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On the consistency of some taxonomic characters in the Scolopendromorpha and comments on the scolopocryptopid subfamily Kethopinae (Myriapoda: Chilopoda)

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Abstract. With the increase in taxonomic data it has become apparent that some characters are less reliable as phylogenetic and taxonomic characters in the Scolopendromorpha than previously thought. Examples of this are considered. The problematic scolopocryptopid subfamily Kethopinae is discussed. New World species of *Scolopendra* Linnaeus, 1758 plus the Old World species *S. valida* Lucas, 1840 are a monophyletic group, usually with an anterior transverse sulcus (ring furrow) on T1. A subgroup of ten species have 17 antennal articles, and dorsodistal prefemoral spines on legs anterior to the ultimate pair. A second subgroup of six species have more than 17 antennal articles and lack the dorsodistal prefemoral spines on legs anterior to the ultimate pair. Exceptions are discussed. *S. valida* fits into neither group. Some *Cryptops* (*Trigonocryptops*) Verhoeff, 1906 lack the otherwise characteristic sternite trigonal sutures and *C.* (*Cryptops*) *anomalans* Newport, 1844 shows some of the morphological characters used to characterise *Trigonocryptops* Verhoeff, 1906. The rather incomplete data for *Kethops utahensis* (Chamberlin, 1909) (Scolopocryptopidae, Kethopinae) and the description of *Thalkethops grallatrix* Crabill, 1960 suggests that they are characterised by ultimate legs with rows of saw teeth on the prefemur, femur and tibia, with a single saw tooth on tarsus 1. This is not the case, however, in *K. atypus* Chamberlin, 1943 which shows characters typical of many *Cryptops* species and may be a *Cryptops* with 23 leg-bearing segments. The reason why some important characters may be overlooked is discussed.

Key words. Taxonomy, Myriapoda, Chilopoda, Kethopinae, New World *Scolopendra*, *Cryptops*, *Kethops*, *Thalkethops*.

INTRODUCTION

Edgecombe (2007) reviewed the changes in schemes of scolopendromorph classification since Attems' (1930) monograph and Di et al. (2010) reviewed the Plutoniumidae showing how opinions as to the value of some morphological characters have changed.

Attems (1930) distinguished two scolopendromorph families largely on the presence or absence of ocelli, the Scolopendridae with, the Cryptopidae without. Schileyko (1992, 1995), however, regarded leg number to be of great significance recognising two suborders, the Scolopocryptopida Newport, 1844 with 23 leg-bearing segments and Scolopendrida Newport, 1844 with 21. He also considered the number of spiracles to be of major importance separating his Scolopendrida into the families Plutoniidae with 19 pairs of spiracles and Scolopendridae comprising five subfamilies: the Sterropristinae with ten pairs, i.e. spiracles on segment seven and Otostigminae, Scolopendrinae, Theatopsinae and Cryptopinae with nine, i.e. without spiracles on segment seven. The Scolopendrida thus included both blind and ocellate clades.

Shelley (2002) also regarded leg number as of fundamental importance, distinguishing the blind Scolopocryptopidae with 23 pairs of legs and Cryptopidae with 21 pairs of legs, from the ocellate Scolopendridae also with 21 pairs of legs.

A unique exception to the condition in Scolopendridae is provided by *Scolopendropsis bahiensis* (Brandt, 1841) which has 23 pairs of legs. Schileyko (2006) showed that *Rhoda calcarata* (Pocock, 1891) with 21 pairs of legs was a junior synonym of *S. bahiensis* so leg numbers can vary intraspecifically in the Scolopendridae. Vahtera et al. (2013) have shown that the Plutoniumidae with 21 trunk segments nest within the Scolopocryptopidae with 23.

With respect to spiracle number, Di et al. (2010) described *Theatops chuanensis* Di, Cao, Wu, Yin, Edgecombe et Li, 2010 (Plutoniumidae) which has well developed spiracles on segment 7. These are absent in all other known species of *Theatops* Newport, 1844. They reviewed the literature and observed that evidence is increasing to indicate that the presence or absence of spiracles on segment 7 is less reliable as a phylogenetic and taxonomic character than previously thought. Subsequently Edgecombe (2012) placed *Dinocryptops* Crabill, 1953 which has spiracles on segment 7 in synonymy with *Scolopocryptops* Newport, 1844 where they are absent and Vahtera et al. (2013) showed that *Tidops* Chamberlin, 1915 which lacks segment 7 spiracles nests within *Newportia* Gervais, 1847 which has them.

Vahtera et al. (2012, 2013) concluded that the blind Scolopendromorpha (Plutoniumidae, Cryptopidae, Scolopocryptopidae) unite as a monophyletic group consistent with a single event of eye loss i.e. Attems' (1930) Cryptopidae excluding *Mimops* Kraepelin, 1903 which has a single ocellus on each side of the cephalic plate and which Lewis (2006) placed in a separate family Mimopidae. Only one species of Scolopendridae, the Vietnamese *Tonkindentus lestes* Schileyko, 1992, is blind. Vahtera et al. (2013) concluded that eye-loss may therefore only have occurred twice in the Scolopendromorpha.

Some other cases of species which show exceptions to the expected condition are discussed here as are the problematic scolopocryptopid subfamily Kethopinae. Possible reasons for under-recording of some exceptions are considered.

Additional data on American *Scolopendra* species in the Zoological Museum of Moscow University (ZMMU) kindly provided by Arkady Schileyko are incorporated.

The terminology for the external anatomy proposed by Bonato et al. (2010) is followed here.

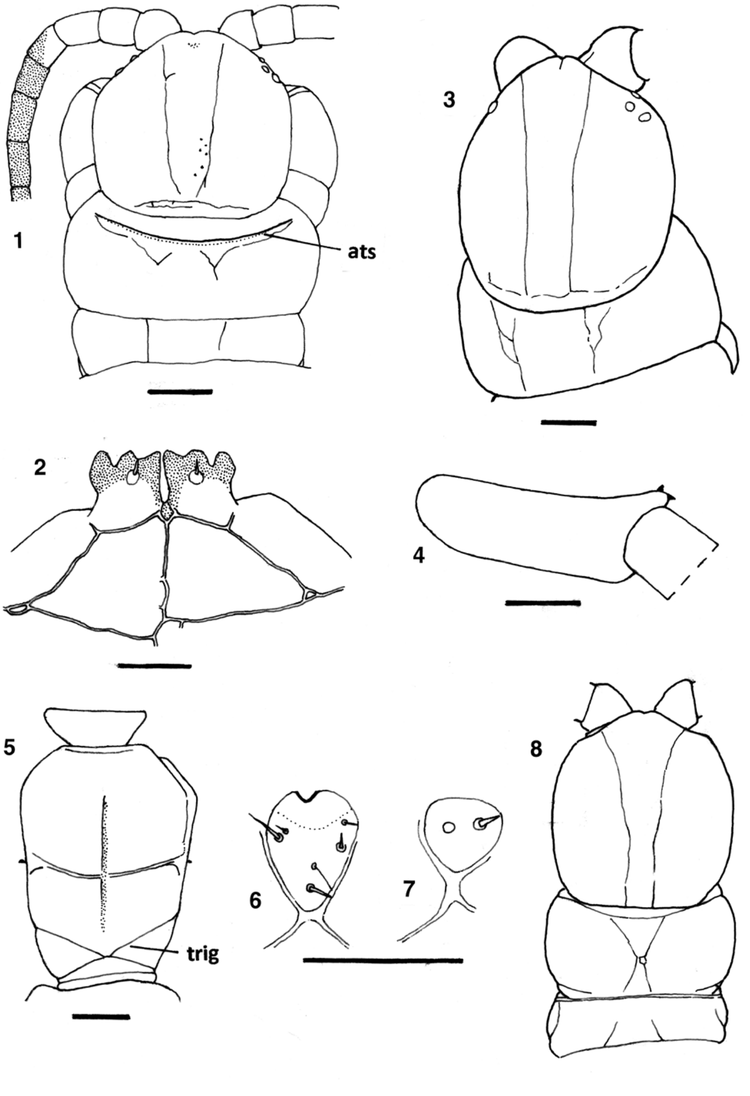
CONSISTENCY OF SOME TAXONOMIC CHARACTERS

Anterior transverse sulcus, antennal articles and legs with distodorsal prefemoral spines in American *Scolopendra* species

Analyses by Vahtera et al. (2013) resolve the New World species of *Scolopendra* Linnaeus, 1758 plus an Old World species *S. valida* Lucas, 1840, as a monophyletic group that are morphologically united by a ring furrow or groove (anterior transverse sulcus) on T1 (Fig. 1). This is von Porat's (1876) *Collaria* for which the replacement name *Nurettiniella* was proposed by Özdikmen (2007: see Vahtera et al. 2013 for details). Vahtera et al. (2013) concluded that there is a single origin of the ring furrow in Scolopendrini. In addition, most New World *Scolopendra* species have transverse and often also longitudinal sutures on the forcipular coxosternum (Fig. 2). Old World *Scolopendra* species (except *S. valida*) lack the transverse sulcus although the longitudinal sutures may be developed to a greater or lesser extent in some.

Fourteen of the 16 New World *Scolopendra* species have an anterior transverse sulcus on T1. However, *Scolopendra alternans* Leach, 1813 which clearly belongs to this group lacks this sulcus, it having failed to develop. Attems (1930) noted that the normally associated longitudinal sutures are scarcely visible. They are absent in small specimens from the US Virgin Islands (Lewis 1989), present, but very fine, in large specimens (Fig. 3). In a second species, *Scolopendra arthrorhabdoides* Ribaut, 1912 there are, according to Attems (1930), merely traces of the anterior transverse sulcus. It is absent in specimens from Colombia (Chagas Jr. et al. 2014). Arkady

Schileyko (personal communication) reports that whereas *S. pachygnatha* Pocock, 1895 and *S. viridicornis* have a solid/continuous and well-developed anterior transverse "suture", in *S. crudelis* C. L. Koch, 1847 it is thin, discontinuous and branching. Paradoxically Kraepelin (1903) in



Figs 1–8. 1 – *Scolopendra valida*: Al Mindak, Saudi Arabia. Cephalic plate and tergites 1 and 2 after Lewis (1986), ats – anterior tranverse sulcus. 2 – *S. valida*: Kassala, Sudan. Coxosternal tooth plates after Lewis (1967). 3 – *S. alternans*: Cueva de Murcielagos, Cuba; leg. P. Beron. Cephalic plate and tergite 1. 4 – *S. valida*: W. Daykah, Saudi Arabia. Prefemur of leg 20. 5 – *Cryptops* (*Trigonocryptops*) *loveridgei*: Mbara, Tanzania. Sternite 5 after Lewis (2005), trig – trigonal sutures. 6 – *C.* (*T.*) *loveridgei*: Mbara, Tanzania. Clypeal setose plate. 7 – *C. anomalans*: Chapeltown, Sheffield, UK. Clypeal setose plate. 8 – *C. anomalans*: Cephalic capsule and tergites 1 and 2 after Eason (1962). Scale bars: Fig. 1 … 2 mm. Fig. 2, 3 & 4 … 1 mm. Fig. 5 … 0.5 mm. Figs. 6 & 7 … 0.25 mm.

Table 1. Some characters of New World *Scolopendra* species and *Scolopendra valida*. Based on data from Attems (1930), Shelley (2002), Minelli (2006) and Schileyko (personal communication). Atypical characters in bold

species	anterior transverse sulcus on T1	antennal articles	transverse coxosternal suture	legs with distodorsal prefemoral spines
Scolopendra alternans	**absent**	17	present	19–21
Scolopendra angulata	present	17	present	19–21
Scolopendra armata	present	17	present	19–21
Scolopendra arthrorhabdoides	**absent**	17	present	20, 21
Scolopendra crudelis	present	17–**18**	present	19–21
Scolopendra galapagoensis	present	17	present	2–21
Scolopendra gigantea	present	17	present	1/2–21
Scolopendra hermosa	present	17	present	18–21
Scolopendra robusta	present	17	present	**21 only**
Scolopendra viridicornis	present	17	present	varies from 1–21 to 20, 21
Scolopendra valida	present	**19–27**	present	19–21
Scolopendra heros	present	24–26	present	21 only
Scolopendra pachygnatha	present	25	**absent**	21 only
Scolopendra polymorpha	present	(21)25–31	**absent**	21 only
Scolopendra pomacea	present	**17**–18	**absent**	21 only
Scolopendra sumichrasti	present	23–26	present	21 only
Scolopendra viridis	present	21–31	**absent**	21 only

a footnote on page 226 noted that he found in the Paris Museum a typical *Scolopendra morsitans* Linnaeus, 1758 from Peking with a clear anterior transverse sulcus (*Halsringfurche*).

Lewis (2000) observed that the 10 New World *Scolopendra* species with 17 antennal articles have distodorsal spines on the prefemora of some of legs 1–20 in addition to those on the prefemoral process on the ultimate pair of legs (Fig. 4). Shelley (2002, Figs. 42–48) illustrates those of *S. alternans*. *Scolopendra robusta* Kraepelin, 1903 is an exception in lacking them. In most species they are confined to leg pairs 19 and 20 but are present on most legs in *S. galapagoensis* Bollman, 1889, *S. gigantea* Linnaeus, 1758 (illustrated by Shelley & Kiser, 2000) and on many or few in *S. viridicornis* Newport, 1844 (2–21 in ZMMU specimens from Brazil). Several species have, in addition, distodorsal femoral spines on some legs. ZMMU specimens NN6767 and 6768 of *S. crudelis* C. L. Koch, 1847 from Hispaniola have 17 or (atypically) 18 antennal articles and transverse coxosternal sutures not previously noted for the species.

Scolopendra valida, whose range extends from the Canary Islands to India, also has dorsal prefemoral spines on legs 19 and 20 but, in contrast to the New World forms, has variable number of antennal articles (19–27) rather than 17. Pocock (1888) noted that it "possesses characters which seem to point to relationship between it and some species from South America".

A second group of six species with a variable antennomere number (18–27) lack dorsodistal prefemoral spines on legs 1–20 (Table 1). The Mexican *Scolopendra pomacea* C. L. Koch, 1847 exceptionally has only 17 or 18 antennal articles. ZMMU specimens N6776 and N6777 of *S. pachygnatha* Pocock, 1895 from Jamaica have 19+20 and 18+18 antennal articles respectively (Attems, 1930 gave 25). Both specimens lack transverse coxosternal sutures (not previously recorded).

Species with 17 antennal articles are South and Central American, those with more than 17 North and Central American (Table 2). The inadequately described *Scolopendra hirsutipes* Bollman, 1893 from the West Indies is a possible member of the second group. The holotype is lost and Shelley (2002) regarded it as a junior synonym of *S. alternans*. It lacks an anterior transverse sulcus as does *S. alternans* but has 25–27 antennal articles. *Scolopendra alternans* has 17 so it seems unlikely that they are the same species. Mercurion (2016) is also of the opinion that *S. hirsutipes* is not *S. alternans* and suggests that *S. alternans* is probably an evolving species group.

Trigonal sutures in *Cryptops* (*Trigonocryptops*)

Verhoeff (1906) characterised his genus *Trigonocryptops*, as having paratergites clearly delimited, clypeus delimited by a triangular suture, a transverse thickening on the sternites between the coxae and endosternites delimited anteriorly by crossed (trigonal) sutures. Also a projection on each of the anterior corners of the endosternites, spiracles slit-like, the katopleure divided and all legs with divided tarsi. Another character shared by members of *Cryptops* (*Trigonocryptops*) is an anterior setose area on the clypeus delimited by sutures (Edgecombe 2005). Typical examples of the trigonal sutures and the anterior setose area on the clypeus are shown for *C.* (*Trigonocryptops*) *loveridgei* Lawrence, 1953 in Figs 5 and 6 respectively.

Attems (1930) pointed out that the tarsi of walking legs were not always divided and the head overlies T1 which has an anterior transverse suture, but these characters are seen in some *Cryptops* (*Cryptops*) Leach, 1815 species. Details of the endosternites are best seen in cleared specimens.

Vahtera et al (2013) drawing either upon morphological characters, molecular data or their combination for four species of *C.* (*Trigonocryptops*) concluded that the subgenus is monophyletic. Morphologically, the species analysed are united by shared presence of sternal trigonal sutures. However, Lewis (2005) synonymised *Paratrigonocryptops* Demange, 1963 from Mont Nimba, Guinea which comprises *C.* (*P.*) *royi* Demange, 1963, *C.* (*P.*). *quadrisulcatus* Demange, 1963, and *C.* (*P.*) *quadrisulcatus uncinulus* Demange, 1963 under *Cryptops* (*Trigonocryptops*) arguing that trigonal sutures can be very poorly developed and that Demange's species were, in fact, *Trigonocryptops* in which they were not expressed.

Table 2. Distribution of New World *Scolopendra* species and *Scolopendra valida*

species	distribution
Scolopendra alternans	South Florida, USA, West Indies, Venezuela, Brazil
Scolopendra angulata	West Indies, Venezuela, Bolivia, Ecuador, Brazil
Scolopendra armata	Venezuela, Brazil
Scolopendra arthrorhabdoides	Colombia
Scolopendra crudelis	West Indies
Scolopendra galapagoensis	Cocos Island, Galapagos; Costa Rica, Ecuador to S. Peru
Scolopendra gigantea	Venezuela. Records from the West Indies, Mexico and Honduras probably due to accidental human introduction
Scolopendra hermosa	Peru
Scolopendra robusta	Mexico
Scolopendra viridicornis	Colombia and Surinam to Argentina
Scolopendra valida	Canary Islands, Cameroon, through Northeast Africa to Saudi Arabia, Iran and India
Scolopendra heros	USA, Mexico
Scolopendra pachygnatha	Mexico, Jamaica
Scolopendra polymorpha	USA, Mexico, Hawaii (imported)
Scolopendra pomacea	Mexico
Scolopendra sumichrasti	Mexico Guatemala, Honduras, Panama
Scolopendra viridis	USA to Panama, Pearl Islands

Trigonocryptops **characters in** ***Cryptops anomalans***

Cryptops anomalans Newport, 1844 shows some of the morphological characters of *Trigonocryptops*. The most detailed description is that of Brolemann (1930) as *Cryptops savignyi*, Leach 1817. The species has the clypeus clearly delimited by a triangular suture and an anterior setose area on the clypeus with two setae also delimited by sutures (Fig. 7). These are also figured by Eason (1964) and for the holotype of *C. savignyi* by Lewis (2014). The anterior segments have well-developed endosternites with a projection on each of the anterior corners figured both by Brolemann and Eason. Brolemann's Fig. 336 shows what appear to be faint traces of trigonal sutures on S5 but these have not been recorded by other workers. He wrote that they gradually disappear from S7. Examination of a British specimen shows that the spiracles are oval rather than slit-like. Further sampling may show that the separation of the two subgenera *Cryptops* and *Trigonocryptops* may not be as clear cut as current research indicates. *Cryptops* (*Trigonocryptops*) *iporangensis* de Ázara et Ferreira, 2013, from Brazil, likewise only exhibits some characters of the subgenus.

Variation in the ***anomalans*** **group of** ***Cryptops*** **(*****Cryptops*****)**

Vahtera et al. (2013) reported some conflict is present between existing groupings of *Cryptops* (*Cryptops*) i.e. the *hortensis*, *doriae* and *anomalans* groups proposed by Lewis (2011, 2013) and their molecular trees. They showed that there is a well-supported clade that unites *C. hortensis* Donovan, 1810 and *C. parisi* Brolemann, 1920, of the *hortensis*-group with *C. anomalans*, and *C. punicus* Sivestri, 1896, of the *anomalans* group contradicting the morphological analyses. The term *anomalans* group was proposed for those species with an anterior transverse suture on tergite 1. It is here retained for convenience of reference. There are about 78 species in the group.

The presence of an anterior transverse suture on T1 tends to be associated with cephalic sutures and various and extensive sutures on T1, the anterior part of which is usually overlain by the cephalic plate (Fig. 8). This suggests that this set of characters may be linked or it could be an example of pleiotropism. However, the anterior transverse suture may be absent in some populations. For example *Cryptops dentipes* Lawrence, 1960 from Ankaratra, Madagascar has only a median longitudinal depression on T1 but a specimen from Tananarive has an anterior transverse suture (*sillon collaire*) but no central depression (*fossette*) (Lawrence 1960). *Cryptops vanderplaetseni* Demange, 1963 has a central crescentic depression and only lateral traces of an anterior transverse suture on T1 but *C. vanderplaetseni* var. *perfectus* Demange, 1963 has a complete anterior transverse suture. According to Kraepelin (1903) the head plate generally overlaps the anterior margin of T1 in *C. galatheae* Meinert, 1886 but rarely is the reverse the case; the anterior transverse suture may be present or absent.

Kethops **and** ***Thalkethops*** **(Scolopocryptopidae: Kethopinae)**

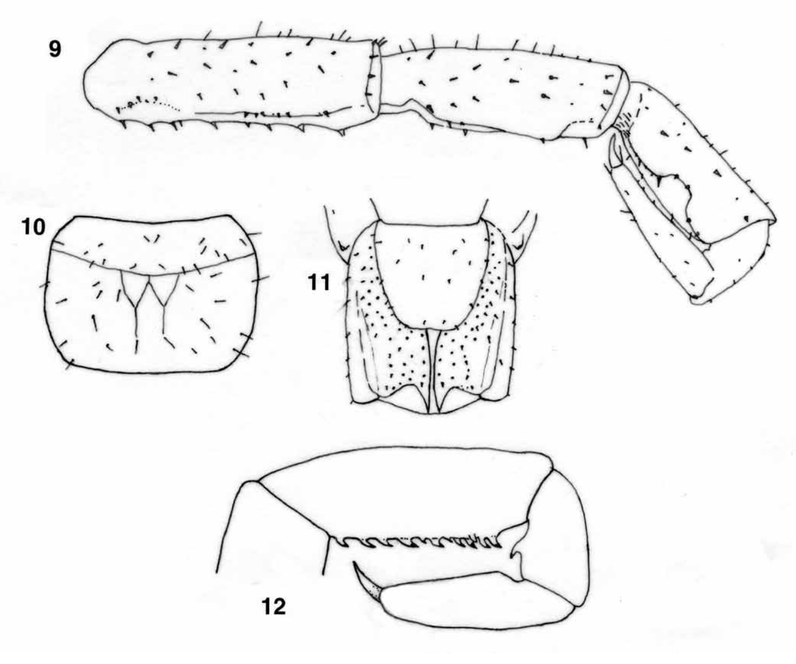
The Kethopinae, a subfamily of the Scolopocryptopidae, are not well known and present some interesting problems. Edgecombe & Bonato (2011) defined the Scolopocryptopidae, as lacking ocelli, with a pectinate second maxillary claw, the forcipular coxosternite without prominent serrate tooth-plates, but having at most a few small teeth and the number of leg-bearing segments invariably 23. The gizzard with stiff, pineapple-shaped projections, the main zone of projections having a kink near their midlength. The subfamily Kethopinae was erected by Shelley (2002) to receive *Kethops* Chamberlin, 1912, and *Thalkethops* Crabill, 1960. The subfamily he defined as having the ultimate legs curled and incrassate i.e. like *Cryptops*, second tarsi [of ambulatory legs] not redivided and prefemora of ultimate legs with more than one ventral spine [presumably saw tooth] apiece.

The type species of *Kethops*, *Kethops utahensis* (Chamberlin, 1909) was originally described as a *Newportia*. However, the specimen lacked ultimate legs. Chamberlin described a second specimen with ultimate legs in 1912. The description of the legs is puzzling "prefemur of anal legs armed with rows of spines on mesal and ectal surface and on most of the ventral. Femur similarly armed mesally and ventrally. The tibia with similar spines ventrally. Tarsi composed of but two joints and ending in a distinct and very stout claw." Chamberlin's Fig. 6 shows what appear to be short spinous setae rather than saw teeth (Fig. 9).

Crabill (1958) says of *Kethops* "Their diminutive size and pale colour, their suturation, their lack of prehensorial plates and denticles and their remarkable rear legs, which are almost identical with the type found in the Cryptopinae, all suggest a very close affinity with ... this subfamily despite the discrepancy in pedal segments between the two groups (23 vs 21)." However the claw of 2nd maxillary telopodite is pectinate (in his *K. euterpe* Crabill, 1958) as in other Scolopocryptopidae as he noted was the also the case for *Thalkethops* (Crabill, 1960). The gizzard morphology of *K. utahensis* shows scolopocryptopid characters (Koch et al. 2009) as does the morphology of the peristomatic region (Edgecombe & Koch 2008).

Shelley (2002) synonymised *Kethops leioceps* Chamberlin, 1925, *Cryptops colomanus* Chamberlin, 1941, *Cryptops glenvilleus* Chamberlin, 1941 and *Kethops euterpe* under *Kethops utahensis*. That Chamberlin having described *Kethops* should then have described two "*Cryptops*" species from California is surprising. Shelley (2002) examined the holotypes and finding that they have 23 pairs of legs synonymised them under *Kethops*, and concluded (e-mail dated 21 November 2013) that Chamberlin "didn't even bother to count the legs".

Shelley (2002) in his diagnosis of *K. utahensis* gives maximum length 27 mm, cephalic plate overlapping T1, with cervical groove (anterior transverse suture) giving rise to sutures in "W"



Figs 9–12. 9 – *Kethops utahensis*: ultimate leg after Chamberlin (1912). 10 – *K. euterpe* (= *utahensis*): tergite 1 after Crabill (1958). 11 – *K. utahensis*: ultimate leg bearing segment, ventral after Chamberlin (1912). 12 – *Thalkethops grallatrix*: tibia and tarsi of ultimate leg after Crabill (1960).

Table 3. Numbers of saw teeth on the articles of the ultimate pair of legs of the species of Kethopinae. ND = No data. Atypical numbers in bold

	prefemur	femur	tibia	tarsus 1
Kethops utahensis synonyms[1]				
Kethops leioceps Chamberlin, 1925	4	4	a series	ND
Cryptops colomanus Chamberlin, 1941	**0**	3	12	1
Cryptops glenvilleus Chamberlin, 1941	3	3	7	1
Kethops euterpe Crabill, 1958	3	3–4	9–10	1
Thalkethops grallatrix Crabill, 1960	7	12	11	1
Kethops atypus Chamberlin, 1943	**0**	**0**	6	**3**

[1] Chamberlin's (1912) description of the ultimate legs of *K. utahensis* is confusing.

configuration (Fig. 10). Further details are given in Crabill's (1958) description of *K. euterpe*: sternites with pronounced submarginal sulci, coxopleuron with a "spine", presumably a process, with 3 small spines. Chamberlin (1912) illustrated this "process" in his *K. utahensis* (Fig. 11). The ultimate legs of *K. euterpe* have 3 saw teeth on the prefemur, 3 or 4 on the femur, 9 or 10 on the tibia and one on the tarsus. Crabill (1958) used the term spine for saw tooth. *Thalkethops grallatrix* Crabill, 1960 is not dissimilar to *K. euterpe* having 7 prefemoral, 12 femoral, 11 tibial saw teeth and one on tarsus 1. The sternites lack submarginal sulci and there is a short spinous coxopleural process.

Apart from Chamberlin's (1912) puzzling Fig. 6, the only figures of the ultimate legs of Kethopinae are Crabill's (1958) Fig. 3 of the tibia and tarsus 1 and 2 of his *K. euterpe* and his Fig. 15 (Crabill 1960) of the tibia and tarsus 1 and 2 of *T. grallatrix* (Fig. 12). As the prefemur and femur were not illustrated by Crabill, I initially thought that only the tibia and tarsus 1 bore saw teeth.

Chamberlin's terminology for the articles of the ultimate leg in his "species" is confusing. For his *Cryptops colomanus* he gave "third joint [prefemur] of anal legs with numerous short spines beneath ... fourth joint [femur] with longer, stout setae beneath but no spines, bearing a longitudinal series of three widely separated teeth, the fifth joint [tibia] with a series of 12 teeth beneath, and the first tarsal joint with one." For *Cryptops glenvilleus* he gave "third joint [prefemur] of anal legs with a longitudinal series of three well spaced teeth ... fourth joint [femur] with three well spaced teeth ... the fifth joint [tibia] with a comb like series of seven teeth and the first tarsal joint with one tooth beneath".

In Chamberlin's "*K. leioceps*" "The anal legs in general as *utahensis* ... femur [prefemur] toward mesal side of ventral surface a series of four stout spines or teeth. Tibia [femur] also with a series of four ventral teeth. Metatarsus [tibia] with a ventral series of close-set teeth, not with an edge excised in the middle as in *utahensis*".

The distribution of saw teeth described for the various *K. utahensis* specimens and for *K. atypus* Chamberlin, 1943 and *T. grallatrix* is shown in Table 3.

Kethops atypus is quite unlike *K. utahensis*. Shelley's (2002) figure 145 of the holotype shows the cephalic plate, which lacks sutures, is overlapped by T1 which also lacks sutures. Chamberlin gave cephalic plate overlapping the first tergite! Chamberlin made no mention of sternite submarginal sulci which are present in *K. utahensis* nor of a coxopleural process and described the ultimate leg spinulation as metatarsus [tibia] armed beneath with a series of six teeth, the first tarsal joint with a series of three teeth. These are, apart from the fact that there are 23 pairs of legs, characters of many *Cryptops* species. There are no data on the maxillae, gizzard or peristomatic region. Further data are required but it is possible that this is uniquely a *Cryptops* with 23 pairs of legs.

If this is so, then we might categorise *Kethops* as having the ultimate legs with (0)3–4 prefemoral, 3–4 femoral, 7–12 tibial saw teeth and a single saw tooth on tarsus 1. In *Thalkethops* there are numerous prefemoral, femoral and tibial saw teeth but, again only a single saw tooth on tarsus 1. The remarkable and unique Brazilian *Cryptops* (*Cryptops*) *spelaeoraptor* de Ázara et Ferreira, 2014 has numerous saw teeth on all articles of the ultimate legs.

DISCUSSION

Key characters such as the anterior transverse sulcus on T1 in American *Scolopendra* species may not always be expressed. Similarly 35 or the 36 species of *Newportia* reviewed by Schileyko and Minelli, 1998 have an anterior transverse suture on T1 but in one, *Newportia sargenti* Chamberlin, 1958 from Venezuela the suture is absent. It may also be the case that some *Trigonocryptops* lack the usually characteristic trigonal sutures. As the number of scolopendromorph species surveyed increases so the exceptions lacking "key" characters appear. As noted above Di et al 2010 observed that evidence is increasing to indicate that the presence or absence of spiracles on segment 7 is less reliable as a phylogenetic and taxonomic character than previously thought.

It is possible that characters such as the presence, or absence of spiracles on leg bearing segment 7 are under recorded. I tend not to check for these in specimens in which the genus is obvious, for example, species of *Scolopendra*, *Asanada* or *Cryptops.* However, I always check for these in *Otostigmus/Rhysida*–like material which, as Kraepelin (1903) pointed out, possess the same 'Habitus' and are differentiated solely by the presence of these spiracles: present on segment 7 in *Rhysida*, absent in *Otostigmus.* However, in a study of the life history and distribution of *Rhysida nuda togoensis* Kraepelin, 1903 (= *R. immarginata togoensis*) in Nigeria (Lewis, 1972) having satisfied myself as to the genus and species, I did not check all 85 specimens for the presence of spiracles on segment 7. Specimens with an unexpected number of leg-bearing segments may also be overlooked which appears to have been the case when Chamberlin (1941) mistook specimens of *Kethops* for *Cryptops.*

The tendency is to check characters expected to vary such as number of antennal articles and legs with tarsal spurs but not to check those expected to be constant such as number of leg-bearing segments. Other characters may be overlooked for example the presence of a saw tooth or teeth on the ultimate leg femur in several *Cryptops* species (Lewis 2011). This problem was recognised by Ribaut (1923), who, when discussing the distinction between *C. neocaledonicus* Ribaut, 1923 and *C. megaloporus* Haase, 1887, pointed out that in *C. megaloporus* the ventral femoral [saw] tooth is not apparent but it may have been overlooked as it is difficult to recognise it amongst spiniform setae.

Some characters appear spasmodically in several genera. For example W-shaped sutures on T1 occur in *Cryptops angolensis* Machado, 1951, *C. mirabilis* Machado, 1951 and in some *Newportia*, *Tidops* and *Kethops;* this suggests that they are of little adaptive value.

Vahtera et al. (2013) have shown that the Plutoniumidae with 21 leg-bearing segments nests within the Scolopocryptopidae with 23. It is here suggested that *Kethops atypus* with 23 pairs of legs may be a *Cryptops*, species which otherwise have 21.

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