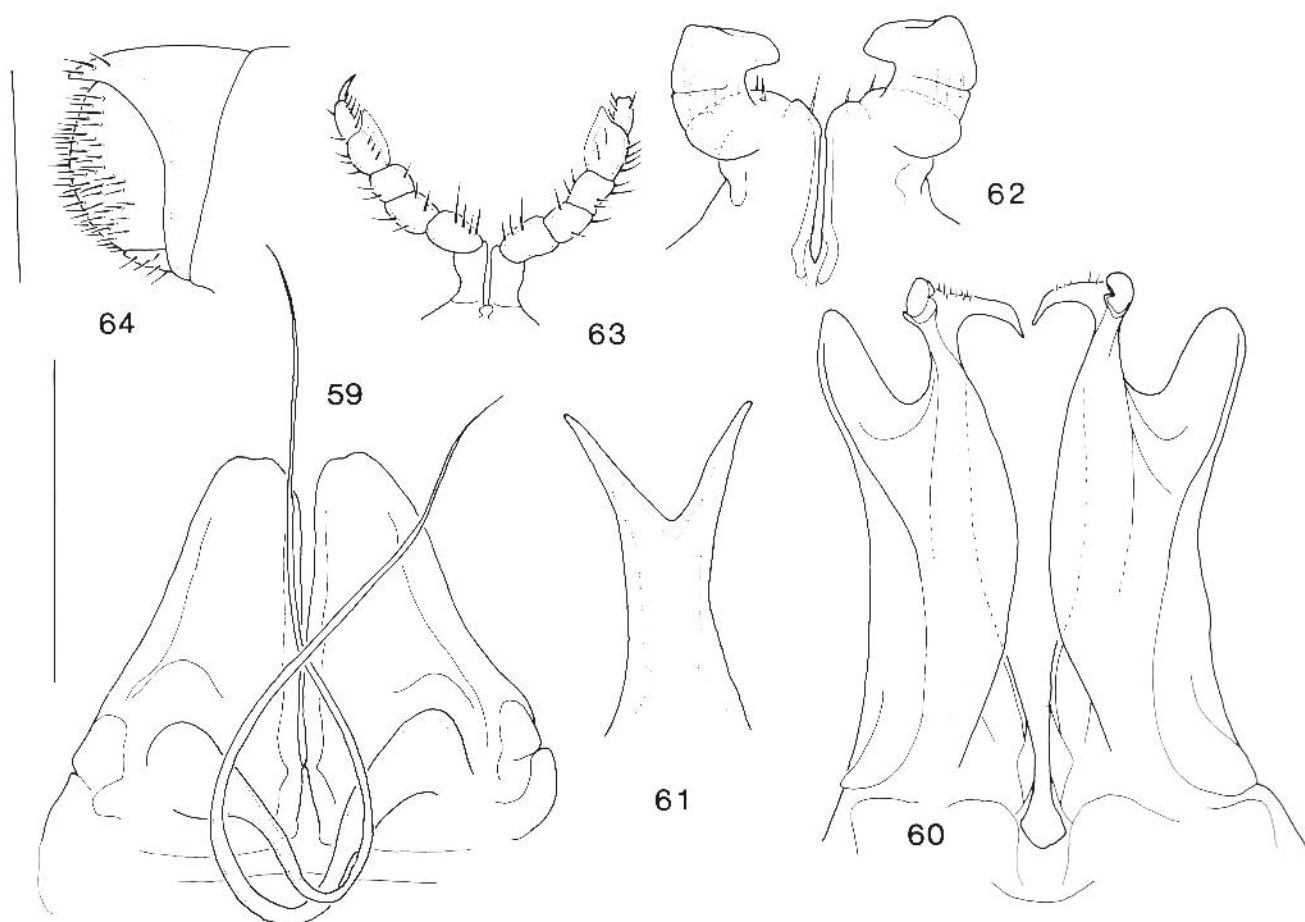
Male gonopods: Promerites slender (Fig. 52). Lateral lamella of opisthomerite long, subequal to opisthomerite, from which widely separated, its shape very slender, almost without any membranous lamella, only with sclerotized support, with undulate or slightly serrulate margin; “head” of opisthomerite short, concave; “beaks” very broad, tips pointed, only with a few hairs (Figs. 53–54). Median lamella subapically with fine hairs below its margin (not in every specimen).

Female vulvae: Bursa with 17–19 setae, 5–7 on lateral and mesal sclerites; ampulla spherical, apodematic tube longer, spiralled. Operculum with a small median “tooth”, with only 6–7 setae on frontal side.

Distribution: Nepal (Map 2).



Figs. 56–57. *Anaulaciulus pakistanus* n. sp. – 56) promerites, caudal view. – 57) opisthomerites, frontal view. – Scales 0.5 mm.
 Figs. 58. *Anaulaciulus tibetanus* n. sp., right opisthomerite, frontal view. – Scale 0.5 mm.



Figs. 59–64. *Anaulaciulus tigris* n. sp. – 59) promerites, caudal view. – 60) opisthomerites, frontal view. – 61) penis, caudal view. – 62) male first legpair, caudal view. – 63) male second legpair, caudal view. – 64) female body end. – Scales in Figs. 59–62: 0.5 mm, in Figs. 63–64: 1 mm.

Anaulaciulus pakistanus n. sp.

Figs. 56–57

Holotype: ♂ (MHNG), Pakistan: Swat, Malam Jabba, 2500–2600 m, Abies forest, sifted leaves and mosses, 18. v. 1983; leg. C. BESUCHET & I. LÖBL.

Paratypes: 1 ♂ (TMB, slide prep. no. AN-21), data as holotype. – 1 ♀ (MHNG, slide prep. no. AN-22, 23), Swat, above Utrot, 2600 m, wet meadow, some rotten wood, mosses, 13. v. 1983; leg. C. BESUCHET & I. LÖBL. – 1 ♂ (MHNG), same locality, 2500–2600 m, Abies and Cedrus forest, rotten Abies log, 14. v. 1983; leg. C. BESUCHET & I. LÖBL.

Total material: 3 ♂♂, 1 ♀.

Derivatio nominis: The species is named after the country of origin.

Diagnosis: Differs from other group-members by colouration and by the short lateral lamina on the opisthomerite. Closest relative *tigris*, from which it differs by middorsal stripe pattern and gonopod conformation.

Description: Length 19–21 mm (♂♂, slightly stretched), 12 mm (♀); height 1.3–1.4 mm (♂♂), 1.3 (♀); n.p.s. 37–43 (♂♂), 33 (♀).

Colouration: Yellowish orange-yellow, with brown pattern on prozonites, head and penultimate segments chestnut brown, anal valves light yellow or pale yellowish brown. Middorsal stripe narrow, present only on prozonites; the transverse bands, provided by the brown prozonites and yellow metazonites along the body, thus more emphasized. Legs light brown or whitish.

Head with 19–21 (♂♂), 18 (♀) ocelli per eye, length of antennae 105 % (♂), 107 % (♀) of body height. Metazonital striation weak, hardly visible, ozopores small, hidden, behind or in suture. Preanal ring with short dorsal projection, subanal scale with a few setae, anal valves densely pilose. Length of legs 54 % (♂), 52 % (♀) of body height, leg slenderness 7.2 (♂) and 5.8 (♀).

Male gonopods: Promerites Fig. 56. Lateral lamella of opisthomerite short, a quarter shorter than the opisthomerite, its connection to the opisthomerite with a shallow incision, with entire margin; “head” of opisthomerite round, expanded; “beaks” with a few hair, tips slender, pointed (Fig. 57).

Female vulvae: Bursa with 21–24 setae, 8–9 on lateral and mesal sclerites; ampulla slightly elongated (as in Fig. 43), apodemetic tube simple. Operculum with a weak median cusp, with only 6 setae.

Distribution: Northern Pakistan (Map 1).

Anaulaciulus tibetanus n. sp.

Fig. 58

Holotype: ♂ (BMNH 1938.7.19.81–82., slide prep. no. AN-121), China: East Tibet, valley of Dü Chu, vii. 1936; leg. R. KAULBECK.

Paratypes: 1 ♀ (TMB, slide prep. no. AN-122, 123), data as holotype. – 1 ♀ (BMNH 1932.10.15.149), India: Assam, 28° 25' N 94° 55' E, 11 000 ft a.s.l., 20. ix. 1931; leg. LORD CRANBROOK & Capt. J. Kingdon WARD (according to the original label “China: Southeast Tibet”, but the geographical co-ordinates presently locates it as stated above).

Total material: 1 ♂, 2 ♀♀.

Derivatio nominis: The species is named after the region from where it is originated.

Diagnosis: Differs from group-members by gonopod conformation (short and broad lateral lamina on opisthomerite). Closest relative by gonopods *pakistanus*, from which it differs by colouration.

Description: Length 24 mm (♂), 28 mm (♀♀); height 1.4 mm (♂), 1.7 mm (♀); n.p.s. 44 (♂), 46 (♀).

Colouration: Original colour completely lost due to preservation in alcohol. Present colour uniformly pale yellow, remnants of julid pattern on head, and traces of a thin, continuous middorsal line. Legs whitish.

Head with 35 (♂), 23 (♀) ocelli per eye in a rounded, small field, antennae broken on all three specimens. Frontal setae missing on all specimens, but probably present in the species. Metazonites almost smooth, very finely striated, shining like silk; ozopores small, hardly visible, behind suture. Preanal ring with broad dorsal projection, subanal scale with a few setae, anal valves with traces of dense pilosity. Length of legs 97 % (♂), 62 % (♀) of body height, leg slenderness 8.9 (♂) and 7.8 (♀).

Male gonopods: Promerites as in Fig. 59. Lateral lamella of opisthomerite very short, widely connected to opisthomerite, broad “velum” with entire margin, sclerotized support short, weak; “head” of opisthomerite short, round, concave; “beaks” very slender, slightly curved downwards, pointed (Fig. 58).

Female vulvae: Bursa with 22–23 setae, 7 on lateral and mesal sclerites; ampulla spherical, apodemetic tube longer, curved and coiled. Operculum with a weak median cusp, with 8 setae on frontal side.

Distribution: China: SE Tibet and the neighbouring region in India: Assam (Map 1).

Anaulaciulus tigris n. sp.

Figs. 5, 12, 59–64

Holotype: ♂ (MHNG), Pakistan: Swat, above Miandam, 2400–2500 m, Abies forest, under stones, 17. v. 1983; leg. C. BESUCHET & I. LÖBL.

Paratypes: 2 ♂♂ (1 ♂: TMB [slide prep. no. AN-13]; 1 ♂: ZMUC [SEM prep.]), data as holotype. – 1 ♂ (MHNG), same locality, sifted leaves and mosses. – 1 ♀ (MHNG, slide prep. no. AN-11, 12), same locality, 2300 m, under stones near snow and near stream, 10. v. 1983; leg. C. BESUCHET & I. LÖBL.

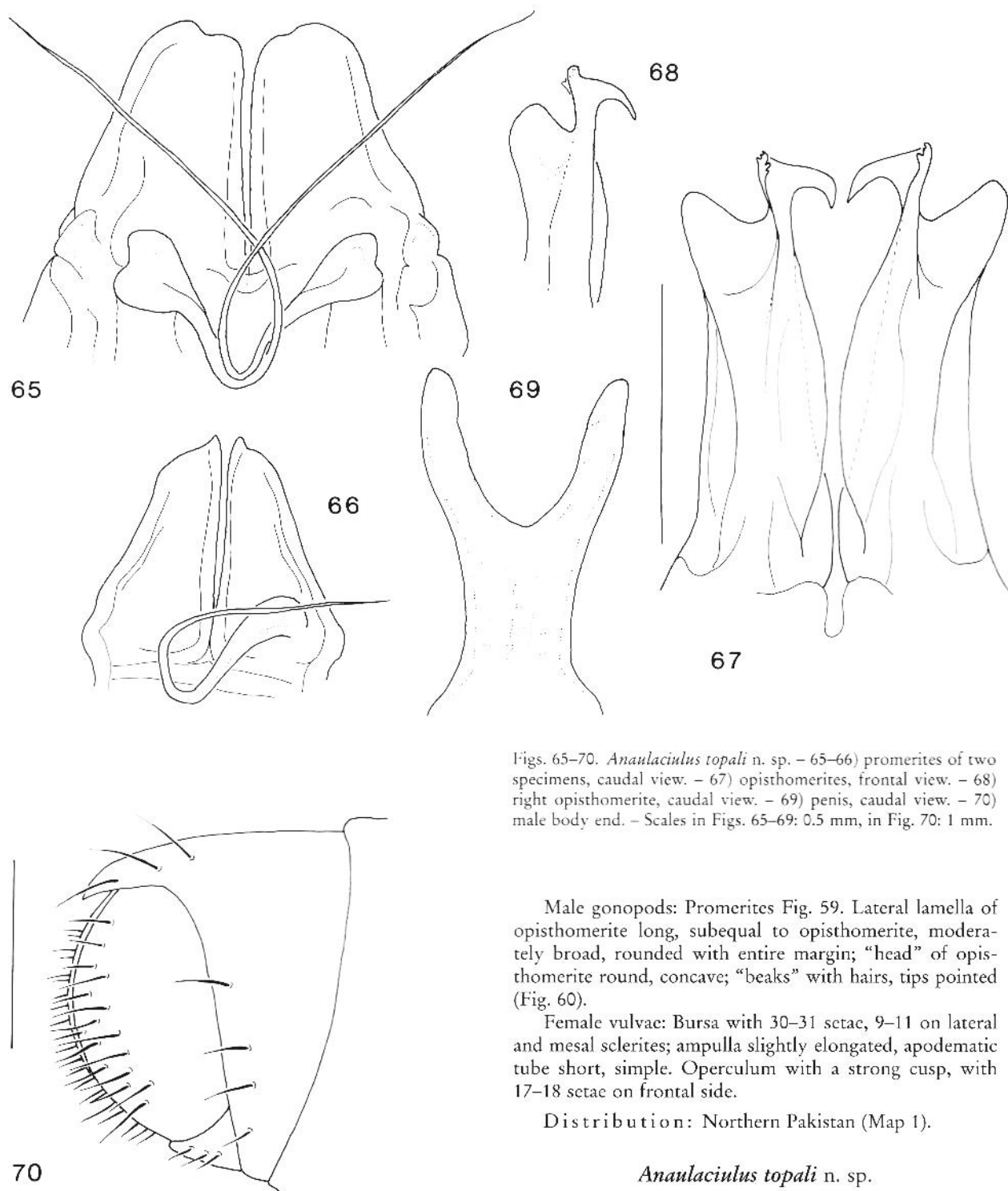
Total material: 4 ♂♂, 1 ♀.

Derivatio nominis: The species is named after its characteristic colour pattern, i.e., the dark brown spots and stripes on a light orange-yellow background.

Diagnosis: Differs from other group-members by colouration. Closest relative *pakistanus*, from which it differs by larger size (Fig. 15), and by gonopod conformation (i.e., lateral lamella longer, more slender).

Description: Length 31–41 mm (♂♂), 49 mm (♀, slightly stretched); height 2.1–2.5 mm (♂♂), 2.4 mm (♀); n.p.s. 47–55 (♂♂), 43 (♀).

Colouration: Bright orange-yellow with dark brown pattern, primitive julid colouration strongly emphasized. Head, first 5 segments and body end with telson very dark. Prozonites with vertical dark brown band, on sides from ventral to dorsal tapering, metazonites orange, especially on midbody. Middorsal stripe dark brown, broad,



Figs. 65–70. *Anaulaciulus topali* n. sp. – 65–66) promerites of two specimens, caudal view. – 67) opisthomerites, frontal view. – 68) right opisthomerite, caudal view. – 69) penis, caudal view. – 70) male body end. – Scales in Figs. 65–69: 0.5 mm, in Fig. 70: 1 mm.

Male gonopods: Promerites Fig. 59. Lateral lamella of opisthomerite long, subequal to opisthomerite, moderately broad, rounded with entire margin; “head” of opisthomerite round, concave; “beaks” with hairs, tips pointed (Fig. 60).

Female vulvae: Bursa with 30–31 setae, 9–11 on lateral and mesal sclerites; ampulla slightly elongated, apodemetic tube short, simple. Operculum with a strong cusp, with 17–18 setae on frontal side.

Distribution: Northern Pakistan (Map 1).

Anaulaciulus topali n. sp.

Figs. 65–70

Holotype: ♂ (TMB, slide prep. no. AN-41), India: Jammu and Kashmir, Pahalgam, 2300 m, under stones in forest, 13. vi. 1967; leg. Gy. TOPÁL.

Paratypes: 1 ♂, 8 ♀♀ (1 ♂, 5 ♀♀: TMB [slide prep. no. AN-42, 43]; 1 ♀: SMF 6820; 1 ♀: ZMUC; 1 ♀: ZMMU), Jammu and Kashmir, Yusmarg (50 km W Srinagar), ca. 2300 m, under bark of trees in coniferous forest, 29. v. 1967; leg. Gy. TOPÁL.

Total material: 2 ♂♂, 8 ♀♀.

Derivatio nominis: The species name is given in honour of the collector, a well-known mammalogist, my colleague Dr. György TOPÁL (Hungarian Natural History Museum,

present on both pro- and metazonites. Anal valves dark brown. Legs and antennae marble brown.

Head with 39–41 (♂♂), 36–37 (♀♀) ocelli per eye, length of antennae 105 % (♂), 88 % (♀) of body height. Metazonites moderately striated, ca. 14 striae in a quarter of midbody segment height, ozopores behind suture with a quarter metazonital length. Preanal ring with short dorsal projection pointed slightly downwards, subanal scale with 8–10 setae, anal valves densely pilose (Fig. 64). Length of legs 101 % (♂), 54 % (♀) of body height, leg slenderness 11.6 (♂) and 8.9 (♀).

Budapest), for his enduring merits in collecting arthropods on his various expeditions, especially to India.

Diagnosis: Differs from group-members by the epiproct (pointed downwards) and gonopod conformation (short and broad lateral lamella on opisthomerite, small processes on the "head").

Description: Length 20–21 mm (♂♂), 26–32 mm (♀♀); height 1.4 mm (♂), 2.1–2.5 (♀♀); n.p.s. 39 (♂), 43–47 (♀♀).

Colouration: Brown, dark orange-yellow with primitive julid pattern, head and anterior border of collum darker, anal valves light brown, yellowish. Thin, black mid-dorsal line, only on prozonites. Legs in males light yellowish, in females amber coloured.

Head with 25 (♂), 34–36 (♀♀) ocelli per eye, length of antennae 96 % (♂), 79 % (♀) of maximum vertical body diameter. Metazonital striation fine, dense, difficult to count, but ca. 13 striae in a quarter of midbody height; ozopores behind suture. Preanal ring with short dorsal

projection pointed downwards (Fig. 70), with several setae on its entire margin, on epiproct and on subanal scale, anal valves with dense pilosity. Legs conspicuously short in both males and females, length of a midbody pair 56 % (♂), 53 % (♀) of body height, leg slenderness 6.5 (♂) and 8.3 (♀).

Male gonopods: Promerites variable as in the entire genus, two examples of their shape illustrated in Figs. 65–66. Lateral lamella of opisthomerite short, widely connected to opisthomerite, rather broad "velum" with entire margin, almost without any sclerotized support; end of opisthomerite slender (without typical "head"), with some short processes; "beaks" with a few hairs, slender, strongly curved downwards, pointed (Figs. 67–68).

Female vulvae: Bursa with 23–25 setae, 7–9 on lateral and mesal sclerites; ampulla spherical, apodemetic tube short, simple (as in Fig. 30). Operculum with a median "tooth", with 9–10 setae on frontal side.

Distribution: India: Kashmir (Map 1).

Comments on ecology and distribution

The following remarks are based on the information kindly provided by Dr. J. MARTENS and are hence related to the distribution of the group-members in Nepal. Although he has extensively collected soil-dwelling arthropods in a multitude of localities all over Nepal except of the extreme west and during all months of the year (see MARTENS 1987), the distribution of *Anaulaciulus* seems to be quite patchy and the species in question are highly local and isolated. All species occur only at high altitudes, not below 2700 m and well above the timberline up to 4300 m, in alpine meadows. This is already a distinct sign of Palaearctic affinities of the genus in the region concerned (MARTENS 1984), no species being able, apart from extreme local endemisms, to conquer lower subtropical altitudes.

The Palaearctic affinities, however, can even be defined in more detail. *A. bilineatus* was found only in dry, more-or-less monsoon-protected areas NW of Dhaulagiri, where it inhabits the local forest remnants and penetrates into the moist alpine meadows above timberline. Similar

conditions hold true for the more abundant *A. nepalensis*, which seems to be confined to the mesophilic coniferous forests in Thakkhola, the "Inner Valley" between Dhaulagiri and Annapurna, also a monsoon-reduced area. It is common in the pine forest above Tukche (Thaksang area), but was surprisingly absent from many other collecting sites in the larger Thakkhola area. Its highly localized occurrence in the western fringe of Dhaulagiri (Thankur) is again unexpected.

The closely related species *A. niger* shows, at least at present, also a very patchy distribution at the eastern slopes of Kangchendzonga in extreme E Nepal, to the W in one of the side valleys of Arun River (Pahakhola), and again several hundred kilometers to the W in the Manaslu massif. The presence of a third (similar) species in the eastern Kangchendzonga (Sikkim), *A. acaudatus*, further complicates the distribution pattern, and one can be sure that with future research more isolated populations will be discovered, and then perhaps will resolve the zoogeography of the group.

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