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A review of some characters used in the taxonomy of *Cryptops* (subgenus *Cryptops*) (Chilopoda: Scolopendromorpha: Cryptopidae)

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Abstract

Variation in a number of taxonomic characters in *Cryptops* (*Cryptops*) is discussed. Some, such as the shape of the poison gland calyx and the arrangement of setae on the anterior margin of the forcipular coxosternum, are very reliable. Others, such as the sutures of the head plate and tergite 1, although sometimes variable, are important, whereas others, for example the shape of sternite 21, are consistent for some species but not for others. Yet other characters are of little or no value. The fact that characters may change with age must be borne in mind. The importance of accurate illustration is stressed.

Keywords: intraspecific, interspecific, variation, reliability, centipede

1. Introduction

The genus *Cryptops*, generally regarded as very difficult taxonomically, comprises five subgenera: *Cryptops* Leach, 1815; *Trigonocryptops* Verhoeff, 1906; *Chromatanops* Verhoeff, 1906; *Haplocryptops* Verhoeff, 1934; and *Trichocryptops* Verhoeff, 1937. Remarks here are confined to the subgenus *Cryptops* of which 148 species are currently recognised (Minelli 2006). I doubt the justification for the other subgenera apart from *Trigonocryptops*. Although many species of *Cryptops* have been described, knowledge of intraspecific variation is poor, and the evaluation of the status of similar populations is difficult and subjective. Lewis (2003) suggested that the number of species would be at least halved after type material had been evaluated. The variability of many characters that have been or might be used in the taxonomy of the nominate subgenus is here examined.

A valuable early contribution to our knowledge of intraspecific variation was made by Kraepelin (1908), who studied *C. australis* Newport, 1845, from 13 Australian localities. He noted a larger degree of variation than previously thought. Archey (1924) and Verhoeff (1931) contributed to knowledge of variation in New Zealand and European species respectively. Verhoeff (1902–25) described the post-larval stadia of *C. hortensis*. More recently Pichler (1987) described variation in *C. hortensis* (Donovan, 1810) and *C. parisi* Brolemann, 1920, Zapparoli (1989) that in *C. canariensis* Latzel, 1895, and Iorio & Geoffroy (2003) that in *C. parisi*.

As most species in the subgenus are less than 30 mm long, it is a simple task to make temporary mounts of specimens cleared in 70 per cent lactic acid or ethylene glycol. This allows maturity to be assessed. Spermatophores are clearly visible in mature males, and mature females have sperm in their seminal receptacles.

Not all characters are considered here, for example the distribution and nature of setae on leg pairs 1 to 19, the shape of the spiracles and the claw of the second maxillary telopodite. Endosternites are only briefly mentioned.

2. Review of taxonomic characters

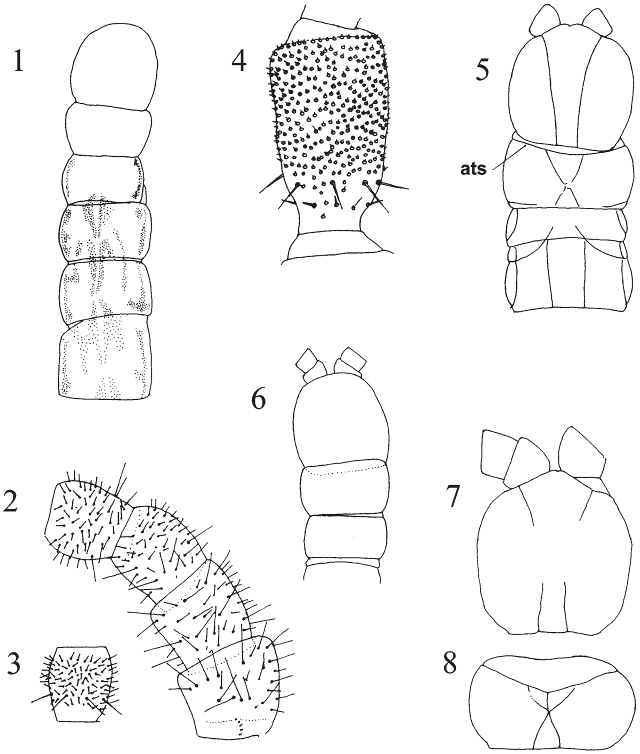
Size. Eason (1964) wrote of *C. parisi* 'Usually described as smaller than *C. hortensis*, but the few British specimens I have examined are rather larger.' Such population differences are probably common. An extreme example is seen in *C. doriae* Pocock, 1891, where the maximum length of specimens from Nepal is 33 mm, from the Seychelles it is 17 mm, and of an introduced population in UK it is 13 mm. In this case the differences may either indicate closely related species distinguishable only by size, or be due to different growth rates and numbers of stadia in different habitats (Lewis 2007a).

Colour. Some species have regions of dark subcutaneous pigment (Fig. 1) and Attems (1930) used trunk with or without this pigmentation in his key but made provision for the fact that some specimens of *C. australis* showed, and others lacked, pigmentation. Pocock (1891) described a specimen of *C. doriae* from Myanmar (formerly Burma) as conspicuously marbled with black whereas two other specimens lacked this pigmentation as do those from Nepal (Lewis 1999). Pigmentation varies in intensity in different populations of *C. decoratus* Lawrence, 1960, from Mauritius (Lewis 2002), and pigment may be present or absent in specimens from the Seychelles. It is always present in *C. nigropictus* Takakuwa, 1936 (Chao & Chang 2006). It should be noted that the pattern might disappear with time in preservative. Demange (1963) stated that many individuals from the Seychelles of what he considered to be *C. philammus* Attems, 1928, had become decolourised in alcohol.

To summarise, some species always exhibit the pigmentation; some may or may not exhibit it and others, e.g. *C. hortensis* and *C. parisi,* are not pigmented.

Antennae. Typically antennomere 1 has many long and very few short setae. The number of short setae increases progressively on antennomeres 2, 3 and 4 (Fig. 2), the long setae becoming restricted to a basal whorl. Antennomeres 4 or 5 to 17 have dense short setae and, usually, a single proximal whorl of long setae (Fig. 3). *Cryptops umbricus* Verhoeff, 1931, however, has two whorls of setae on antennomere 10 rather than the usual single whorl and the antennomeres are very elongated (2½ to 4 times as long as wide). According to Demange (1947), *C. anomalans* Newport, 1844, has one whorl of long setae on antennomere 10, *C. savignyi* Leach, 1817 (Fig. 4) and *C. savignyi hirtitaris* Brolemann, 1928, two. Confusion exists as to the identities of *C. anomalans* and *C. savignyi*, although they are currently regarded as synonyms.

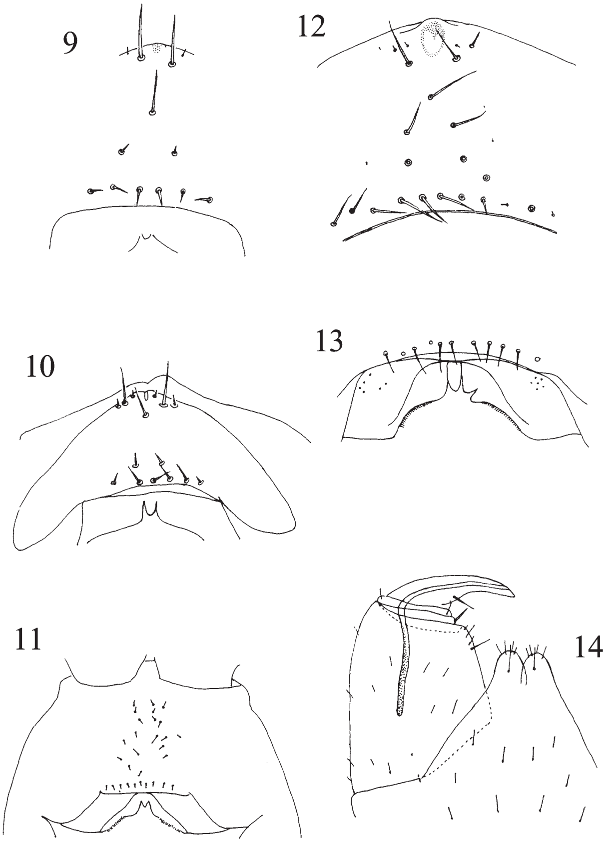
Differences in length and density of setae and between dorsal and ventral sides exist between some species. Such differences have rarely been explored, are difficult to convey in words, and need accurate illustration such as Eason's (1964) figures of *C. hortensis* and *C. anomalans*.



Figs 1–8 **1**: *Cryptops decoratus*, Round Island, Mauritius, head plate and first five tergites. (After Lewis 2002); **2**: *Cryptops hortensis*, Hampshire, England, antennomeres 1 to 4; **3**: Antennomere 7 of the same; **4**: *Cryptops savignyi* sensu Demange, antennomere 10. (After Demange 1947); **5**: *Cryptops anomalans,* head plate and tergites 1 to 3. (After Eason 1964); a**ts** anterior transverse suture; **6**: *Cryptops niloticus*, Yemen, head plate and tergites 1,2 and part of 3; **7**: *Cryptops anomalans hirtitarsis*, head plate simplified from Brolemann (1930); **8**: Tergite 1 of the same.

Head plate. In species with an anterior transverse suture on tergite 1 the posterior margin of the head plate usually overlaps tergite 1 (Fig. 5), and in species lacking that suture the reverse is the case (Fig. 6). Attems (1930) used overlapping or overlapped in his key, however there are exceptions. Thus, Verhoeff (1901) observed that in rare cases the head overlaps the anterior margin of tergite 1 in *C. hortensis*. *Cryptops dilagus* Archey, 1921, has an anterior transverse suture and tergite 1 overlaps the head plate. In *C. canariensis* Latzel, 1895, from the Canary Islands (Gran Canaria), the posterior margin of the head plate is generally overlapped by the anterior margin of the first tergite but specimens from Tenerife show no preferential arrangement i. e. overlapped or overlapping (Zapparoli 1989).

The paramedian sutures on the head plate may vary. For example, the posterior longitudinal sutures are short or absent in *C. canariensis* (Zapparoli 1989), and complete or incomplete in *C. croaticus* Verhoeff, 1931 (Matic 1972). According to Verhoeff (1931) they are usually complete in *C. anomalans* but may be broadly interrupted (Verhoeff may have been referring to the condition in *C. anomalans hirtitarsis* Brolemann, 1928 (Fig. 7) which he regarded, incorrectly, as the female of *C. anomalans*). Nevertheless sutures are important specific characters: absent or very short in *C. canariensis*, always present and longer in the closely related *C. trisulcatus* Brolemann, 1902 (Zapparoli 1989). Similarly, they differentiate *C. parisi* (sutures at posterior margin of head) from *C. hortensis* (posterior sutures absent). According to Attems (1930) the Cretan *C. anomalans* var. *labyrinthiacus* Attems, 1902, lacks paramedian sutures on the head plate. Such differences should be assessed with circumspection. They may represent individual variation or different species, in which case other differentiating characters should exist.



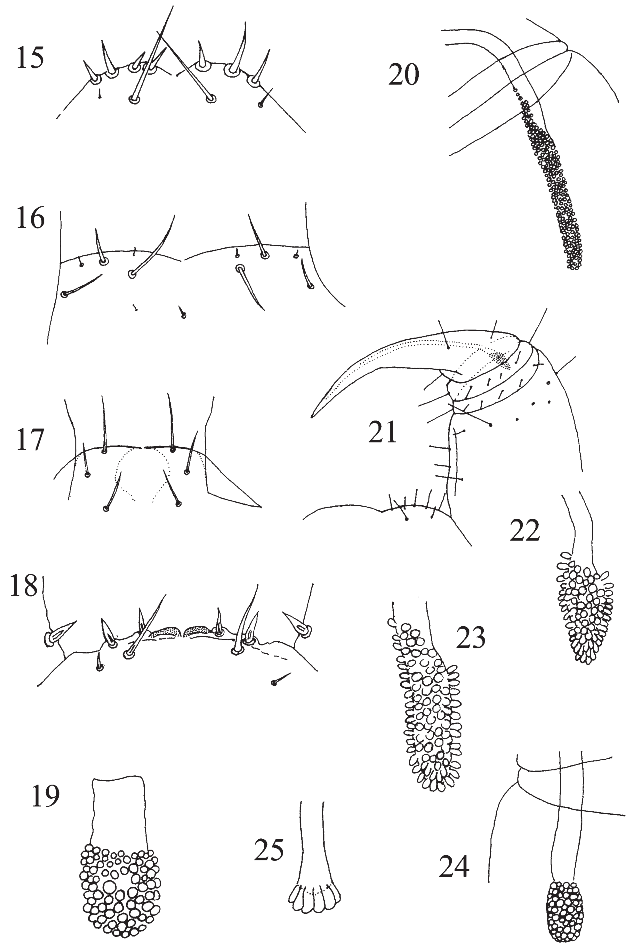
Figs 9 –14 **9**: *Cryptops decoratus*, Aride, Seychelles, clypeus and part of labrum; **10**: *Cryptops ribauti,* Mont Nimba, Guinea, clypeus and labrum. (After Demange 1963); **11**: *Cryptops vulcanius*, Canary Islands, clypeus and labrum. (After Zapparoli 1990); **12**: *Cryptops doriae*, Nepal, clypeus. (After Lewis 1999); **13**: *Cryptops parisi*, Austria, atypical labrum. (After Pichler 1987); **14**: *Cryptops lobatus*, France, right forcipule and forcipular coxosternum. (After Verhoeff 1931).

Clypeus. The number of prelabral setae is quite often recorded for *Cryptops* species, but the arrangement of the other clypeal setae is noted much less often. In *C. decoratus* there is a pair of minute setae just anterior to a pair of post-antennal setae, behind which is a single median seta and then a pair. There is a row of six prelabral setae (Fig. 9). In *C. ribauti* Demange, 1963, the clypeal area is clearly delimited (Fig. 10). In the troglobitic *C. vulcanius* Zapparoli, 1990, the pair of post-antennal setae is absent but there are 19 irregularly arranged setae and a row of 10 in front of the labrum (Fig. 11). In some species, at least, the number of setae increases with age; thus, in small *C. doriae* (10.5 mm) there are 2 (post antennal) + 1 + 2 + 2 clypeal setae and a row of 8 prelabral setae. A larger specimen exhibits 4 (very small) +2 + 1 + 2 + 4 + 1 clypeals + 11 prelabrals (Fig. 12) but the basic arrangement (2 + 1 + 2 +2) is still evident. In *C. parisi* the number of prelabral setae varies between 8 and 15 and occasionally even 17 to 19 (Iorio & Geoffroy 2003). The arrangement of clypeal setae, and whether the clypeus is clearly delimited or not, may be useful characters which should be more fully explored. As it is difficult to convey the exact arrangement in words, verbal descriptions should always be accompanied by accurate illustrations.

Labrum. The sidepieces are not usually notched at their median angles, the labrum being described as unidentate. The only exceptions in the subgenus that I am aware of in which the sidepieces are notched (tridentate labrum) are *C. parisi, C. caucasius* Verhoeff, 1934 and *C. umbricus* Verhoeff, 1931. The condition in the last being recorded by Iorio & Minelli (2005). Verhoeff (1931), however, reported specimens of *C. parisi* with the labrum incised on only one side (Fig. 13) and Pichler (1987) also recorded this condition. At least some Iberian specimens of *C. parisi* have a unidentate labrum (Lewis, unpublished). This labral character (tridentate) should, therefore, be used with caution: a good character when present but not necessarily indicating different species when absent. The condition is also seen in *C.* (*Trigonocryptops*) *spinipes* Pocock, 1891 (Schileyko 2007).

Forcipular coxosternum. The shape of the anterior margin of the forcipular coxosternum is sometimes used as a specific character, as in *C. lobatus* Verhoeff, 1931, where it is produced into two pronounced lobes not seen in any other species (Fig. 14). The shape is sometimes subject to variation; thus Kraepelin (1908) reported that it was swollen (‘gewulstet’) in older but not young *C. australis*. The anterior margin is mostly incised medially, but can be completely straight.

The type and arrangement of setae on the anterior margin, as well as those posterior to it, are useful characters but have not been widely used. In some species, such as *C. parisi*, the setae are situated on the anterior margin (Fig. 15), in others, e.g. *C. decoratus* they are submarginal (Fig. 16). According to Verhoeff (1902–25), the number of marginal setae in *C. hortensis* increases from 1+0–1 on each side in stadium adolescens I, to 1+4–5 in the maturus. The smallest individuals of *C. parisi* have no setae on the anterior margin, just a single submarginal seta on each side (Fig. 17) (Koren 1986). There may also be some individual variation. *Cryptops aelleni* Demange, 1963 has two elongated sclerotised protruberances on the anterior wall (Fig. 18).



Figs 15–25 **15**: *Cryptops parisi,* Vascões, Portugal, anterior wall of forcipular coxosterum; **16**: *Cryptops decoratus*, Aride, Seychelles, anterior wall of forcipular coxosterum; **17**: *Cryptops parisi*, Austria, anterior wall of forcipular coxosterum of a very small specimen. (After Koren 1986); **18**: *Cryptops aelleni*, Mont Nimba, Guinea, anterior wall of forcipular coxosterum. (After Demange 1963); **19**: *Cryptops trisulcatus*, poison gland calyx. (After Verhoeff 1931); **20**: *Cryptops parisi*, Castanheira, Portugal, poison gland calyx; **21**: *Cryptops hortensis*, Monte de Santa Tecla, Spain, anterior wall of forcipular coxosternum and forcipule; **22**: Poison gland calyx of the same; **23**: *Cryptops hortensis*, St Helena, poison gland calyx; **24**: *Cryptops doriae*, Le Niol, Seychelles, poison gland calyx; **25**: *Cryptops daszaki*, Les Aigrettes, Mauritius, poison gland calyx.

Poison glands. Verhoeff (1931) suggested that the poison gland was of taxonomic significance noting that in *C. trisulcatus* Brolemann, 1902, the pore tube is short and wide and the pores vary in size (Fig. 19). He noted however, that in most species the pores of the gland are small and of equal size (Fig. 20). In *C. parisi* and *C. lobatus* the elongated pore tube reaches halfway down the forcipular trochanteroprefemur (figs. 14 and 20), whereas in *C. hortensis* the calyx is short, situated mainly in tibia (Fig.21), and varies in shape (Figs 22 and 23). Rounded calyces vary from goblet-shaped in *C. mauritianus* Verhoeff, 1939 (Fig. 24), to a shallow cup-shape in *C. daszaki* Lewis, 2002 (Fig. 25), this latter condition probably relating to the small size of the species (7.5 mm maximum).

Chao & Chang (2006) described the rounded calyces of *C. japonicus* Takakuwa, 1934, and *C. nigropictus* Takakuwa, 1936. Noting that Lewis (1999, 2002) had described rounded ones in three other species, all situated anteriorly in the trochanteroprefemur, they suggested that this short form of the poriferous region separated *Cryptops* from all other genera of Scolopendromorpha that they examined. Verhoeff's (1931) and subsequent observations show that there is much greater variation in the genus than Chao & Chang supposed, the structure of the poison gland in some *Cryptops* resembling the long cylindrical calyces in other scolopendromorphs.

Tergite 1. An anterior transverse suture ('Querfurche') is either well-developed on tergite 1 or absent. An exception is *C. vanderplaetsini* Demange, 1963 where it is incomplete in two specimens and complete in five others ('variety' *perfectus*). The other sutures on tergite 1 are subject to more variation. In *C. anomalans*, a cruciform suture which runs from the anterior transverse suture sometimes encloses a small area at its point of intersection at the centre of the tergite, and there is sometimes a median suture running anteriorly and sometimes one posteriorly Verhoeff (1931) (Fig. 8). Verhoeff noted that small subsidiary sutures may be present but the basic pattern is unchanged. Matic (1972) illustrated some of the variation in *C. anomalans* and *C. croaticus*. According to Attems (1930) the Cretan *C. anomalans* var. *labyrinthiacus* Attems, 1902, lacks cruciform sutures. In *C. trisulcatus* a pair of sutures diverge from the mid-point of the anterior transverse suture (Fig. 26) but these may or not converge and join the transverse suture separately (Fig. 27). In *C. trisulcatus* var. *cassinensis* Verhoeff, 1931, only short posterior paramedian sutures are present. In *C. canariensis* the longitudinal sutures running back from the anterior transverse suture do not reach the posterior margin of the tergite and may be absent or, especially in specimens from Tenerife, continue to the posterior tergal margin as in *C. trisulcatus* (Zapparoli 1989). As with variation in cephalic sutures, these differences should be assessed with circumspection. They may represent individual variation, population differences, or different species.

Tergite paramedian sutures and sulci (furrows). In *Cryptops* each tergite paramedian suture (hinge line) (Fig. 28) lies in a sulcus (groove or furrow) that may extend beyond the limit of the suture or vice versa (Lewis et al. 2005). Sulci are visible with reflected light but are not seen in cleared specimens, in which, however, the sutures are distinct (Lewis, 1999).

According to Archey (1924), the condition of these sutures in New Zealand species constitutes one of the most constant distinguishing characters (Archey used the term sulci but as he used the term 'cephalic sulci' I presume that he meant what are here termed sutures). *Cryptops australis* and *C. dilagus* have incomplete sutures on segments 4 and 5 or 3 and 4 or 3 to 5, complete sutures on 6 to 19, and complete or incomplete ones on 20. They can be separated from *C. lamprethus* Chamberlin, 1920, and *C. polyodontus* Attems, 1903 (incomplete from 3 to 7, complete 8 to 18, incomplete on 19), despite moderate individual or age variation. On the whole, the incomplete sulci extend further cephalad and caudad in larger specimens. Lawrence (1960) used 'tergites sans sillons paramédians' to distinguish *C. milloti* Lawrence, 1960, from other Malagasy species**.**

In a population of small *C. doriae* (maximum size of specimens 13 mm) the paramedian sutures are very fine, can only be seen under high magnification in specimens cleared in ethylene glycol and their precise extent is difficult to determine (Lewis 2007a). In a very small (5.5 mm) individual of *C. niloticus* Lewis, 1967, tergal paramedian sutures were absent.

Whilst sometimes useful, there is clearly individual variation in both the extent of paramedian sutures and sulci, and the degree of development of the former clearly varies with age. When viewed by reflected light the apparent extent of the sulci varies with the angle of illumination. The characters are more easily viewed in air, which risks desiccation especially with small specimens. Good photographs or scanning electron micrographs would be invaluable here.

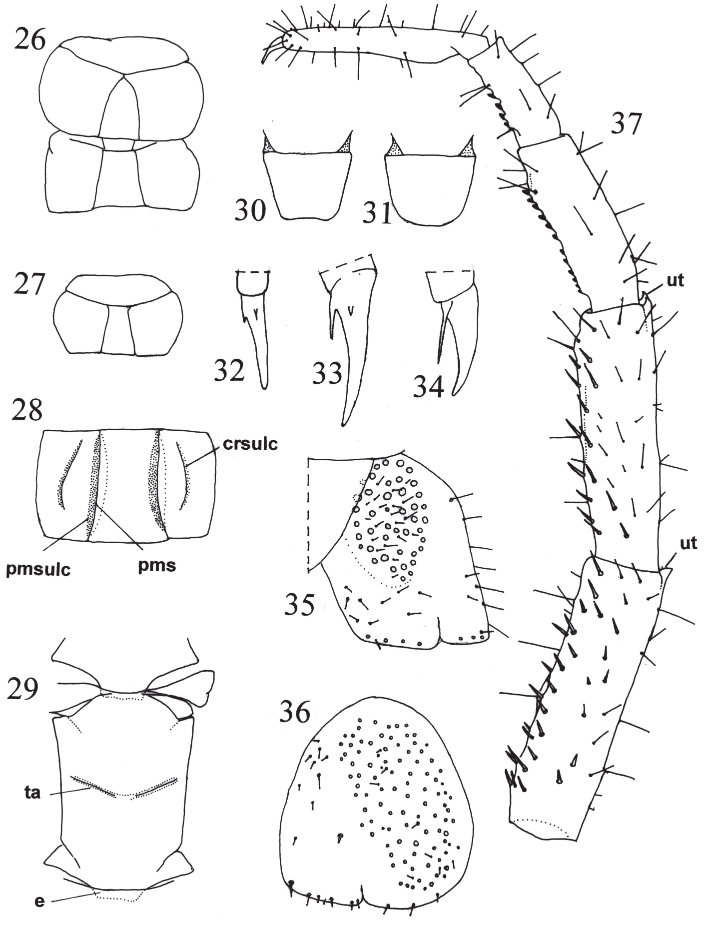
Lateral crescentic sulci. Lateral crescentic sulci (Brolemann's 'sillons arqué') (Fig. 28) are present on most segments in probably all species. They are visible in reflected light but not in cleared specimens, although the apodeme beneath them is then seen. Archey (1924) noted that these sulci are present on more segments in older specimens and their limits are less easy to discern than paramedian sulci because they gradually fade out. These have not been used in taxonomic discrimination and appear to be of little value.

Endosternites. The endosternites (Fig. 29) are only seen in cleared specimens and are infrequently used in keys. Brolemann (1930) used 'endosternites limited anteriorly by crossed fissures' in *C. anomalans* and, for *C. hortensis* and *C. parisi*, as far as segment 3 in the former and segment 5 in the latter. However, as the endosternites become progressively smaller on posterior sternites, a decision as to when they disappear may be subjective.

Sternite sulci and transverse skeletal thickening. The sternites are divided as far forward as the second segment by an arched transverse sulcus (groove) with the concavity anterior running between the coxae; in addition, there is generally a median longitudinal sulcus. Seen by reflected light, the apparent extent of the sulci varies with the angle of illumination and they are best illustrated by photos or scanning electron micrographs. They require further investigation. Lewis (1999) used the transverse sulcus 'narrow and sclerotised' as a character for *C. nepalensis* Lewis, 1999.

Beneath the tergal surface lies a transverse apodeme and sometimes traces of a longitudinal apodeme that may bifurcate anteriorly. The apodeme is only seen in cleared specimens (Fig. 29) and is not always apparent; for example, it is absent or weak and incomplete in *C. niloticus* and was present in only one specimen of *C. neocaledonicus muchmorei* Lewis, 1989. It appears to be of little, if any, taxonomic value in the subgenus.

Shape of sternite 21. Posterior margin of sternite 21 curved or straight (truncated) can be a good character, as for example the truncated margin in *C. hortensis*. In other species it is variable. Thus Kraepelin (1908) described the posterior margin of sternite 21 in *C. australis* as typically truncated but also occasionally rounded. It is straight or weakly rounded in Nepalese *C. doriae*. In *C. dilagus* it is slightly convex, straight or slightly emarginate (Figs. 30, 31).



Figs 26–37 **26**: *Cryptops trisulcatus*, Monaco, France, tergites 1 & 2. (After Brolemann 1930); **27**: *Cryptops trisulcatus*, France, tergite 1. (From Brolemann 1930, after Ribaut); **28**: *Cryptops* sp., tergite of mid trunk. **crsulc** crescentic suture, **pms** paramedian suture, **pmsulc** paramedian sulcus; **29**: *Cryptops parisi*, posterior margin of sternite 4 and sternite 5, **e** endosternite, **ta** transverse apodeme. (Simplified from Brolemann 1930); **30**: *Cryptops dilagus*, Mount Algidus, New Zealand, sternite 21. (After Archey 1921); **31**: *Cryptops dilagus*, Akaroa, New Zealand, sternite 21. (After Archey 1921); **32**: *Cryptops hortensis*, Monte de Santa Tecla, Spain, pretarsus (claw) leg 2; **33**: *Cryptops parisi*, Vascões, Portugal, pretarsus (claw) leg 5; **34**: *Cryptops niloticus*, Rodrigues, pretarsus (claw) leg 18; **35**: *Cryptops doriae*, Nepal, coxopleuron. (After Lewis 1999); **36**: *Cryptops parisi*, coxopleuron. (After Eason 1964); **37**: *Cryptops trisulcatus,* ultimate leg, **ut** unciform tubercle. (After Brolemann 1930).

Tarsi of walking legs (Legs 1 to 19). According to Attems (1930) members of the subgenus *Cryptops* have tarsi 1 to 19 mostly undivided in contrast to *Trigonocryptops* where they are mostly divided. He used 'present' or 'absent' in his 1930 key, but as there may be only the faintest indication of tarsal subdivision, scoring this character is difficult. In *C. doriae* from Nepal for example, the tarsi of most legs are divided; in some specimens this is obvious, especially if tarsi 1 and 2 are flexed, but in others the division is very faint. In such cases repeated observations were not always consistent. This is a subjective character unless the tarsus is clearly divided.

Accessory pretarsal spurs (claw spines). The character can be useful, at least in some species, for example in separating small *C. mauritianus* from *C. decoratus* (Lewis 2002). They also differ in *C. hortensis* where there are two very short spurs (Fig. 32) and *C. parisi* where there is one long and one short (Fig. 33). In *C. niloticus* there is a single spur (Fig. 34). Careful examination is required, as a smaller second spur may not be obvious. Lewis (2003) suggested that the accessory pretarsal spurs might be subject to wear so their size, which has been used as taxonomic character, should be treated with caution. This, however, this appears to have been conjecture.

20th pair of legs. Kraepelin (1903) observed that a covering of dense short setae ('stärkere flaumige Behaarung') on the underside of the prefemur, femur, and tibia of the twentieth pair of legs characterises males, a condition recorded in New Zealand species by Archey (1924). However, Verhoeff (1931) found no difference between male and female *C. anomalans*, but this is unusual if, indeed, it is the case. According to Koren (1986) the 20th pair of legs in *C. hortensis* is thin and as long as the ultimate legs, in contrast to *C. parisi*, where they are never as long as the ultimate legs.

Coxopleura. Verhoeff (1902–25) described the increase in coxopleural pores in the postembryonic stadia of *C. hortensis* from 11–12 in the adolescens I to 65–90 in the maturus. Archey (1924) noted that, although the number varied in accordance with size, specimens of equal size in some species could be distinguished by the number of pores. *Cryptops australis* (17 mm to 35 mm in length) has 17 to 34 pores, *C. dilagus* (27 to 33 mm) has 73 to 85 and *C. lamprethus* Chamberlin, 1920, has 100 to 150. This character is, however, generally of little use.

In most cases a 'wide pore-free strip (Fig. 35)', or 'pores almost reaching the posterior margin of the coxopleuron (Fig. 36)', is a good character, as shown by Archey (1924) for *C. dilagus* and *C. lamprethus.* An exception is *C. parisi* in which Brolemann (1930) described the pore field as not reaching the posterior margin of the coxopleuron, but Eason (1964) described it as almost doing so (Fig. 36). In this particular case, the extent of the pore field increases with the size of the individual. In Iberian specimens, however, the pore field does not reach the posterior margin of the coxopleuron although the specimens are mature (Lewis, unpublished data).

The distribution of setae within and without the pore field varies with the species. A single seta in the posterior region of the pore field is a characteristic of *C. hortensis*, but in most species the number of setae increases with age. There may be no setae in the smallest specimens and a few or many in larger ones. For example there are 4 or 5 pores with no setae in the field in the smallest specimens of *C. nepalensis*, 56 pores and about 20 setae in the largest (Lewis 1999). In *C. parisi* the setae vary from 6 in immatures to 29 in large adults (Iorio & Geoffroy 2003).

Ultimate (21st) pair of legs. Apical or end teeth ('Endzähne', 'Endzähnchen or 'Dornen') that may be situated dorso-distally at the end of the prefemur, femur and tibia of some *Cryptops* species, were not considered by Lewis et al. (2005). The current state of knowledge suggests that they are tubercle-like or unciform (hooked) (Fig. 37) in the nominate subgenus but spiniform in some species of the subgenus *Trigonocryptops*, for which Lewis (2005) termed dorsomedial and dorsolateral spinous processes. *Cryptops* (*Trigonocryptops*) *spinipes* from Vietnam has tuberculate end teeth (Schileyko 2007). Attems (1930) used the terms 'Endzähne' and 'Endzähnchen' for the structures in both subgenera but did not illustrate them.

The distribution of the tubercles was used by Zapparoli (1989) as a distinguishing feature – present on the external side of the femur and the internal and external sides of the tibia, absent on the prefemur in *C. canariensis*; present on the internal side of the prefemur and on the internal sides of the femur and tibia in *C. trisulcatus*. They are fainter and less evident in *C. canariensis* than in *C. trisulcatus*. In some species, however, they are variable: one tubercle present or absent on the femur and two (lateral and medial) present or absent on the tarsus in *C. doriae* (Attems 1907, 1930). They are very rarely present in *C. doriae* from Nepal (Lewis 1999). Schileyko (2007) considered that these tubercles are of little taxonomic value, at least in *Cryptops* s. str.

It has long been appreciated that the number of saw teeth on the tibia and tarsus of the ultimate leg increases with the size of the animal. Verhoeff (1902–25) gave data for *C. hortensis* and Kraepelin (1908) for *C. australis*. However, the number in mature individuals is of value as is their shape, size and spacing. The presence or absence of one, two or, rarely, three such teeth on the femur is an important distinguishing feature and appears to be constant, although the single tooth may sometimes be insignificant and easily overlooked.

C. hortensis is characterised by the presence of a ventral groove on the prefemur and femur, but Pichler (1987) described as *C.* cf. *hortensis* specimens from 1000 to 1300 m in the Austrian North Tirol lacking this groove that were otherwise typical *hortensis*. She considered their status as uncertain, more material being required to clarify the problem.

Verhoeff (1931) recorded slight but significant sexual differences in the ultimate legs of *C. hortensis* and *C. parisi*. In males the lateral surface of the prefemur and femur bears many long setae, whereas in females the lateral surface of the prefemur predominantly bears spinous setae and the spinous and non-spinous setae on the femur are sparse. These observations have not been repeated. According to Demange (1981) the ultimate legs in *C. philammus* Attems, 1928, exhibit secondary characters. In the male they are short with a different pilosity compared to the female. The setae are long, relatively less dense and the spinous setae are more numerous, robust and shorter. Demange, however, was dealing with at least two species (Lewis 2007b). The degree of development and distribution of lanceolate and spinous setae varies between species but is not reviewed here. They are best illustrated by photos or electron micrographs.

3. Discussion and conclusions

The characters used in *Cryptops* taxonomy vary in their reliability. The structure of the poison gland and the shape and disposition of setae on the anterior region of the forcipular coxosternum appear, however, to be reliable in all except very young specimens in the case of the latter. The sutures on the head plate and tergite 1 are good characters although sometimes variable. The coxopleura and ultimate legs too provide valuable characters. Some, such as the relationship between the head plate and tergite 1, hold for most but not always all individuals. Yet other characters, for example the shape of sternite 21, are consistent for some species but not others. Subcutaneous pigmentation may be invariably present in some species. In others, it is sometimes present. Many species, however, never show this pigmentation. The arrangement of clypeal setae may prove to be useful even though the number of setae appears to increase through development.

Clypeal setae, poison glands and pretarsal spurs of the walking legs have been under utilised and more data are required on the claw of the second maxilla and the pretarsal spurs. It is sometimes difficult to make reliable decisions about certain characters, for example whether the tarsus is or is not divided, the limit of endosternites and the presence or absence of dorso-distal tubercles on the prefemur, femur and tibia of the ultimate leg.

It is desirable to examine both cleared and uncleared specimens but it may not be practical to clear large individuals. Pereira (2000) recommended ethylene glycol as a clearing agent for geophilomorphs as specimens can remain in it indefinitely without distortion and can be directly mounted in Canada Balsam. He noted that 60 % lactic acid causes slight swelling of the appendages and a slight increase in length over that measured in 70 % alcohol. In *Cryptops* this may result in the separation of the head capsule and first tergite so that one no longer overlies the other. Whilst many characters, in particular sutures, are readily visible in cleared specimens, some e.g. the poison glands, endosternites, sternal transverse apodemes, spermatophores, ova and seminal receptacles are only visible in cleared specimens. Viewed by reflected light the apparent extent of tergite and sternite sulci varies with the angle of illumination.

Not discussed above are human observational errors; we don't find what we don't look for. The need for accurate illustrations cannot be over emphasised. For example, the distribution of antennal and clypeal setae is not easy to convey in words but easily illustrated. Good illustrations speak louder than words, which may even convey the wrong meaning. Figures with a few setae added at random are of little value. Furthermore, accurate illustrations record features that may prove significant at a later date. Thus Verhoeff (1931) pointed out that the differences in the position of the poison glands of *C. hortensis* and *C. parisi*, that were not mentioned by Brolemann (1930) were shown, albeit faintly, in his Fig. 352 (for *parisi*) and 366 (for *hortensis*).

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