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Review of the millipede genus *Pterygophorosoma* VERHOEFF, 1897 (Diplopoda, Chordeumatida, Craspedosomatidae)

Abstract
Based on topotypic material from Schaubachhütte, South Tyrol, Italy, a redescription of *Pterygophorosoma alticolum* (VERHOEFF, 1894) is provided, and the present state of knowledge of the genus is discussed.

Kurzfassung
Übersicht über die Gattung *Pterygophorosoma* VERHOEFF, 1897 (Diplopoda, Chordeumatida, Craspedosomatidae)
Anhand von Topotypoiden von der Schaubachütte in Südtirol (Italien) erfolgt eine Wiederbeschreibung von *Pterygophorosoma alticolum* (VERHOEFF, 1894). Der derzeitige Kenntnisstand über die Gattung *Pterygophorosoma* wird zusammengefasst und diskutiert.

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Diplopoda, taxonomy, standardisation of descriptions, redescription, synonymy, distribution, ecology

1. Introduction

In his classification of the Diplopoda, HOFFMAN (1980) pointed out three problematic genera within the Craspedosomatidae that required further clarification through getting and studying topotypic material. These genera were *Aporogona* COOK, 1895, *Basigona* COOK, 1895, and *Pterygophorosoma* VERHOEFF, 1897. HOFFMAN (1980) noted also that it was *Pterygophorosoma*, proposed for *Atractosoma alticolum* VERHOEFF, 1894, a species described based on female material, that should cause no problems in obtaining topotypoids from Schaubachhütte near Sulden, Italian Alps.
HOFFMAN (1980) obviously overlooked that *A. alticolum* had long been assigned to the genus *Orotrechosoma*. This was perhaps because JEEKEL (1970) had selected different type species for both of these genera. But as these two species show only slight differences, there is no doubt that they are congeneric.
Ignoring his own, older, female-based description from Schaubachhütte, VERHOEFF (1911) described *Orotrechosoma alticolum dormeyeri*, this time based on male material and deriving exactly from the same locality, and he distinguished it from the "true" *O. alticolum*. He chose to attribute the latter name to material from Pic Padella near Samaden (= Albula Pass, Switzerland), the place whence he described a male. Even at present it remains unclear if both taxa are indeed different.
The above shows both the degree of confusion and that at least topotypoids of *alticolum*, better coupled with type material of *dormeyeri*, would be crucial to finally clarify the identity of *Pterygophorosoma alticolum*.
During an excursion, supported by a grant received from the von-Kettner-Stiftung, the author made in September 1999 to clarify the status of some taxa of Central European soil organisms, several known and new localities where members of the genus *Pterygophorosoma* might be expected to occur were visited. At least in part the trip was successful, as it was possible to obtain topotypoids of *P. alticolum* from near Schaubachhütte near Sulden in the Ortler Mountain Range, South Tyrol. The occasion is taken here to both provide a review of the genus *Pterygophorosoma* and to complement the description of its type species.
It is remarkable that *Iulogona tirolense* has also been described from the Sulden Valley. It was possible to collect this species only a few kilometres away from its type locality several times during that excursion.

2. Material and methods

2.1 Specimens studied

Three males, three females and nine juveniles have been collected only a few hundred metres west of Schaubachhütte, 4 km south of Sulden, South Tyrol, Italy, on a northern slope in a depression under stones.
For comparative purposes, another male has been provided by Dr. ARIANE PEDROLI-CHRISTEN, collected in the Swiss National Park at the summit plateau of Munt La Schera (2500-2540 m a.s.l.) (DETHIER & PEDROLI-CHRISTEN 1983).

2.2 Geographical reference to localities

In some cases it is quite easy to find localities given in faunistic or taxonomic papers, but in other cases it is really a detective game. Unfortunately, never ever the German myriapodologists of the classical period gave co-ordinates. This makes it quite difficult to produce maps. For this reason, whenever possible, the co-ordinates of the cited localities have been determined. They are given in decimal degrees. Western longitude and southern latitude are marked with a negative sign. This way of representation is to be preferred over the classical form with degrees, minutes and seconds as it is

easier to store in electronic databases and allows an easier access via GIS systems. In the present paper the so-called German "Generalkarten" have been used to determine the co-ordinates.
Based on the co-ordinates, a map has been produced. Type localities of taxa have been marked with arrows, pointing from the name to the locality. This convention should be used as a standard in future.

3. Standardisation of descriptions in the Craspedosomatini and other millipedes

Unfortunately even now descriptions in millipedes are not standardised. This often makes it difficult to compare taxa with each other. Another special case in present-day millipede systematics is neglect of peripheral characters in favour of gonopods, the male secondary copulatory organs. The reason is, that the authors of the classical period, especially ATTEMS, BROLEMANN and VERHOEFF, based their classifications exclusively on gonopod structure. Descriptions often consisted only of gonopod drawings and their verbal description. Consequently it is mostly impossible to identify a species without having a male, although from time to time promising attempts have been made to alter this (e.g. RIBAUT 1913, SCHUBART 1934). The fact that the descriptions appear to be dispersed over a great amount of small papers, often published in rare/obscure periodicals, makes it extremely difficult not only to gather all relevant literature but also to consider everything. Summarising the present knowledge and supplementing the descriptions if necessary, i.e. building up a homogeneous foundation for comprehensive comparisons, becomes increasingly topical.
In succession some character complexes will be treated that must be taken into account in future descriptions. At present this attempt is to be considered as preliminary, to be completed at a later time.

head

In some millipedes either the males or both sexes show bosses, depressions or darker sclerotized structures like horns. At present, no head modifications other than a flattened frons of the male (figs. 5b-c) in nearly all Craspedosomatidae are known.

mouthparts

Structure of the mouthparts has been used from time to time in diplopod taxonomy. It is well-known that the structure of the gnathochilarium is distinct in the different orders of millipedes. In the Chordeumatida it is important if the mentum is divided or not. There are some bizarre cases of gnathochilarium modifications in diplopods, e.g. in *Leucogeorgia* VERHOEFF, 1930 (Julida: Julidae), *Ingurtidorgius* STRASSER, 1974 (Polydesmida: Trichopolydesmidae) and a few others. Some of such modifications are sex-linked, e.g. in males in species of the genus *Ophyiulus* BERLESE, 1884 and of the order Stemmiulida. Chordeumatida in general show special structures above the inner palps (COOK & COLLINS 1895). These structures are usually more or less tri- or quadridentate (figs. 4i-j). They are called styliform processes. They do not appear to exist in other orders of millipedes, except in some Polydesmida. In *Mastigona mutabile* (LATZEL, 1884) (fig. 4j) and *M. bosniense* (ATTEMS, 1899) (ATTEMS 1926, p. 37, fig. 40), the innermost cone of the internal palps is modified into a serrate hyaline lobe. This character, perhaps occurring in all Mastigophorophyllidae, has not been observed in several other members of this order.
Although the structure of the mandible is known to carry important taxononomic characters too (ENGHOFF 1979, KÖHLER & ALBERTI 1990), it is largely neglected in species descriptions, perhaps because of the difficulties in preparation (destruction of the head) and drawing (SHEAR 1972).

antennae

The antennae often allow discrimination of taxa at higher, genus or family, taxonomic levels. It was apparently RIBAUT (1913) who was the first to recognise the antennae as an important taxonomic character. According to RIBAUT (1913), the length and width of each of the seven antennomeres, and their length-width index must be considered. Unfortunately, this procedure had not been standardised until ENGHOFF (1992) proposed dorsal measurements (fig. 1a).
At about the middle of the 7th antennomer, and pointing laterad when the antennae are extended, there is a solitary, rather slender, mammillate-conic, transparent protuberance, narrowed at the tip and produced into a long, very slender, and exceedingly fine-pointed hair. As discovered still by COOK & COLLINS (1895), this structure is characteristic of the order Chordeumatida, not occurring in other millipede orders.

segments

Shape of the tergites, especially their lateral expansions and the position of the macrochaetae are among the most important taxonomic characters in the order Chordeumatida. Unfortunately, only very few authors provided meaningful drawings. Even rarer, the number of the depicted body segment has been mentioned. Again it was RIBAUT (1913) who standardised drawings of body segments in Chordeumatida at the 15th segment. This was a good choice. As most Chordeumatida have 30 segments, the 15th segment is in the middle, where the animal is the broadest. For the same reason, the 10th segment is to be depicted in the order Polydesmida, as the adults of most species possess 20 segments. In most other millipede orders the number of segments is not fixed.

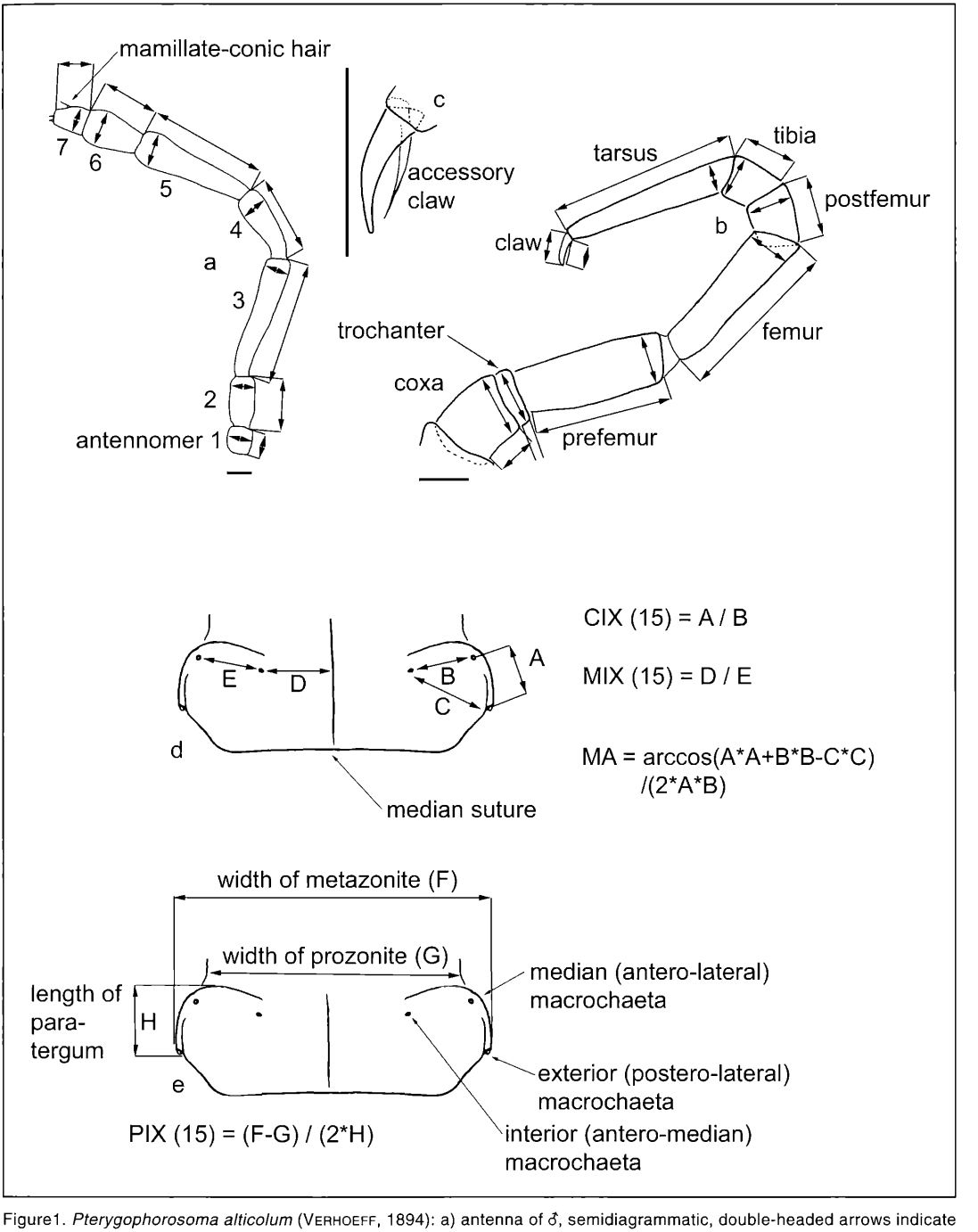

Figure1. *Pterygophorosoma alticolum* (VERHOEFF, 1894): a) antenna of ♂, semidiagrammatic, double-headed arrows indicate length and width of antennomeres; b) anterior leg of 10th segment (♀), anterior view, double-headed arrows indicate length and width of podomeres; c) same, claw, magnified; d) dorsal view of 15th segment (♂), semidiagrammatic, macrochaetae replaced by their insertion points, showing macrochaetal indices; e) same, showing other measures. Figs. a-c: specimen from Schaubachhütte figs. d-e: specimen from Munt la Schera. Scale lines 0.1 mm.

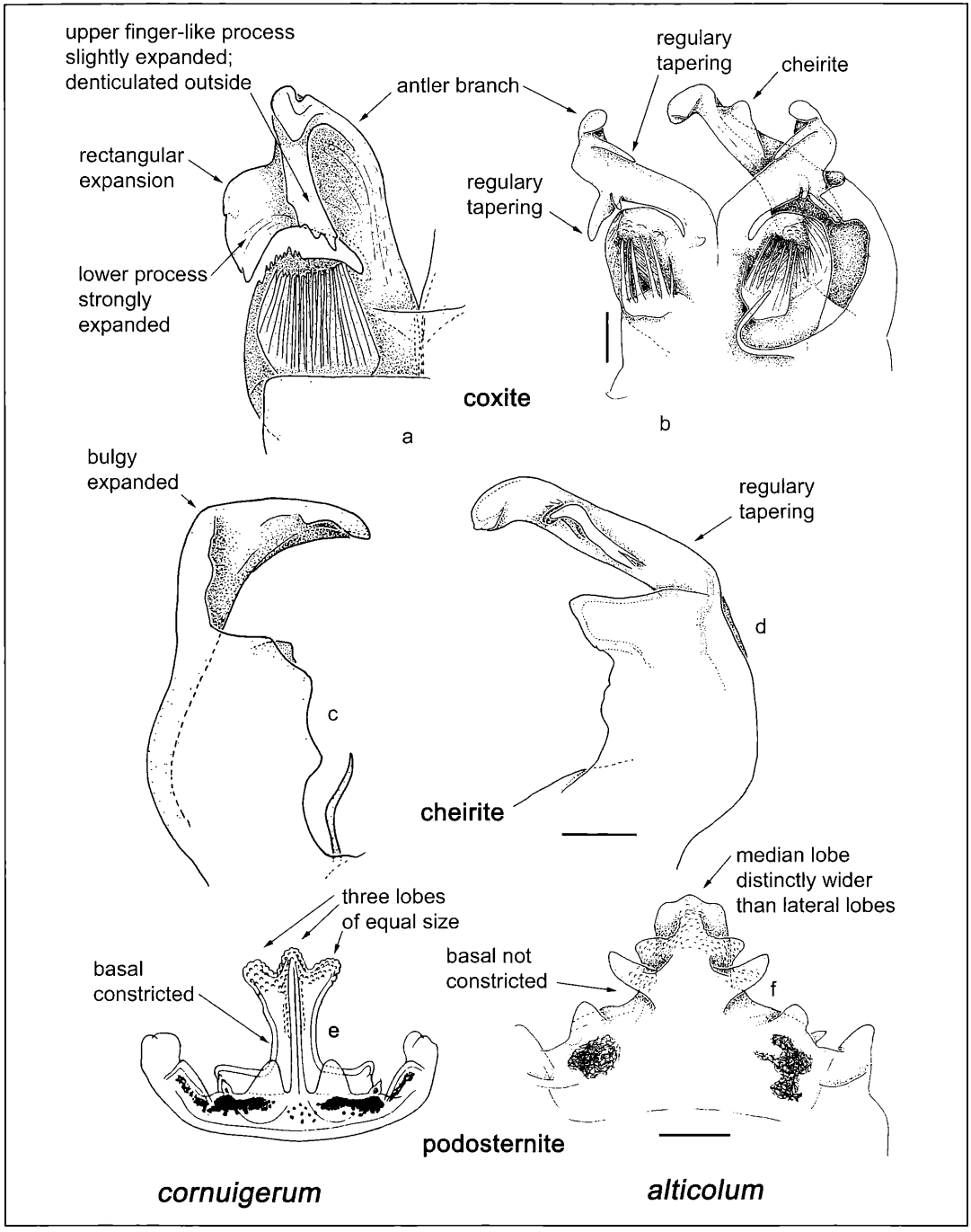

Figure 2. Figs. a, c, e: *Pterygophorosoma cornuigerum* (VERHOEFF, 1894); figs. b, d, f: *Pterygophorosoma alticolum* (VERHOEFF, 1894): a-b) anterior gonopods, coxite, posterior view; c-d) cheirite, external view; e-f) podosternite, anterior view. Figs. a, c: after VERHOEFF (1900), modified; fig. e: after VERHOEFF (1925) , modified; figs. b, f: specimen from Munt la Schera; fig. d: specimen from Schaubachhütte. Scale lines 0.1 mm.

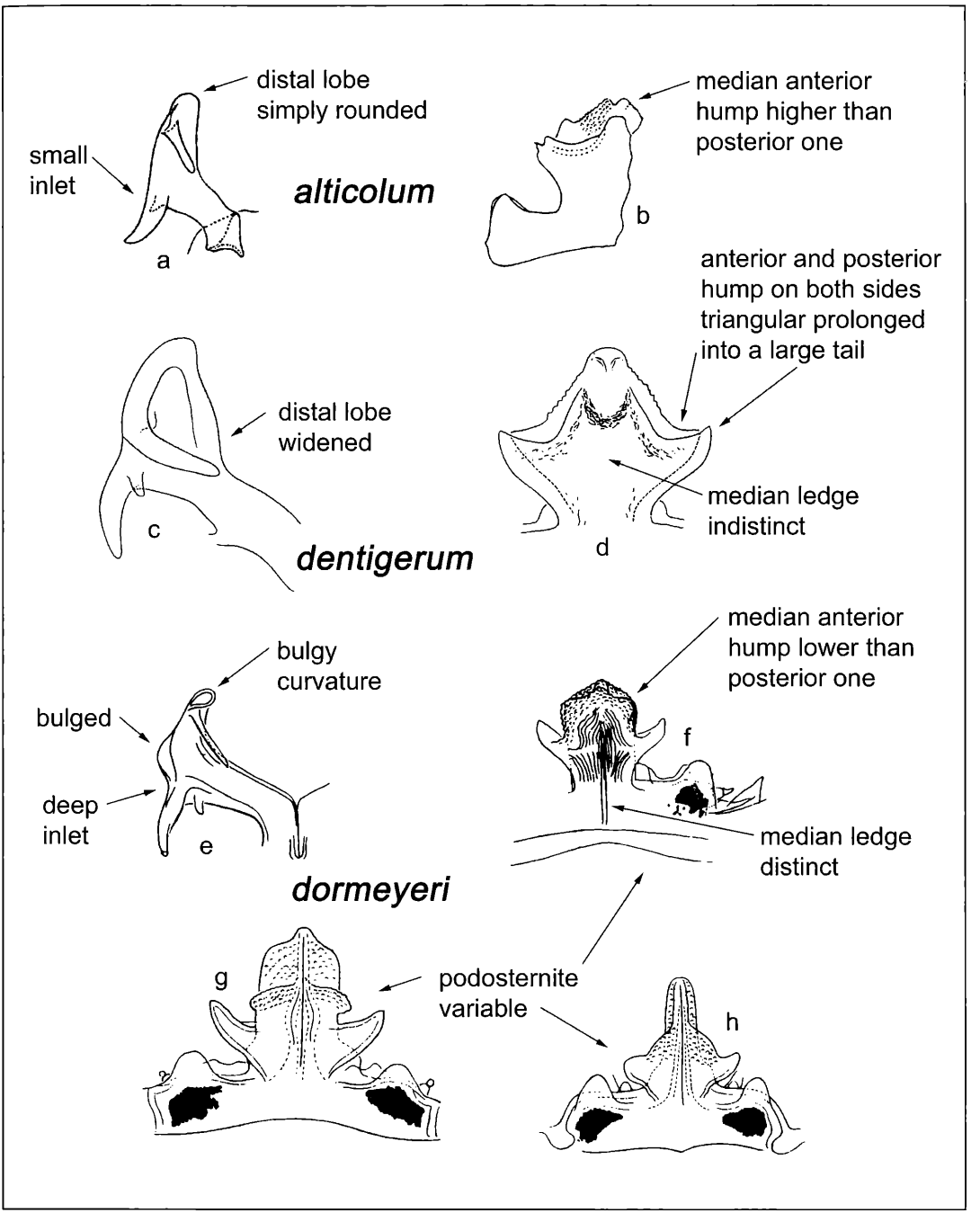

Figure 3. Figs. a-b: *Pterygophorosoma alticolum alticolum* (VERHOEFF, 1894); figs. c-d: *Pterygophorosoma alticolum dentigerum* (VERHOEFF, 1901); figs. e-h: *Pterygophorosoma alticolum dormeyeri* (VERHOEFF, 1911); figs. g-h: var. *excavatum*: a) c) e) anterior gonopods, coxite, antler branch, posterior view; b) d) f) top of podosternite, anterior view; g-h) podosternite, anterior view. Fig a-b: after VERHOEFF (1896), modified; figs. c-d: after VERHOEFF (1901), modified; figs. e-f: after VERHOEFF (1911), modified; figs. g-h: after VERHOEFF (1925), modified.

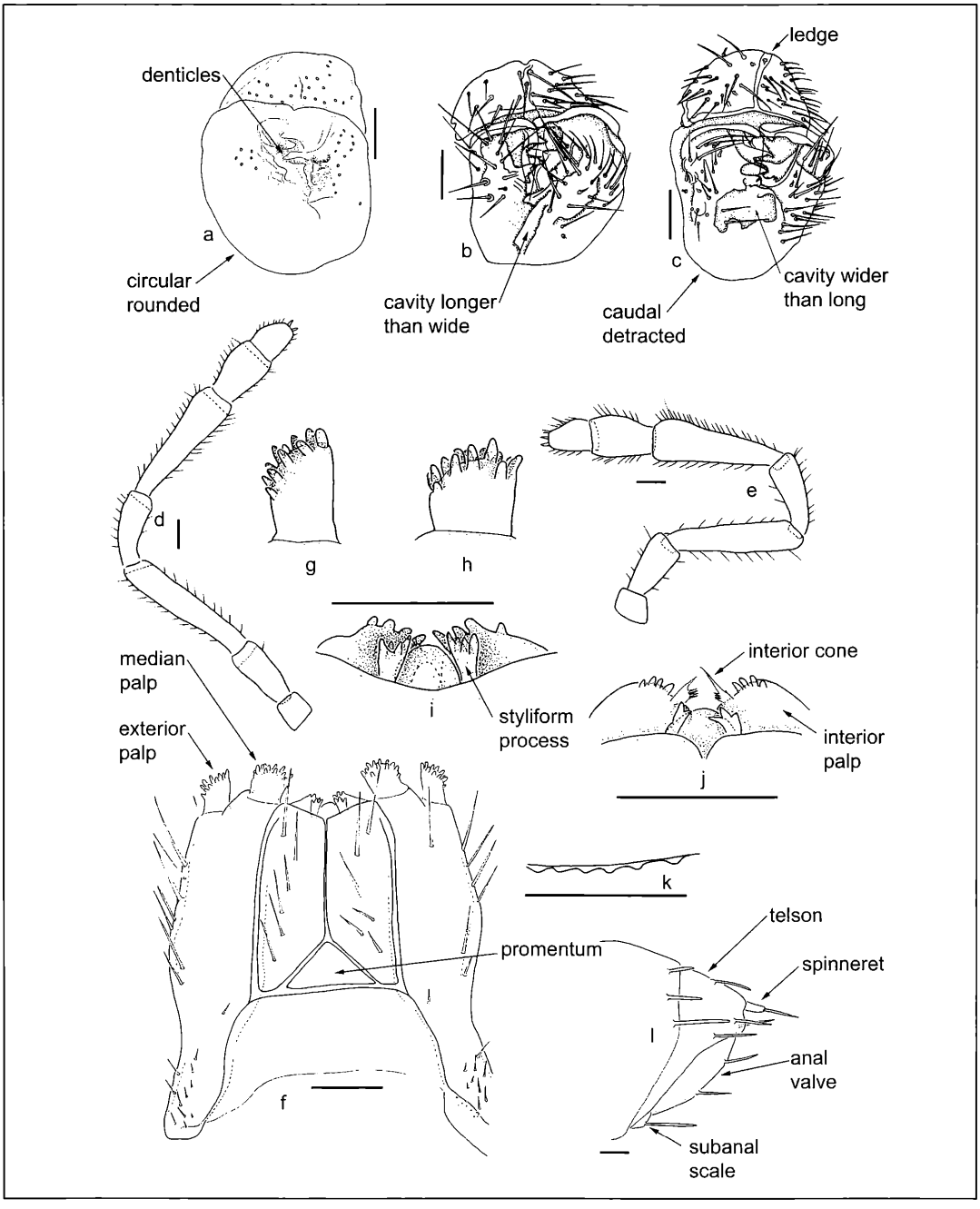

Figure 4. Figs. a-b, d-i, k-l: *Pterygophorosoma alticolum* (VERHOEFF, 1894); fig. c: *Pterygophorosoma cornuigerum* (VERHOEFF, 1894); fig. j: *Mastigona mutabile* (LATZEL, 1884): a-c) vulva, ventral view, scale indicates inner side; d) antenna of ♀, lateral view; e) antenna of ♂, lateral view; f) gnathochilarium of ♂, ventral view; g) same, external palp; h) same, median palp; i): same, inner palps and styliform processes; j): inner palps and styliform processes of *Mastigona mutabile* , for comparison; k) limbus of 15th segment, lateral part of a ♂; l) posterior end of a ♂, external view. Figs. a, d-i, k-l specimen from Schaubachhütte; figs. b-c: after KURNIK (1988), modified; fig. j: specimen from Bavaria: Obermaiselstein. Scale lines 0.1 mm, figs. g-i use the same scale line.

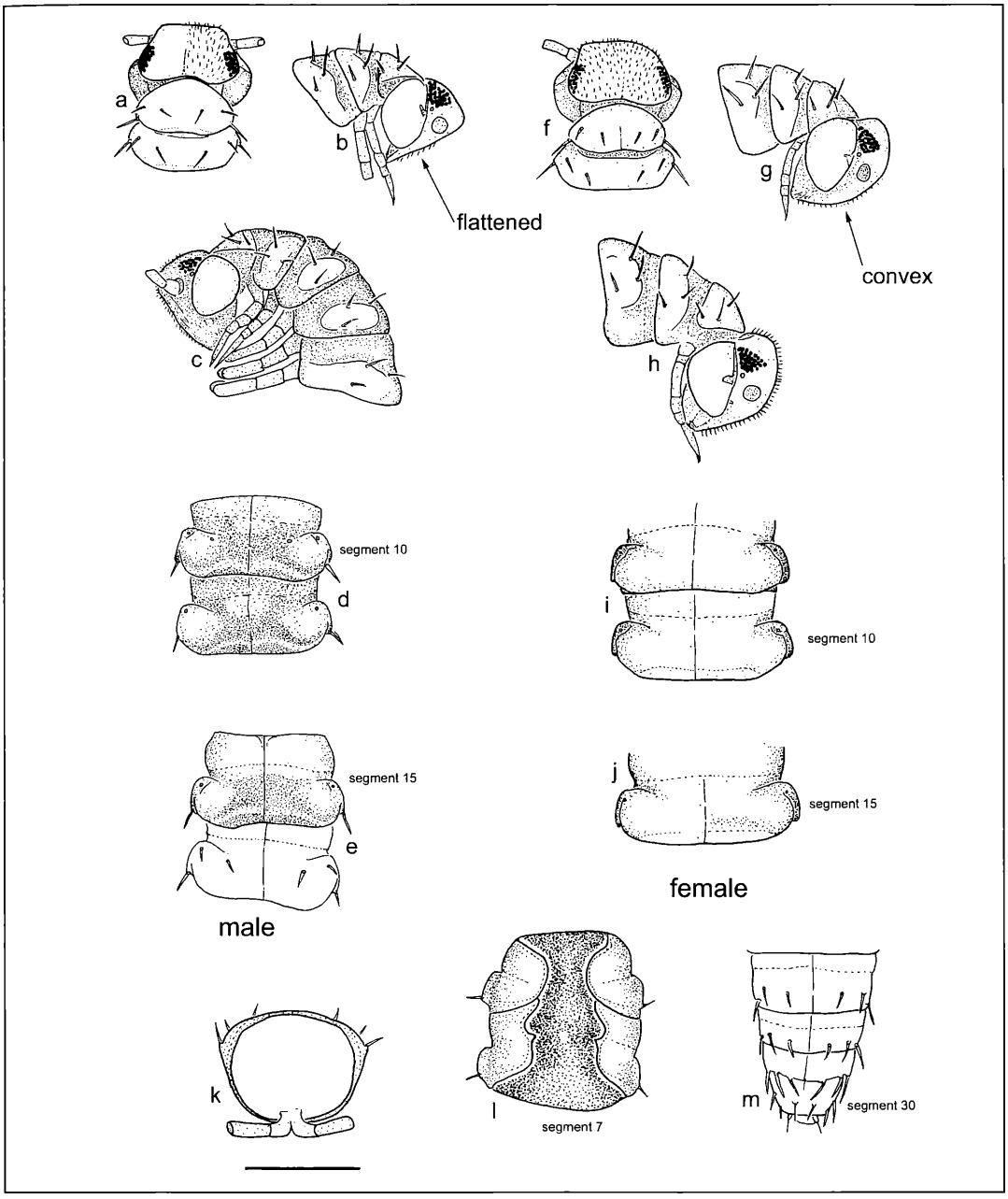

Figure 5. *Pterygophorosoma alticolum* (VERHOEFF, 1894): a) head and first two segments of ♂, dorsal view, showing pilosity on right side; b) head and first three segments of ♂, external view, showing sculpture; c) head and first five segments of ♂, external view, showing sculpture; d) 10th and 11th segment of ♂, dorsal view, showing colour pattern; e) 15th and 16th segment of ♂, dorsal view, showing colour pattern on 15th segment; f) head and first two segments of ♀, dorsal view; g) head and first three segments of ♀, external view, showing sculpture; h) same of another ♀; i) 9th and 10th segment of ♀, dorsal view, macrochaetae omitted, showing sculpture; j) same for 15th segment of ♀; k) 17th segment of ♂, posterior view; l) 6th and 7th segment of ♂, ventral view, inner parts removed; m) last four segments of ♀, dorsal view. Figs. a-b, d-m: specimen from Schaubachhütte; fig. c: specimen from Munt la Schera. Scale lines 1 mm.

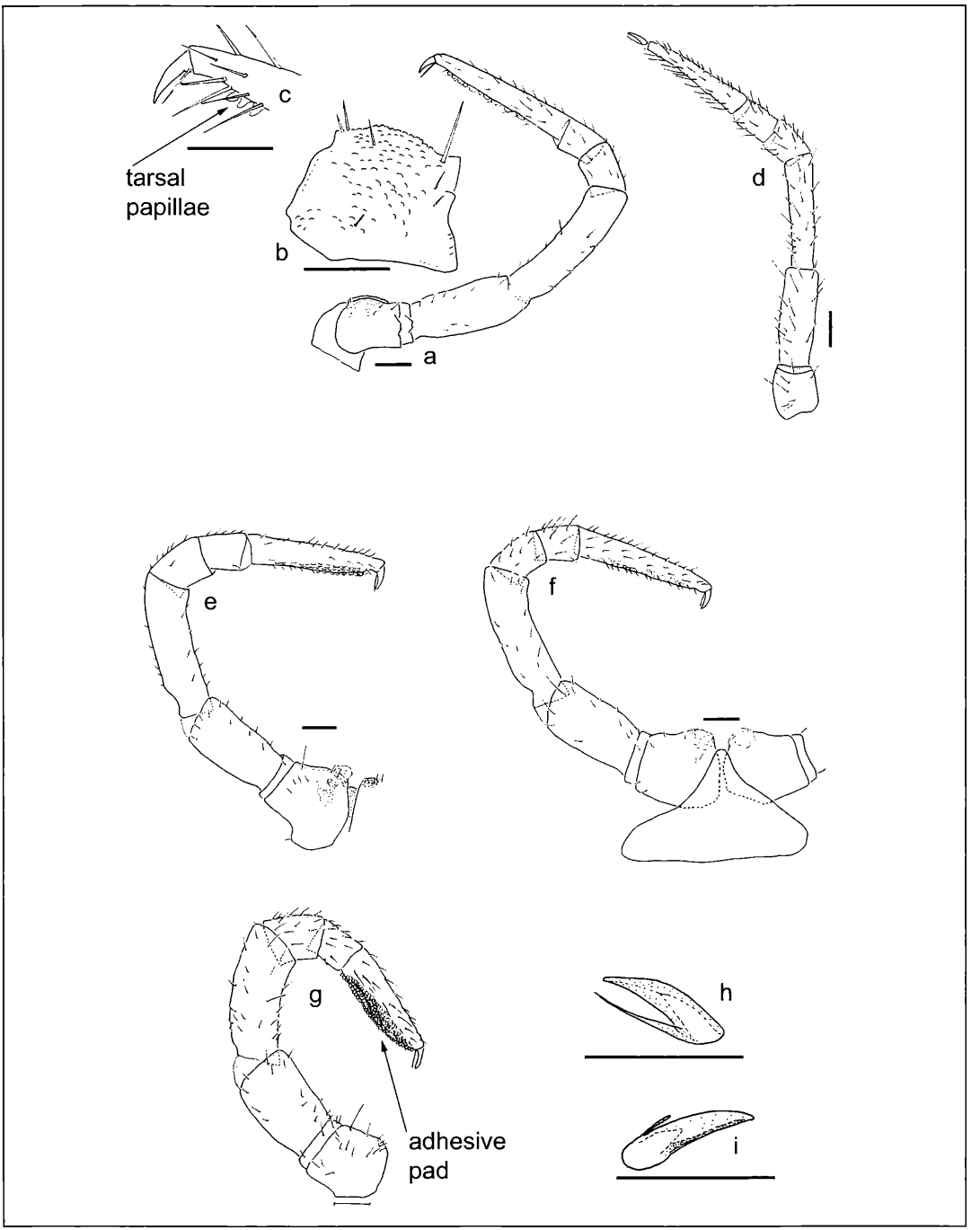

Figure 6. *Pterygophorosoma alticolum* (VERHOEFF, 1894): a) anterior leg of 10th segment of ♂, posterior view; b) same, coxa, magnified; c) same, claw, magnified; d) anterior leg of 10th segment of ♀, anterior view; e) anterior leg of 8th segment of ♂ (= leg10), posterior view; f) posterior leg of 8th segment of ♂ (= leg11), anterior view; g) posterior leg of 6th segment of ♂ (=leg7), anterior view; h) claw of 10th segment of ♀; i) claw of a posterior segment of ♂. All specimen from Schaubachhütte. Scale lines 0.1 mm.

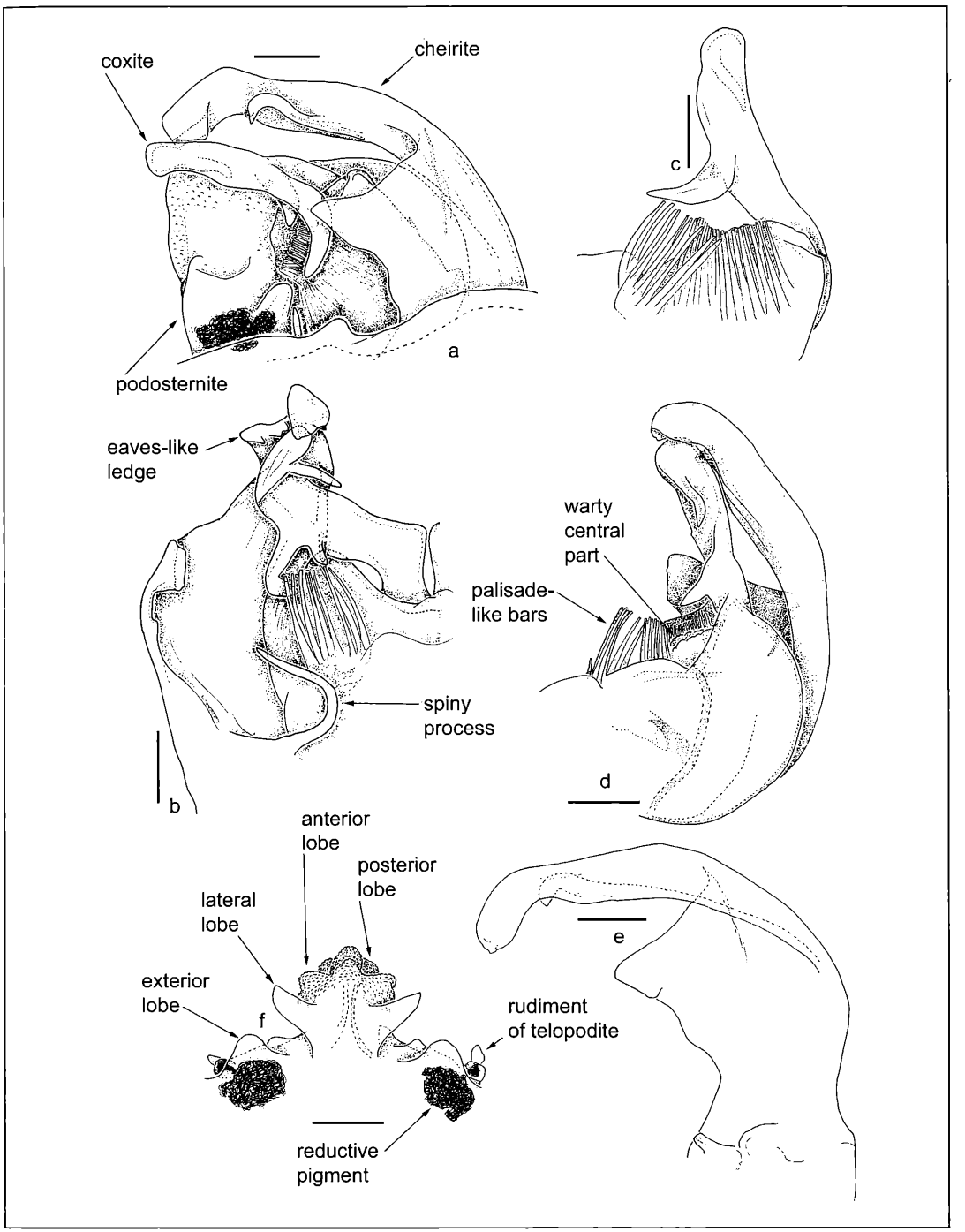

Figure 7. *Pterygophorosoma alticolum* (VERHOEFF, 1894), ♂: a) both gonopods, external view; b) anterior gonopods, posterior view; c) coxite, external view; d) anterior gonopods, internal view; e) cheirite, internal view; f) podosternite, anterior view. Figs. a-d, f: specimen from Schaubachhütte; fig. e: specimen from Munt la Schera. Scale lines 0.1 mm.

In these cases, a midbody segment is mostly used. But it is equally legitimate to use a segment of a given position. This segment should be clearly behind the 7th segment, which contains the gonopods and is often elevated. On the other hand, its position should not be too rear to allow work on incomplete specimens. Because of this, the 10th segment would be a good choice.

It is herewith recommended to give a drawing of both 10th and 15th segment in dorsal view. Supplementary drawings of a segment in lateral and caudal view would be advisable as well. The head, the first (= collum) and the second segment should be drawn in dorsal view. The 7th segment, if it is modified in males, is to be drawn in dorsal view as well. This is easier if it is still connected with the 6th or 8th segment. Taxonomically more important is the 7th segment in ventral view, as often there are conspicuous structures like processes or inlets.

The first attempt towards a mathematical expression of the position of the macrochaetae has been made by SCHUBART (1934). He expressed the position by two numbers in the form of a fraction. In a recent work (SPELDA 1999), two different names have been introduced for these so-called "formulae of SCHUBART":

The macrochaetae index (CIX) is defined as follows (fig. 1d):

$$\text{CIX} = \frac{\text{(distance between exterior and median macrochaeta)}}{\text{(distance between interior and median macrochaeta)}}$$

The median index (MIX) is defined as follows:

$$\text{MIX} = \frac{\text{(distance of interior macrochaeta and median (longitudinal) suture)}}{\text{(distance between interior and median macrochaeta)}}$$

or

$$\text{MIX} = \frac{\text{(distance of both interior macrochaetae)}}{2 \cdot \text{(distance between interior and median macrochaeta)}}$$

Besides these distance relations, the angles formed between the three macrochaetae are also of importance. It can be expressed trigonometrically by the macrochaetal angle (MA)

$$\text{MA} = \frac{\arccos((\text{distance of exterior and median macrochaeta})^2 + (\text{distance of interior and median macrochaeta})^2 - (\text{distance of interior and exterior macrochaeta})^2)}{2 * (\text{distance of exterior and median macrochaeta}) * (\text{distance of interior and median macrochaeta})}$$

The measurements must be taken in dorsal view. This view has to be projected into a plain. This supplementary definition is necessary to treat convex animals. It is as well conceivable to measure the indices in lateral (external) view.

Another important character lies in the shape of the paraterga. It can be expressed by another formula called the paratergal index (PIX, fig. 1e).

$$\text{PIX} = \frac{\text{(distance of exterior edge of paratergum and median suture)} - \text{(distance of edge of prozonite and median suture)}}{\text{(length of paratergum, measured parallel to median suture at the edge between it and the prozonite)}}$$

or

$$\text{PIX} = \frac{\text{(distance of the edges of both paraterga}^{1}\text{)} - \text{(distance of edges of prozonite}^{2}\text{)}}{2 * \text{(length of paratergum}^{3}\text{)}}$$

[1] = width of metazonite
[2] = width of prozonite
[3] measured parallel to median suture at the edge between it and the prozonite

A paratergal index of one indicates a square paratergal wing. A poorly developed paratergum has an index close to zero.

For all these measures the segment at which they were taken should be given in brackets (e. g. PIX (15) = 0.5). Although there is not much variation if an index is taken from a neighbouring segments, there is a clear difference if an absolute measure (e.g. width) is taken either from the 10th or 15th segment.

The following measurements must be given as standard for the 10th and 15th segment: width of prozonite and metazonite, length of paratergum (if present), angle MA, indices CIX, MIX and PIX.

Still another taxonomically important character of the segments is the so-called limbus, a supplementary rear margin of the metazonite which seems to have been introduced to diplopod taxonomy by PORATH (1872). As the limbus must be scrutinised at higher magnification in transmission light, it is often necessary to break off a piece of a segment. This can easily cause a damage to the whole segment. For this reason none of the segments that are to be drawn ought to be selected for the investigation of the limbus. It is either recommended to use the 5th, 8th or 9th segment or to embed the whole 10th or 15th segment. Limbal structure has been used in several orders of millipedes (SCHMIDT 1962). According to previous knowledge, no limbus has been revealed in the group Nematophora (Chordeumatida, Callipodida, and Stemmiulida) (SCHMIDT 1962), but during the present study a limbus has been found in *Pterygophorosoma*, yet only on the sides of the segment. It seems very likely that it has just been overlooked in other Nematophora.

legs

Length and width of single podomeres have only seldom been used in diplopod taxonomy. A good attempt has been maid by ENGHOFF (1982, 1992) who gives standards for these measures: the length has to be taken on the external side and the width right-angled to it at the widest part (fig. 1b). In contrast to ENGHOFF (1982) who took the average value of six median podomeres, it seems to be more reasonable to take a single leg and to describe the variation separately. Si-

milarly to the segments, it is herewith recommended to take the anterior leg of the 10th and / or the 15th segment. Similarly to the antennae both absolute measures and their length-width indices should be given. It might be reasonable to give the length as well as fraction of the femur, usually the longest podomere. Attention is to be paid to the fact that the legs of males are enlarged in many millipedes, especially the anterior legs of numerous Chordeumatida, including the Craspedosomatidae. For this reason males and females must be treated separately.

Especially in the order Chordeumatida, several legpairs can be modified. In the males one or both legpairs of the 8th segment show coxal glands and sometimes additional processes on podomeres, e.g. in the family Haaseidae. Other chordeumatidans show coxal horns or sternal outgrowths on anterior legpairs. In several Craspedosomatidae the coxa of the posterior leg of the 6th segment is enlarged.

In females it is the 2nd or 3rd legpair which is sometimes modified, e.g. in the family Mastigophorophyllidae where the 2nd legpair is reduced to a lobe.

In one of his last papers, ATTEMS (1959) instructed his successors to pay special attention to the shape of the claw (fig. 1c) in chordeumatidan taxonomy. Unfortunately, this promising attempt has only very seldom been adopted. In particular, within the family Craspedosomatidae ATTEMS (1959) was able to recognise several types of claw. He even found differences between anterior and posterior legpairs. Remarkably, *Pterygophorosoma alticolum* was among the species ATTEMS (1959) investigated. In a later attempt, ENGHOFF (1992) recommended to give the length of the accesssory claw as a fraction of claw length. This should be defined as a standard too.

gonopods

Gonopods still carry the most important taxonomic characters in millipede taxonomy. For that reason it is important to have standardised figures. The standardisation depends on the structure of the gonopods. In some cases these are difficult to fix, because their parts are movable against each other. In most julids, the gonopods must be dissected longitudinally at best, except for the Ommatoiulini which can be depicted in posterior view without dissection. A dissection between anterior (pro- and mesomerite) and posterior part (opisthomerite) is mostly impossible, because both are connected by flagellae. These flagellae either break off and remain with the opisthomerite or they cause an unwanted torsion. As the opisthomerites are only loosely connected with each other, it is very difficult to fix them exactly in cranial or caudal view. Mostly they break into two parts and will be found later in a virtual position. Because of such inconsistent preparations several taxa have been described twice.

In the order Chordeumatida we face perhaps the greatest variety of gonopod structures. Depending on family, sometimes even on genus, different orientations have to be chosen. Most times it is only possible to present an external view using an intact specimen. A dissection of the entire gonopod complex requires an experienced specialist and calm handling. Often the anterior and posterior gonopods will be separated during dissection, because they represent different legpairs and remain free from each other.

In the chordeumatidans, the posterior gonopods should be drawn in anterior (cranial) view as a standard. A posterior (caudal) view of the posterior gonopods might sometimes be advisable too. The two halves of the posterior gonopods are connected by a sternal process in most Chordeumatida. In the Craspedosomatini they are fused to a homogeneous structure called podosternite. The posterior gonopods are compressed caudo-cranially. For that reason it is nearly impossible to fix them in lateral view or to dissect them further.

In contrast to the posterior gonopods, the anterior gonopods have to be shown in posterior view. As a standard, anterior, external (antaxial) and internal (paraxial) views are to be depicted too. The anterior view is taxonomically less important, but it is advisable to show it too. To get an anterior or posterior view, the whole anterior gonopods have to be fixed, preferably in a hollow slide.

In the families Craspedosomatidae and Attemsiidae, the anterior gonopods are bipartite, consisting of the external cheirites and the internal coxites (fig. 7a). Sometimes they have to be separated to study them isolated. As both cheirites and coxites are mostly compressed laterally, they have to be shown in lateral view. While figures of the cheirites are given regularly in most descriptions, the coxites are often omitted, especially in the Craspedosomatini. This is comprehensible, as their delicate structures scarcely lend themselves to be drawn. Unfortunately, the coxites carry structures of great taxonomic importance at the species level, otherwise show little variation (SPELDA 1999). The importance of the coxites is obvious if one takes in consideration that they carry out a direct function in sperm transfer.

To sum up, in respect of the gonopods the following procedure is proposed for chordeumatidans:

1. If possible, the gonopods are to be depicted using an intact specimen in external view.
2. The gonopods must be isolated from the 7th segment. If this happens without separating them, they have to be figured in external view.
3. The posterior gonopods ought to be separated from the anterior gonopods. They have to be figured in anterior view, eventually in posterior view too.
4. The anterior gonopods are to be shown in posterior view, and, if omitted up to now (2.), in external view. Eventually the anterior view must be figured too.

5. If possible, the anterior gonopods are to be separated in the middle. They have to be figured in internal and external views.
6. Cheirites and coxites (if present) must be separated. The missing views (cheirite in internal view, coxite in external view) are to be added.

vulvae

The female genitalia, or the vulvae, have long been used as taxonomic characters (BRÖLEMANN & LICHTENSTEIN 1919). Isolated vulvae are difficult to fix, sometimes only in the taxonomically less useful lateral view. To place and keep the vulvae in the important ventral view it is advisable to dissect them together with the 2nd and 3rd legpairs in chordeumatidans and together with the 2nd legpair in julidans. The legs help to turn the vulvae into the right position during their fixation on a slide with a cover glass. Depending on the amount of extrusion the preparation might be directed more to the anterior (operculum) or posterior (bursa) part. It is important to render no pressure to the vulvae, otherwise they might get deformed. For that reason hollow slides are preferable. An absolute fixed orientation, as in gonopods, is not possible, because the vulvae are spherical, soft, therefore easily destructible structures.
In most diplopods the vulvae are strongly covered with setae. For that reason it might be advisable to draw only their insertion points (fig. 4a), otherwise they hide the underlying external structures of the bursa. It is important to show the receptacula too. These are situated inside the vulva. Although their shape varies in detail, the general structure is of taxonomic value. Of course setae can only be omitted if their structure is of no taxonomic significance. Otherwise two figures must to be given, one with and the other without setae.

number of specimen to be investigated

It is remarkable that the authors of the classical period did not pay attention to the variability of measurements. The only laudable exception was OTTO SCHUBART. Especially in his late papers on Brazilian millipedes addid he huge tables with measurements of individual specimens.
To get statistically significant parameters for the variation of the investigated measures, a minimum of six specimens must be investigated for each sex and age class. A higher number is advisable, but the amount of work for a description clearly increases. For practical reasons six specimens seems to be a reasonable compromise.
In practice it is common that for a description or redescription less than six specimens are at hand. In this case the single measures of all specimen should be published in a table. This enables future students, who get additional material, to complement measures and to correct or specify the parameters. For characters of uncertain taxonomic value it might be reasonable to measure a single specimen, just to have a comparison with higher taxa.
It is to be underlined that males and females have to be described separately. In some genera the differences in size between the two sexes are greater than between members of different species within the same sex (e. g. in *Rhymogona* COOK, 1896).

4. Synonymy list of the genus *Pterygophorosoma*

Explanation of abbreviations:
C = citation, D = description, N = note

Pterygophorosoma VERHOEFF, 1897

1897 *Craspedosoma* (*Pterygophorosoma*) VERHOEFF: Arch. Naturgesch., **63** (1): 138 (D, no type species proposed)
1900 *Orotrechosoma* VERHOEFF: Arch. Naturgesch., **66** (1): 370 (D, no type species proposed)
1910 *Orotrechosoma* – VERHOEFF: SB Ges. naturf. Freunde Berlin, **1910**: 35 (N)
1911 *Orotrechosoma* – VERHOEFF: Zool. Anz., **38**: 28, 30-31 (D, including juveniles).
1925 *Orotrechosoma* – VERHOEFF: Zool. Jb. Syst., **50**: 65 (N)
1926 *Orotrechosoma* – ATTEMS: Handb. Zool., **4** (1): 173-174 (D)
1932 *Orotrechosoma* – VERHOEFF: In BRONN, Klassen und Ordnungen des Tierreichs, **5** (2): 1491-1495 (D)
1934 *Orotrechosoma* – VERHOEFF: In BROHMER et al.,Tierwelt Mitteleuropas, **2, 3**: 44, 49 (D)
1970 *Orotrechosoma* – JEEKEL: Monograf. Nederl. Ent. Ver., **5**: 74 (N, subsequent designation of type species: *Orotrechosoma cornuigerum* VERHOEFF, 1900)
1970 *Pterygophorosoma* – JEEKEL: Monograf. Nederl. Ent. Ver., **5**: 77 (N, subsequent designation of type species: *Atractosoma alticolum* VERHOEFF, 1894)
1980 *Orotrechosoma* – HOFFMAN: Classification of the Diplopoda: 133 (N)
1980 *Pterygophorosoma* – HOFFMAN: Classification of the Diplopoda: 125 (N)

According to JEEKEL (1970), the genera *Pterygophorosoma* und *Orotrechosoma* have a neuter gender. For that reason the species names have to end with "–um"

Pterygophorosoma alticolum (VERHOEFF, 1894)

1894 *Atractosoma alticolum* VERHOEFF: Verh. zool.-bot. Ges. Wien, **44**: 21 (D /)
1895 *Atractosoma alticolum* – VERHOEFF: Zool. Anz., **18**: 218-220 (D, ?, without figures)
1896 *Craspedosoma alticolum* – VERHOEFF: Arch. Naturgesch., **62** (3): 208-209, pl. 14, figs. 59-62 (D, ?)
1900 *Orotrechosoma alticolum* – VERHOEFF, Arch. Naturgesch., **66** (1): 384 (N)
1901 *Orotrechosoma alticolum* – ROTHENBÜHLER: Revue suisse Zool., **9**: 366 (N)
1901 *Orotrechosoma alticolum dentigerum* VERHOEFF: Jh. Ver. vaterl. Naturtk. Württemberg, **57**: 105-106, pl. 3, fig. 24-25 (D ?).

1911 *Orotrechosoma alticolum dormeyeri* VERHOEFF: Zool. Anz., **38**: 31, figs. 7-8 (D ?, /).
1925 *Orotrechosoma alticolum* (*genuinum*) – VERHOEFF: Zool. Jb. Syst., **50**: 66 (D, ?)
1925 *Orotrechosoma alticolum dentigerum* – VERHOEFF: Zool. Jb. Syst., **50**: 66,(D, ?)
1925 *Orotrechosoma alticolum dormeyeri* – VERHOEFF: Zool. Jb. Syst., **50**: 66-67 (D, ?)
1925 *Orotrechosoma alticolum dormeyeri* var. *excavatum* VERHOEFF: Zool. Jb. Syst., **50**: 66, pl. 2, figs. 9-10 (D, ?)
1929 *Orotrechosoma alticolum dormeyeri* – BIGLER: Ergeb. Wiss. Unters. Schweiz. Nationalpark, **5**: 13-14 (N)
1934 *Orotrechosoma alticolum* – SCHUBART: In DAHL, Tierwelt Deutschlands, **28**: 126-128, figs. 216-219 (D ? /; synonymy of the taxa *alticolum*, *dormeyeri* und *excavatum*, but without arguments)
1949 *Orotrechosoma alticola* – ATTEMS: SB Ak. Wien, math.-naturw. Kl., **158** I: 136 (N)
1974 *Atractosoma alticolum* – MORITZ & FISCHER: Mitt. Zool. Mus. Berlin, **50**: 326 (N)
1974 *Orotrechosoma alticolum dentigerum* – MORITZ & FISCHER: Mitt. Zool. Mus. Berlin, **50**: 334 (N)
1983 *Orotrechosoma alticolum dormeyeri* – DETHIER & PEDROLI-CHRISTEN: Bull. Soc. vaud. Sc. nat., **76** (364): 376-377 (N)
1984 *Orotrechosoma alticola* – STRASSER & MINELLI: Lavori Soc. Ven. Sc. Nat., **9** (2): 206 (C)
1988 *Orotrechosoma alticola* – KURNIK: Zool. Jb. Syst., **115**: 265-266, fig. 67 (D /: vulva)
1989 *Orotrechosoma alticolum* – THALER: Ber. nat.-med. Verein Innsbruck, **76**: 100 (N)
1993 *Pterygophorosoma alticolum* – PEDROLI-CHRISTEN: Documenta Faunistica Helvetiae, **14**: 99 (N, map for Switzerland, synonymy of the taxon *dormeyeri*, but without arguments)
1995 *Pterygophorosoma alticola* – FODDAI et al.: In MINELLI et al., Checklist delle specie della fauna italiana, **32**: 16 (C)

Pterygophorosoma cornuigerum (VERHOEFF, 1900)

1900 *Orotrechosoma cornuigerum* VERHOEFF: Arch. Naturgesch., **66** (1): 383-384, pl. 16, figs. 28-30 (D ?, /)
1925 *Orotrechosoma cornuigerum* – VERHOEFF: Zool. Jb. Syst., **50**: 65-66, pl. 2, fig. 5 (D ?, /, juveniles)
1949 *Orotrechosoma cornuigera* – ATTEMS: SB Ak. Wien, math.-naturw. Kl., **158** I: 136 (N)
1974 *Orotrechosoma cornuigerum* – MORITZ & FISCHER: Mitt. Zool. Mus. Berlin, **50**: 333 (N)
1984 *Orotrechosoma cornuigerum* – STRASSER & MINELLI: Lavori Soc. Ven. Sc. Nat., **9** (2): 206 (C)
1988 *Orotrechosoma cornuigera* – KURNIK: Zool. Jb. Syst., **115**: 266, fig. 68-69 (D /: vulva)
1995 *Pterygophorosoma cornuigerum* – FODDAI et al.: In MINELLI et al., Checklist delle specie della fauna italiana, **32**: 16 (C)

5. Diagnoses of higher taxa

Family Craspedosomatidae

A family belonging to the order Chordeumatida, characterised by:
- anterior gonopods consisting of two parts: internal coxites and external cheirites (figs. 2b, 7a-b, 7d). Coxae of 7th legpair without large processes (fig. 6g, difference from Attemsiidae).

Tribe Craspedosomatini

A tribe of the family Craspedosomatidae, characterised by:
- Sternite and telopodites of the posterior gonopods fused to a podosternite. Sternal process broadened and covered with warty outgrowths (fig. 2f, 7f).
- Coxites of anterior gonopods with an outer semicircle of palisade-like bars, called "Grannenapparat" by VERHOEFF (1926-1932).

In his classification, HOFFMAN (1980) divided the Craspedosomatidae into five subfamilies, Craspedosomatinae, Iulogoninae, Rhymogoninae, Atractosomatinae, and Rothenbuehleriinae. As this classification seems to generally overrate the rank of most of these taxa, it appears advisable to largely treat them as tribes only. The only exception is the subfamily Rothenbuehleriinae, which is indeed distinctly set off from the other Craspedosomatidae. The subfamily Atractosomatinae sensu HOFFMAN (1980), now treated as a tribe, Atractosomatini, is more or less a heterogeneous "can of worms" to encompass the genera that are still impossible to group properly. They certainly belong to different tribes, and some might prove to belong to the tribe Rhymogonini. Until a major revision clears up the relations, HOFFMAN's (1980) classification is to be retained, with the exception of downgrading most of the taxa to tribal level.

Genus *Pterygophorosoma*

A genus of the tribe Craspedosomatini, characterised by:
- Antler-like outgrowths instead of pseudoflagelloids (antler branch: fig. 2a-b).

accessory characters:
- Podosternite with a laterally and distally expanded median process (fig. 7f). This character is shared with some *Pyrgocyphosoma* species.
- Margin of 7th segment in males with a small tooth (fig. 5l). This character is shared with the genus *Pyrgocyphosoma*.
- Operculum of vulva arched, with a median ledge (fig. 4a-c); bursa with large, tooth-like projections in its inner part and a distal cavity.
- In contrast to other Craspedosomatini, juveniles of *Pterygophorosoma* show the following characters (VERHOEFF 1911: 28):

Table 1: Distinction between *P. alticolum* and *P. cornuigerum*

	alticolum	*cornuigerum*
collum (1st tergite)	not lightened	collum and sometimes 2nd tergite lightened
anterior gonopods: coxite: antler branch: upper finger-like process	regulary tapering; not denticulated	distally mucronate or slightly expanded; at the end denticulated outside
anterior gonopods: coxite: antler branch: lower process	regulary tapering and pointed	strongly expanded, on top with a nearly rectangular expansion
anterior gonopods: cheirite: finger-like process outside	bulgy expanded	regulary tapering
posterior gonopods: top of the podosternite	basal not constricted; median lobe distinctly wider than lateral lobes	basally constricted; distally expanded with three lobes of equal size
vulva: central part	caudal detracted	caudally expanded into a circular emargination
vulva: bursa	inwards declining	not inwards declining

Table 2: Distinction of the nominal subspecies of *P. alticolum* (according to VERHOEFF 1925)

	alticolum	*dentigerum*	*dormeyeri*
anterior gonopods: antler branch	at the end simply rounded; outwards only with a small inlet	as in alticola, but distal branch much wider	at the end with a bulgy curvature; outwards with a deep inlet and bulged behind it
posterior gonopods: podosternite	median anterior hump higher than a hidden posterior one, latter only slightly higher than its strongly projecting lateral lobes	anterior and posterior hump of the top on both sides extended into a triangular, large tail; median ledge indistinct	median anterior hump lower than posterior one, latter distinctly higher than small lateral lobes; median ledge distinct
paratega: colour	like the rest of the body	distinctly reddish brown, contrasting	

- without three dark longitudinal bands as in *Craspedosoma* LEACH, 1814 (one in the middle, the others below paraterga);
- 3+3 macrochaetae on segments only slightly larger than in adults; especially median macrochaetae rather short, not reaching the posterior margin on most segments;
- basal nodes of macrochaetae weakly developed.

6. Taxa previously described in *Pterygophorosoma*

Two species, *P. alticolum* and *P. cornuigerum*, are generally accepted in *Pterygophorosoma*. They can easily be distinguished by the characters given in tab. 1. The differences in all parts of the gonopods are striking (figs. 2a-f). The vulvae also allow separation of both species (figs. 4a-c), as shown by KURNIK (1988). Two additional subspecies have been described in *P. alticolum*. The character used to discriminate them from each other, according to the latest treatment by VERHOEFF (1925), are given in table 2 and figures 3a-h.

7. Redescription of *Pterygophosoma alticolum* (VERHOEFF, 1894)

Measures of individual specimens are given in table 3.

Length 13-16 mm; width, measured on 15th and 10th segment, 1.3-1.7 mm. Colour of body in alcohol marbled dark chocolate to dark reddish brown (colour pattern shown in figs. 5d-e), somewhat varying individually, antennae a little darker, legs a little bit lighter than the rest of the body.
Body with 30 segments; paraterga small, distinctly rounded (figs. 5d-e, 5i-k) but not totally so as in *Craspedosoma*; paratergal index PIX 0.4-0.6 on segments 10 and 15.
Ocelli in an almost equilateral triangular field, composed of about 25 ocelli in 5-6 rows, consisting of 7-6-5-4-2(-1) ocelli; deviations of about one ocellus per row common.
Antennae long and slender (figs. 4d-e), antennomere 3 longest; relative lengths of antennomeres in relation to antennomere 3: 0.18-0.23, 0.41-0.51, 1.0, 0.27-0.31, 0.45-0.51, 0.21-0.24, 0.14-0.18; length/width indices of antennomeres: 0.77-1.12, 1.65-2.17, 4.25-4.94, 2.45-2.95, 2.45-4.00, 1.28-2.38, 1.14-1.58.
Gnathochilarium (fig. 4f) with a promentum, styliform processes quadri-dentate (fig. 4i), innermost cone of internal palps not modified.

Collum semi-circular, not covering the head (figs. 5a, 5f). Segments with 3+3 dorsal, spiniform macrochateae (figs. 5d-e, 5i-j); macrochaetae of midbody segments (10 and 15 measured) forming an angle of 89-116°; macrochaetae index CIX 0.62-1.10; median index MIX 1.12-1.55. Limbus (fig. 4k) present only on sides of segments, missing in central part, consisting of isolated, more or less rounded lobes.
Claws of anterior legs (figs. 6c, 6h) about 3 times longer than wide, with a ventral, setiform accessory claw about the length of the claw; posterior legs with a second, dorsal accessory claw (fig. 6i), reaching about half of the length of the claw.

male

Frons flattened (figs. 5b-c); ventral side of 7th segment with a triangular projection (fig. 5l); legs with tarsal papillae ("Sohlenbläschen" of VERHOEFF 1926-1932) on tarsi of all legs (fig. 6c) except for the first two and the last five pairs, broadened into pads on legpairs 2-7 (fig. 6g). Legs 3-7 distinctly incrassate, thus having relatively small length/width indices, especially on prefemur, femur and tarsus; length/width indices for leg 7 from coxa to tarsus: 1.13-0.18-1.52-2.28-1.38-1.35-3.35. Second legpair of 6th segment (= legpair 7) with an unmodified coxa (fig. 6g). Both pairs of 8th segment with coxal sacs, but no other modifications (figs. 6e-f). Relative lengths of anterior leg of 10th segment (fig. 6a) in relation to femur (coxa to tarsus): 0.41-0.08-0.62-1.00-0.36-0.26-0.97; length/width indices: 1.19-0.25-1.78-3.39-1.40-1.24-5.43; coxa of anterior leg of 10th segment (fig. 6a) covered with warts on ventral side.
Anterior gonopods (figs. 2b, 7a-b) fused with each other, no separate sternite visible, divided in two parts, i.e. exterior cheirites and interior coxites. Coxite (figs. 7b-d) with a usual exterior semi-circle of palisade-like bars (fig. 7d), surrounding an area covered with semicircular warts, but without any projection. Instead of pseudoflagelloids of other Craspedosomatini, an antler-like branch present. This antler-branch with 3 more

Legend table 3: Abbreviations: BL = length of body, HW = width of head; EW = width of external margins of eyes, CW = width of collum, CL = length of collum, AW = width of antennomer, AL = length of antennomer, AI = antennomer index (length/width), PW = width of prozonite, MW = width of metazonite, PL = length of paratergum, MID = distance of both interior macrochaetae, MMD = distance of both median macrochaetae, MED = distance of both exterior macrochaetae, MIMD = distance between interior and median macrochaeta, MMED = distance between median and exterior macrochaeta, MIED= distance between interior and exterior macrochaeta, MA = macrochaetal angle, CIX = macrochaetal index, MIX = median index, PIX = paratergal index. Numbers in brackets indicate segment or antennomer number. All measures are given in mm, angles in degree. Specimen reference: 15-1 = JSP000215-001, 15-2 = JSP000215-002, 15-3 = JSP000215-003, 15-4 = JSP000215-004, 18-1 = JSP000218-001, 18-2 = JSP000218-002, all from Schaubachhütte; 96-5 = JSP280896-005 from Munt la Schera.

Table 3: Some measurements of studied material.

specimen	96-5	15-2	15-3	18-1	15-1	15-4	18-2
sex	♂	♂	♂	♂	♀	♀	♀
BL	14	14	14		13	16	15
HW	1.21	1.14	1.10		1.17	1.26	
EW	0.83	0.88	0.90		0.90	0.98	
CW	0.83	0.88	0.88		0.88	1.00	
CL	0.38	0.45	0.50		0.40	0.50	
AW (1)	0.11	0.13	0.10	0.11	0.10	0.11	
AW (2)	0.12	0.12	0.12	0.11	0.11	0.12	
AW (3)	0.11	0.11	0.11	0.11	0.10	0.11	
AW (4)	0.12	0.11	0.11	0.11	0.10	0.12	
AW (5)	0.12	0.15	0.16	0.15	0.14	0.19	
AW (6)	0.10	0.15	0.16	0.15	0.14	0.19	
AW (7)	0.12	0.11	0.12	0.12	0.11	0.12	
AL (1)	0.10	0.10	0.10	0.11	0.11	0.11	
AL (2)	0.21	0.19	0.21	0.24	0.23	0.26	
AL (3)	0.52	0.45	0.48	0.52	0.49	0.52	
AL (4)	0.31	0.31	0.30	0.33	0.27	0.29	
AL (5)	0.48	0.49	0.49	0.51	0.45	0.48	
AL (6)	0.23	0.24	0.24	0.24	0.21	0.24	
AL (7)	0.17	0.18	0.14	0.14	0.14	0.14	
AI (1)	0.89	0.77	1.00	1.06	1.12	0.95	
AI (2)	1.80	1.65	1.71	2.11	2.17	2.14	
AI (3)	4.89	4.28	4.50	4.94	4.88	4.68	
AI (4)	2.60	2.89	2.83	2.95	2.71	2.45	
AI (5)	4.00	3.32	3.07	3.35	3.35	2.45	
AI (6)	2.38	1.64	1.46	1.54	1.46	1.28	
AI (7)	1.40	1.58	1.14	1.15	1.21	1.14	
PW (10)	1.14	1.07	1.10		1.12	1.26	1.26
MW (10)	1.45	1.38	1.38		1.43	1.62	1.55
PL (10)	0.31	0.30	0.33		0.31	0.32	0.33
MID (10)	0.70	0.74	0.69		0.69	0.81	0.79
MMD (10)	1.24	1.17	1.17		1.21	1.40	1.36
MED (10)	1.40	1.33	1.33		1.36	1.55	1.52
MIMD (10)	0.26	0.24	0.24		0.31	0.33	0.29
MMED (10)	0.25	0.24	0.26		0.19	0.25	0.26
MIED (10)	0.41	0.33	0.40		0.43	0.43	0.40
MA (10)	109	89	108		116	93	95
CIX (10)	0.95	1.00	1.10		0.62	0.75	0.92
MIX (10)	1.34	1.55	1.45		1.12	1.21	1.38
PIX (10)	0.5	0.52	0.43		0.50	0.56	0.43
PW (15)	1.05	1.07	1.07		1.26	1.31	1.29
MW (15)	1.33	1.33	1.38		1.45	1.64	1.55
PL (15)	0.30	0.31	0.31		0.27	0.36	0.32
MID (15)	0.63	0.69	0.69		0.74	0.86	0.81
MMD (15)	1.15	1.17	1.17		1.26	1.45	1.36
MED (15)	1.30	1.31	1.36		1.40	1.60	1.50
MIMD (15)	0.24	0.26	0.26		0.29	0.31	0.29
MMED (15)	0.24	0.24	0.26		0.24	0.26	0.29
MIED (15)	0.37	0.38	0.40		0.38	0.40	0.42
MA (15)	102	99	101		93	90	94
CIX (15)	1.00	0.91	1.00		0.83	0.85	1.00
MIX (15)	1.33	1.32	1.32		1.29	1.38	1.42
PIX (15)	0.48	0.42	0.50		0.35	0.47	0.41

or less finger-like, proximally directed processes; base of antler-like branch attached to the rest of the coxite more strongly sclerotized. Cheirite (figs. 2d, 7e) shovel-shaped with a gradually tapering finger-shaped internal branch and a shorter, triangular outer branch; finger-shaped branch carrying an eaves-like ledge with a distal hook on its inner side; cheirite at base with a long, inner, frontolaterad, spiniform process.
Posterior gonopods fused with sternum into a podosternite (figs. 2f, 7f); distal part of podosternite with a tower-like top, consisting of lower anterior and higher posterior lobes, with warts on cranial side and a triangular lateral lobe proximal of anterior lobes; base of podosternite with a semi-circular exterior lobe on each side and a very small telopodite, latter consisting of two joints; podosternite proximally with a large area of reduced pigment.

female

Frons convex (figs. 5g-h); neither leg nor body modifications as in male. Relative lengths of anterior leg of 10th segment (fig. 6d) in relation to femur (coxa to tarsus): 0.36-0.05-1.00-0.36-0.29-1.00; length/width indices: 0.95-0.18-2.76-4.00-1.25-1.14-5.09.
Vulvae (figs. 4a-b) without a visible receptaculum; operculum arched, with a median ledge (fig. 4a-b); bursa with large, tooth-like projections in its inner part and a distal cavity, latter about 3 times longer than wide.

characters probably constant in most Chordeumatida, often varying in other orders of millipedes

Cheeks (= genae) laterally expanded and very prominent, not obviously divided into separate cardines and stipes, but with a groove on cephalic (dorsal) face instead of a separating line of other millipedes (figs. 5b-c, 5g-h). Head and genae densely setose, vertigial (= epicranial) suture well visible. Body segments open ventrally, without pilosity; macrochaetae of penultimate segment (fig. 5m) at posterior end; telson with interior macrochaetae situated more cranially, at end with a pair of spinnerets, protruding from under the dorsal part of the telson (fig. 4l). Transverse suture between pro- and metazonite well developed; axial suture well-developed. Ozopores absent. Labrum with 3 median teeth at anterior margin. Antennae with usual mammillate-conic, finely pointed hair on antennomere 7 (fig. 1a). Anal valve with 3 setae at margin (fig. 4l); subanal scale with 1+1 setae.

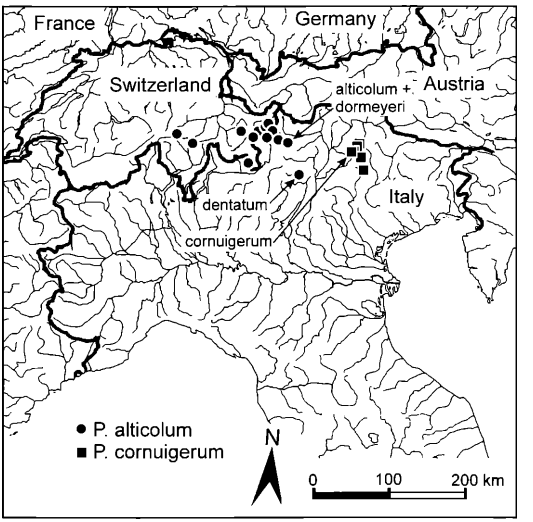

Figure 8: Distribution of the genus *Pterygophorosoma*.

8. Synopsis of the distribution of *Pterygophorosoma*

The localities where specimens of *Pterygophorosoma* have been collected are shown in fig. 8. During the excursion in September 1999, besides the locality "Schaubachhütte" the localities "Stilfserjoch" (Stilfserjochhütte and the northern slope of Mt. Scorluzzo) and "Langkofel" (T. Demetz-Hütte-Langkofelscharte) have been checked, unfortunately without positive result.

Pterygophorosoma alticolum (Verhoeff, 1894)

The taxon *alticolum*:

Type locality: Verhoeff (1894): 21
- "5 reife / und 4 / Pulli unter Steinen in der Umgebung der Schaubachütte bei Sulden. 2650m.": co-ordinates (related to Schaubachhütte): 10.596° E, 46.491° N

Verhoeff (1895): 219
- "?? verdanke ich meinem Freunde dem Faunisten Herrn Amtsrichter Carl Roettgen (Bonn), welcher dieselben auf dem Pic Padella bei Samaden (Schweiz) auffand.": co-ordinates (related to Albulapass): 9.842° E, 46.583° N. As a note (? from Verhoeff or Brolemann) on the material from the NMNHP shows, "Pic Padella" is identical with "Albulapass", the regular name of this locality in present German maps.

Rothenbühler (1901): 366
- "Mittelmoräne des Sordagletschers, Adulagruppe, 2800 m.": co-ordinates (related to route between Capanna Adula and Rheinwaldhorn): 9.031° E, 46.500° N
- "Lischannagebiet, Südseite wildes Hochgebirge, 2900m.": co-ordinates (related to P. Lischana): 9.873° E, 46.538° N
- "Val Triazza, über der lokalen Baumgrenze, 2300m., an einer Endmoräne.": according to the localities given for *Bergamosoma canestrinii,* Val Triazza is situated near Schuls, co-ordinates (related to Schuls): 10.301° E, 46.799° N

SCHUBART (1934): 128
– The author provides a raw geographical and ecological description of the presently known records.
ATTEMS (1949): 136
– "Z.: Sulden, Ostschweiz (Relikt).": This is only a listing of the formerly published records.
– "Lv.: Euganeen.": This record is mysterious. Apparently it does not belong to the "Colli Euganei" south of Verona, because these little mountains never reach alpine heights (601 m being highest altitude). Possibly it refers to a record of GANGLBAUER (KURNIK 1988). This is very likely, because the material of Ganglbauer is deposited in the Natural History Museum in Vienna (NHMW).
MORITZ & FISCHER (1974): 326
– "ZMB 1780 (1 /, Syntypus) – Tirol, VERHOEFF leg.": In their list of the types kept in the Zoological Museum in Berlin (ZMHB), MORITZ & FISCHER (1974) as well listed the marks on the labels. From them it follows that labels made by Verhoeff, especially in his early years, were not very precise. The same has been observed concerning the Verhoeffian material housed at the Museum of Natural History in Karlsruhe (SMNK).
KURNIK (1988): 265
– "Schweiz: Piz Padella, 5 / NMW 1897, VERHOEFF leg.": This series, kept at the Museum of Natural History in Vienna (NHMW), obviously belongs to the original series of VERHOEFF (1895).
– "Italien: Val di Leno, 1 / NMW 1903, Ganglbauer leg.": A record of unknown location.
– "Brenta, Tosahütte, 2500 m, 4 / Thaler leg. 17.8.1985": This record is identical with the record given for the taxon *dentigerum* by VERHOEFF (1901) (see below).
PEDROLI-CHRISTEN (1993):
– In her map the author shows a record that should be located above the tunnel of Gotthard. The record is not mentioned in the text, but the material has been deposited in the National Museum of Natural History in Paris (NMNHP). According to the data provided by J.-P. Mauriès, the record refers to a refuge called "Capanna di Caolimo", situated in the Val Canaria at 2570 m a.s.l.; co-ordinates: 8.696° E, 46.572° N
records from the National Museum of Natural History in Paris (NMNHP):
– "Suisse, Tessin, val Cavraria, Cabanna Caollimo, collecteur: A. Pedroli, 12-08-87, 1 mâle, 1 fem.": see above
– "Italie: Lombardie: Passo Caronelle, 20-09-1888, collecteur: Brolemann, HWB n° 283, 1 ?, 1 / ": A record of uncertain location, possibly referable to the village Carona in the Val Brembana or to one of the passes at the M. Corno Stella (9.807° E, 46.053° N). The fact that BRÖLEMANN collected nearby M. Corno Stella at the Passo di San Marco (9,622° E, 46,045° N, the type locality of *Pyrgocyphosoma dentatum*) would plead for this.
– "Italie: Lombardie: Passo Canciano (Val Malenco), 16-09-1888, collecteur: Brolemann, HWB n° 283, 1 mâle (disséqué par HWB), 3 mâles, 3 mâles j., 9 fem., 8 j. ": co-ordinates (related to P. Cancian): 10.000° E, 46.286° N
– "Suisse, Grisons, Pic Padella (Albula Pass), collecteur: Verhoeff, HWB n° 791, 1 fem.": see above

The taxon *dentigerum*:

Type locality: VERHOEFF (1901): 106
– "Freund Roettgen verdanke ich 1 ?, 2/ von der Tosahütte.": co-ordinates (related to Tosahütte): 10.901° E, 46.158° N
MORITZ & FISCHER (1974): 334
– "ZMB 12912 (1 ?: Gonopoden, 2 Beinpaare, Syntypus: Mikroskop. Präparat Nr. 594 Coll. Verhoeff) – Tosahütte, Tirol, ROETTGEN leg.": As this is the only male of VERHOEFF (1901) from the Tosahütte, it must be selected as lectotype.

The taxon *dormeyeri*:

Type locality: VERHOEFF (1911): 31
– "..., gesammelt in der Nachbarschaft der 2700 m hoch gelegenen Schaubachhütte am Ortler.": co-ordinates (related to Schaubachhütte): 10.454° E, 46.529° N
VERHOEFF (1925): 67
– "Meinem Freunde Gerichtsrat Roettgen verdanke ich 6 ? u. 1 / der *var. excavatum* (und zwar *subvar. a* und *b*) welche er bei etwa 2700m im August 1909 am Stilfserjoch sammelte, ? 13½ -14½ mm lg.": co-ordinates (related to Stilfserjochhaus): 10.596° E, 46.491° N
BIGLER (1929): 14
– „Wo bei den Fundorten kein besonderes Datum angegeben ist, fällt dasselbe in die Zeit zwischen 10.-24.VII. 1918.": If there is no date given, the material has been collected between 10.-24. July 1918.
– "Mittleres Val Müschauns, 2300 m, am steilen Grashang (8 ?, 3 /, 2 j. ? und / à 28 Sgm., 4 Juv. [1 ?, 3 /] a 26 und 1 Juv. à 19 Sgm.)": uncertain, but situated in the Swiss National Park
– "Murtaröl, 2300-2587 m (3 ?, 5 /, ein Pärchen in Copula)": co-ordinates (related to P. Murtaröl): 10.290° E, 46.572° N
– "Hinteres Val Tantermozza und Nordgrat des Piz d'Esen, 2300-2800m (17 ?; 18 /, 15 Juv. [3 ?, 12 /] à 28, 1 á 26, 6 à 23, 2 à 19 Sgm.). In der Ritze eines Granitsteines wurden 9 Entwicklungsstadien von 19, 15, 11 u. 9 Sgm. gefunden und 3 Pärchen in Copula).": co-ordinates (related to P. d´Esan): 10.063° E, 46.627° N
– "Val de Diavel, 2200m, 8.X.1919 (1 ?, 1 /).": co-ordinates (related to P. dal Diavel): 10.141° E, 46.625° N
– "Kammübergang Murtèr, 2600m, Juli und Okt. (18 ?, 20 /, 10 Juv. à 28, 5 á 26 und 4 á 23 Sgm.)." co-ordinates (related to P. Muters): 10.246° E, 46.690° N
– "Mt. la Schera, 2400-2588 m (3 ?, 2 /, 3 Juv. à 28 Sgm.).": co-ordinates (related to Munt la Schera): 10.211° E, 46.648° N
– "Val Ftur, 2700m (2 ?, 1 /) und 2100m (je 2 Juv. à 26 und 26 Sgm.)." : uncertain, but situated in the Swiss National Park
– "Val Tavrü und Mot de Gaier, 2260-2600 m (2 ?, 6 /, 2 Juv. à 26 Sgm.).": co-ordinates (related to P. Tavrü): 10.298° E, 46.688° N
– "Am Munt della Bês-cha (nördlich Ofenpaßhöhe), 2500m (3 ?, 3 /, 1 Juv. à 28 Sgm.).": co-ordinates (related to north of Ofenpaß): 10.298° E, 46.650° N. BIGLER (1929) explicitly emphasised the location to be north of the Ofenpaß. This he certainly did to avoid confusion with the Munt da la Bês-cha (determined co-ordinates 9.918° E, 46.511° N) north of Pontresina.
– "Val Sesvenna, 2600-2700m (3 ?, 5 /)": co-ordinates (related to P. Sesvenna): 10.404° E, 46.708° N
– "Bei Punkt 2784,21 südöstlich von St. Maria, 2700-2780m (2 ?, 5 /, 5 Juv. à 28, 1 à 26 Sgm.).": co-ordinates (related to P. Mischuns): 10.488° E, 46.582° N
– "Fuorcla Saßalb (nördlich Lü), 2500m (2 ?, 1 /)." co-ordinates (related to P. Terza): 10.399° E, 46.645° N
DETHIER & PEDROLI-CHRISTEN (1983): 373
– "De 1977 à 1980, nous avons étudié un *Caricetum firmae* (KERNER) BR.-BL. ou «*Firmetum*» situé sur le plateau sommital du Munt La Schera (2540m).": see above
THALER (1989): 100
– "Südtirol: Ortler A., Mt. Scorluzzo 3000-3090m (4 ? 4/; 17 Juli 1987).": co-ordinates (related to Mt. Scorluzzo): 10.441° E, 46.524° N

***Pterygophorosoma cornuigerum* (Verhoeff, 1900)**

Type locality: Verhoeff (1900): 284

– "1 ? 1 / und 2 Junge wurden in 2600m Höhe von meinem Freunde C. Roettgen im sog. „Gartl", einer Partie im Rosengarten, erbeutet.": co-ordinates (related to Gartlhütte): 11.622° E, 46.460° N

Verhoeff (1901): 105

– "Langkofelhütte, ...": co-ordinates (related to Langkofelhütte, 2253 m): 11.721° E, 46.520° N

– " Contrinhütte, ": co-ordinates (related to Contrinhütte, 2016 m): 11.818° E, 46.431° N

– " Regensburger Hütte (1 Paar in Copula, Juli) (Roettgen)": co-ordinates (related to Regensburger Hütte, 2037 m): 11.760° E, 46.591° N

Verhoeff (1925): 65-66

– " habe ich später noch in mehreren Stücken ebenfalls durch meinen Freund Gerichtsrat Roettgen (Coblenz) erhalten und zwar 1 ? von 11½ mm, von der Vajoletthütte...": co-ordinates (related to Vajolethütte): 11.632° E, 46.460° N

– "...sowie 1?, 2 / und eine Larve von der Mulazhütte in der Nordpalagruppe der Dolomiten, ? 11½ , / 12 mm lg.": co-ordinates (related to Rif. Mulaz, 2560 m): 11.836° E, 46.312° N

– "Aus dem oberen Val grande der Nordpala erhielt ich ebenfalls ein Pärchen, ": exact locality uncertain, but probably near Mulazhütte

Attems (1949): 136

– "Lv.: Dolomiten: Rosengarten, Langkofelhütte, Vajoletthütte, Palagruppe.": only a list of previously known records.

Moritz & Fischer (1974): 333

– "ZMB 2380 (1 /, 1 juv. /, Syntypen) – Tirol, alpin, Roettgen leg.": see under *P. alticolum*

– "ZMB 12911a (1 ?: 1. bis 7, Beinpaar, Syntypus: Mikroskop. Präparat Nr. 595 Coll. Verhoeff) – "im Gartl", Tirol.": As this is the only male of Verhoeff (1900), it must be selected as lectotype.

Kurnik (1988): 266

– "Italien: Dolomiten, Langkofelhütte, 1 / NMW 19101, Verhoeff leg.": The single female studied by Kurnik (1988), from the Natural History Museum in Vienna, obviously belongs to the original series of Verhoeff (1901).

9. Ecology of the genus *Pterygophorosoma*

Nearly all specimens I have managed to find myself were taken at once in a depression on a slope of northern exposure, just before the ascent, under stones. Only three juveniles have been collected outside this depression, but on the same northern slope under stones as well. In several places chordeumatidans have been observed as preferring to occur under large stones/boulders at the base of depressions. These locations are very cool and only a few plants, largely mosses, grow there. Chordeumatidans would best be found there before sunrise or during sunset. As soon as sunbeams reach the place, the chordeumatidans disappear into deeper layers. As it is mostly inevitable to collect during daytime, because the ascent takes its time, these depressions, which the sun did not reach, are the most promising localities then.

During my sampling on 15.09.1999, no other millipedes were recorded around Schaubachhütte. In contrast, Verhoeff (1894) emphasised that *Mastigona mutabile* occassionally occurred there too, and he was also able to collect a juvenile female of *Atractosoma meridionale* nearby.

Bigler (1929) confirmed Verhoeff's (1911) opinion that *Pterygophorosoma* is a genus of the alpine region: "I have found this animal only under stones above the timberline. From my data I can confirm Verfoeff's point of view to call them alpine animals. The best places to collect them were situated near spots of snow, where the melted snow has caused heavy moisture at the substrate. Several times I found them there in copulation."

(Original: „Das Tierchen habe ich immer nur oberhalb der Waldgrenze unter Steinen gefunden. Ich kann Verhoeffs Bezeichnung der Orotrechosomen als Alpentiere für meine Vertreter durchaus bestätigen. In nächster Nähe von Schneeflecken, auf vom Schmelzwasser total durchfeuchteter Unterlage war die Ausbeute immer am reichsten. Zu verschiedenen Malen habe ich gerade an solchen Stellen kopulierende Pärchen getroffen").

Pedroli-Christen (1993) recorded *Pterygophorosoma* between 2000 and 2900 m a.s.l. Most of the records belong to localities above 2500m. The animals have been found there from June to October, occurring mainly in July. In their paper on the fauna of the Munt La Schera, Dethier & Pedroli-Christen (1983) reported *P. alticolum* from *Firmetum typicum* and *Elynetum* plant communities.

Unfortunately, we have no ecological information about *P. cornuigerum*. The reason is, that Verhoeff did not collect material by himself. The records suggest this species occurs in habitats similar to those of *P. alticolum*. In contrast, the majority of the records are situated distinctly lower, between 2000 and 2100 m a.s.l.

10. Discussion

Although it was not possible to recollect material of *P. cornuigerum*, there is no doubt that this is a different species. Verhoeff (1925) explicitly stressed low variability in the gonopods between males from different localities in this species. The differences given for the vulvae of both species partly result from a misinterpretation by Kurnik (1988). The author did not recognise the long, distal central structure as being a cavity as well (fig. 4a-b). In *P. alticolum* this cavity is about 3 times longer than wide and directed inward. In *P. cornuigerum* it is distinctly wider than long and truncate distally. The new interpretation emphasises the close relationship of both species. They are distinguished from other members of the family Craspedosomatidae by the ledge of the operculum, the denticles in the central part of the bursa, and the distal cavity.

In contrast to *P. cornuigerum*, *P. alticolum* shows considerable variation. Yet the early description of *alticolum* (VERHOEFF 1896) rather reflects the lower quality of the author's drawings than real differences. BIGLER (1929) already pointed out that the description of the male of *P. alticolum* might be incorrect, while that of the taxon *dormeyeri* shows the correct relations. According to BIGLER (1929), VERHOEFF (1896) mistook the anterior and posterior lobe of the podosternite in his description. My own preparations of the antler-like branch in a strict caudal view also show exactly the relations given for *dormeyeri*: at the end with a bulgy curvature and outwards with a deep inlet and a bulge behind it.

VERHOEFF (1925) already noticed considerable variation in shape of the podosternite in the taxon *dormeyeri*. In fact his var. *excavatum* is easily explicable by a ventrocaudal, not strictly ventral view, while his subvarieties (fig. 3g-h) reflect a real difference. My own preparations in strict cranial view hardly reveal any variation. They correspond to fig. 3f given by VERHOEFF (1911).

The study material clearly shows that both *alticolum* and *dormeyeri* represent the same taxon distributed both in the Ortler Massif and Engadine, Swiss National Park.

The taxon *dentigerum* still requires topotypoids to be taken to solve its status. The distant type locality and the triangular posterior lobes of the podosternite seem to favour its independent taxonomic position. The widened distal lobe with its upper finger-like process set low at its base might either reflect a real difference or a ventrocaudal aspect.

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