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An extraordinary new genus of the millipede family Nemasomatidae (Diplopoda: Julida)

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ABSTRACT

Chelojulus sculpturatus, n. gen., n. sp., is described from Idaho, USA. The genus is unique among the Julida in having the ozopores borne on ovoid dorsolateral swellings, and in having the fifth pair of male legs transformed into functional forcepts. Arguments are presented in favour of the hypothesis that *Chelojulus* is the sister-group of *Telsonemasoma,* a nemasomatid genus known from Oregon, USA.

INTRODUCTION

In a recent paper on the millipede order Julida (Enghoff, 1981) I stated that "The Julida are comparatively uniform in external appearance." Had I then had at hand the species described in the present paper, this sentence might have been omitted: *Chelojulus sculpturatus* is certainly the most disjunct of julidan millipedes as far as external structure is concerned.

I am extremely grateful to Dr. R. L. Hoffman, Radford, Virginia, who discovered the new species among unidentified millipedes belonging to the Florida State Collection of Arthropods (FSCA). Dr. Hoffman at once recognized the significance of the speciments and generously forwarded them to me for study.

The drawings of habitus and body segments are due to the skill of Mr. Robert Nielsen, artist of Universitetets Zoologiske Museum, Copenhagen.

TAXONOMY

Chelojulus, new genus

Diagnosis: A genus of Nemasomatidae (sensu Enghoff, 1981). Agreeing with other nemasomatids in the possession of handlike branched teeth in the mandibular pectinate lamellae, and particularly with *Telsonemasoma* in the occurrence of biramous anterior gonopod telopodites. Differing from all other julidan millipedes in the dorsolateral position of the ozopores on ovoid tubercles and in the form of the fifth pair of male legs, which are transformed into pairs of forceps consisting of a prefemoral apophysis and a modified femur.

Type species: *C. sculpturatus,* new species, the only known member of the genus.

Distribution: Idaho, USA.

Etymology: The generic name refers to the chelate fifth male legs.

Chelojulus sculpturatus, new species.—Figures 1-17.

Type material: Male holotype, (FSCA) 5 male and 9 female paratypes from USA: Idaho, Clearwater Co., French Mountain Road, 3280 ft. ASL, 8½ mi. E, 5 mi. N of Pierce; A. K. Johnson leg. 9 September 1978. 3 male, 1 female paratypes from Idaho, Latah Co., Cleveland Gulch, 3050 ft. ASL, 4½ mi. N, 8½ mi. E. Harvard, A. K. Johnson leg. 16 September 1978; 5 female paratypes from Idaho, Idaho Co., Knoll Creek drainage, 4550-4750 ft. ASL, 10¼ mi. E, 6¼ mi. S. Pierce, A. K. Johnson leg. 23 August 1978. All paratypes in FSCA except 3 males and 3 females in Universitetets Zoologiske Museum, Copenhagen. Total material, 9 males, 15 females.

Diagnosis: With the characters of the genus.

Description: Segment formulae (= podous + apodous segments, excluding preanal ring; the "RO" numbers refer to stadial numbers as inferred from the number of rows of ocelli (Sahli, 1969):

6 RO: 26+4 (f), 28+4 (f)
7 RO: 29+2 (2 ff), 34+2 (m)
8 RO: 30+1 (f), 31+1 (2 ff), 32+1 (m, 2 ff), 34+1 (m)
9 RO: 31+1 (2 ff), 33+1 (m, f), 34+1 (f)
10 RO: 33+1 (f), 34+1 (m), 35+1 (m)
11 RO: 37+1 (m), 38+1 (m)
12 RO: 38+0 (m)

Length 15-24 mm (males, 10-19 mm (females). Midbody vertical diameter 1.3-1.9 mm (males), 1.0-1.7 mm (females). Body tapering at both ends (Fig. 1).

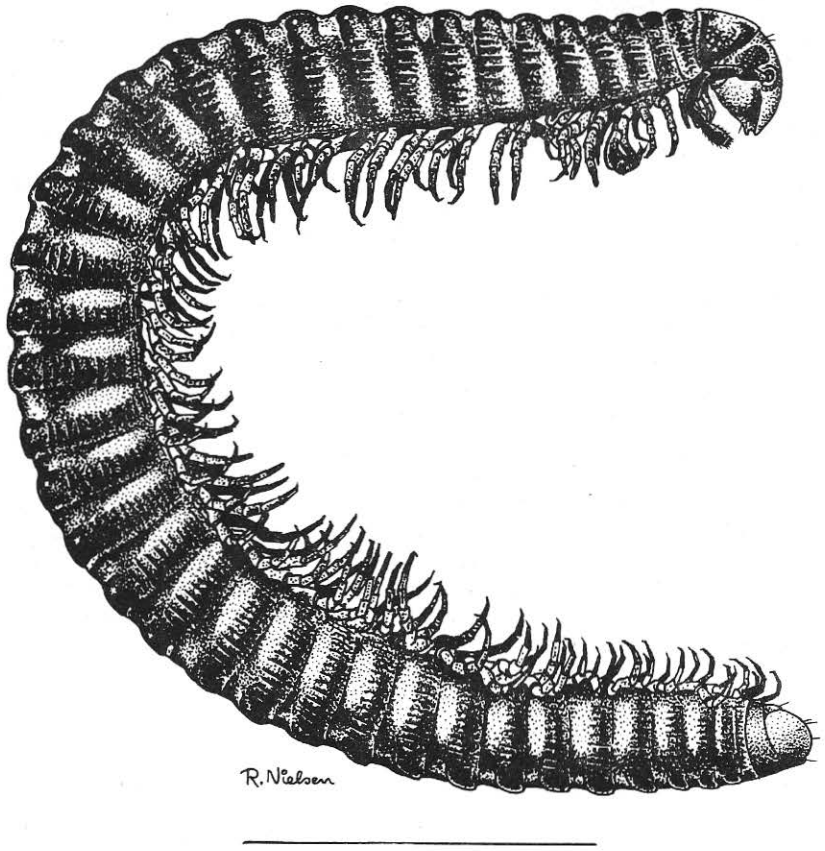


Fig. 1. *Chelojulus sculpturatus* n. sp. ♂ Clearwater Co. Robert Nielsen del. Scale 5 mm.

Colour of preserved specimens: Head pale brown with a darker network, lateral and anterior margins of head capsule, and a triangular spot mesal to each eye, uniformly dark brown. Antennae dark brown. Collum with typical julidan pattern: dark brown margins and middorsal stripe surrounding pale brown areas with dark network. Prozona of body segments (Figs. 2-3 dark brown in anterior ¾, pale in posterior ¼; metazona dark brown, somewhat paler ventrally and immediately mesal to poriferous tubercle; poriferous tubercles contrastingly pale; dorsal and lateral crests a little darker than areas between crests. Legs (Figs. 2, 4) pale at base, from femur outwards with longitudinal dark stripes. Preanal ring pale with dark dorsal stripe. Anal valves and subanal scale pale.

Head without peculiarities, labrum with 4-6 denticles; 4 supralabral setae and a row of labral setae (24 counted in a ♀); 2 vertigial setae. Antennae without peculiarities, reaching back to segment V, with 4 apical sensory cones. Eyes subtriangular-ovoid, each with up to 52 ocelli arranged in up to 12 regular rows. External tooth of mandibles with 3 accessory cusps; four pectinate lamellae; some posterior teeth in pectinate lamellae branched, handlike (seen with the scanning electron misroscope); molar plate without grooves. Gnathochilarium (Fig. 5) typically julidan; postmentum apparently reduced into two small lateral sclerites; stipites each with 3 apical setae; promentum broad, completely separating lamellae linguales, with basal concavity accommodating projections from stipites; lamellae linguales each with 2-5 setae; interior sensillum of lingual lobes setiform.

Collum slightly depressed in the middle, with a fine middorsal crest, a few incomplete lateral crests, and a row of short setae about $^1/_3$ collum length in front of posterior margin.

Body segments (Figs. 2-4) very slightly compressed, strongly constricted between pro- and metazona. Prozona with fine curved striae (Fig. 2), as in the julid genera *Ommatoiulus* and *Tachypodoiulus*. Metazona each with a middorsal crest, a pair of prominent dorsolateral, ovoid tubercles, and 12-17 crests on each side below tubercles, ventralmost crests somewhat U-shaped. Ozopores opening on dorsolateral tubercles, about ¼ tubercle length in front of posterior margin, starting on segment VI; segments III-V with smaller tubercles, segment II without tubercles. A whorl of very short and inconspicuous setae ¼ - $^1/_3$ metazonum length in front of posterior margin of each segment (the setae on the poriferous tubercles are comparatively easy to see, Figs. 2, 4). Sterna of the usual juliformian type: fused to pleuroterga, except on segments II-III. Limbus with straight margin.

Legs (Fig. 6) a little longer than body diameter in both sexes. No accessory claw, except on anteriormost legs (Figs. 7, 8, 16).

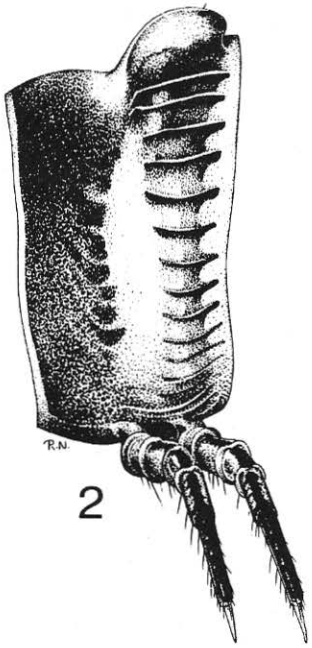
Preanal ring with a short dorsal projection not reaching caudal margin of anal valves, with a posterior whorl of setae. Anal valves and subanal scale without peculiarities, each with 2 setae.

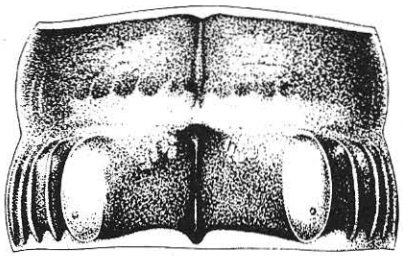
Male sexual characters

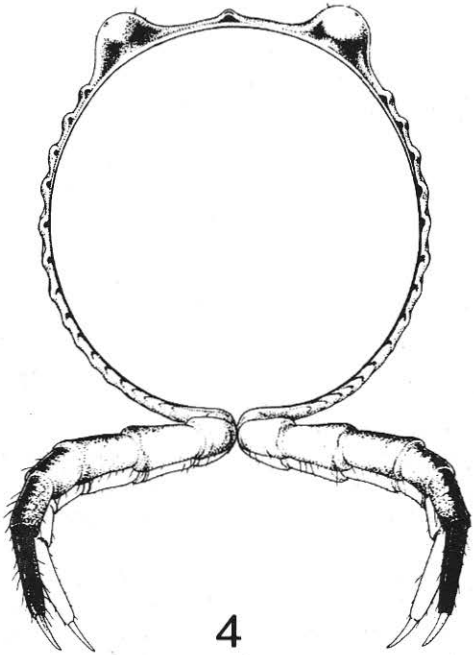
First and second pairs of legs with very short prefemora, otherwise similar to ensuing legs in 8 among 9 examined ♂♂. First pair of legs in one ♂ reduced to a pair of tiny, unsegmented vestiges. Penis (Fig. 8) short, double, each half with 2-3 apical setae. Fifth pair of legs (Fig. 9) strongly modified; prefemur and especially femur incrassate; prefemur with broad ventrodistal apophysis, shaped somewhat like a spoon with the concavity directed ventrad-caudad; femur ventrally desclerotized and densely setose. No sexual modifications of other legs, nor of mouthparts.

Ventral margins of seventh segment separate but converging towards posterior margin, with posterior ventrad lobes protecting tips of gonopods.

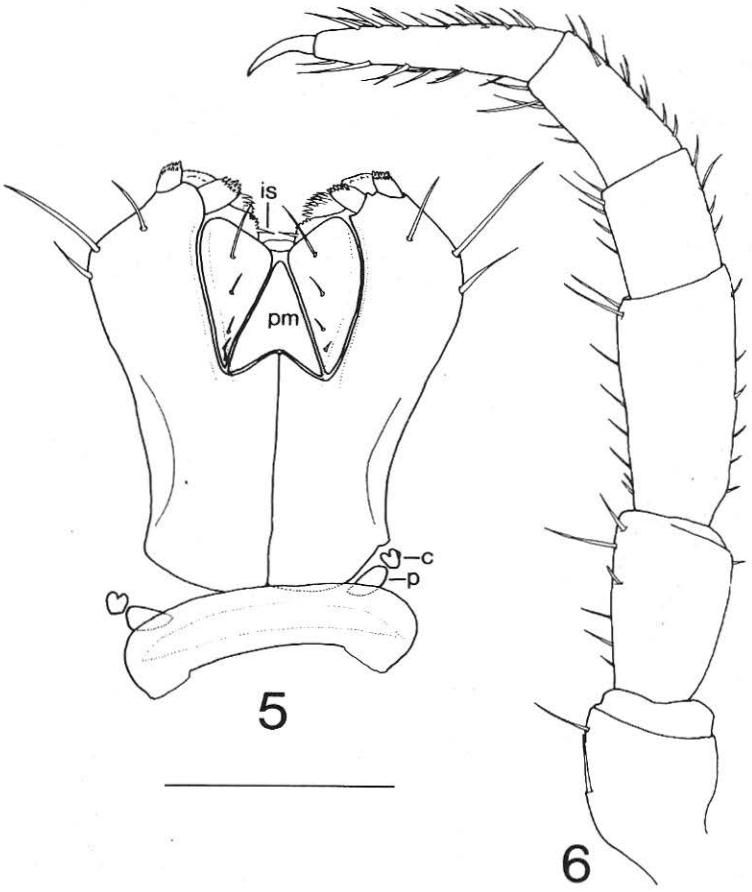
Gonopods almost entirely concealed within segment seven, only tips of anterior telopodites visible in lateral view. Anterior gonopods (Figs. 10-12) with a subrectangular sternum; coxae not fused, with large somewhat spoon-shaped processes with concavities directed caudad-laterad, mesal margins of coxae basally with irregular surfaces; no flagella: telopodites large, biramous, with a basal, lateral spinose field, anterior branch of moderate length, terminating in hook fitting around anterior edge of coxal process; posterior branch long and slender, reaching beyond tip of coxal process, with numerous minute denticles along its length, a stout subterminal spine, and a terminal subtriangular "velum", basal margin of "velum" serrate.





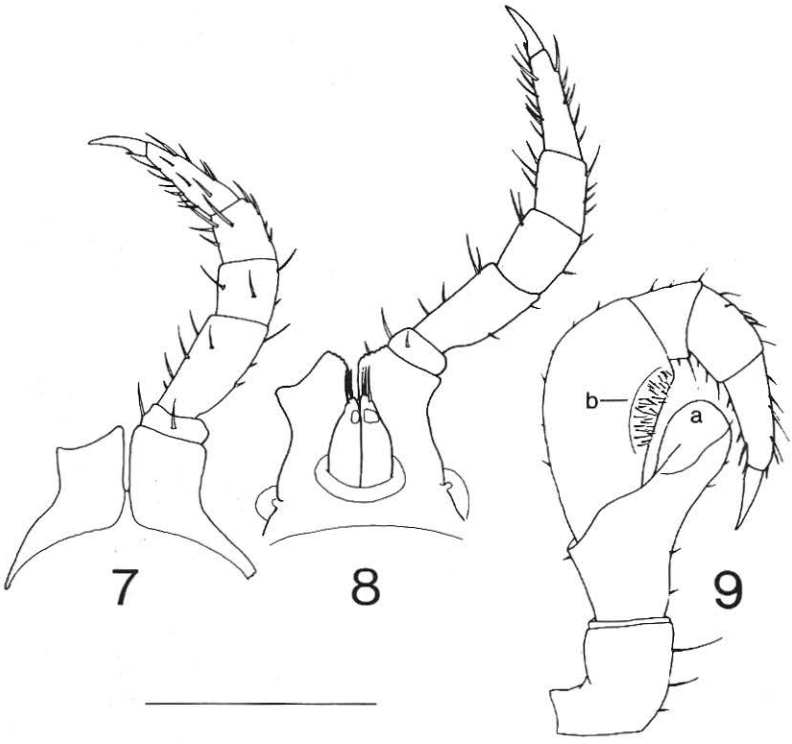


Figs. 2-4. *Chelojulus sculpturatus* n. sp. ♂, Clearwater Co., midbody segment. 2. lateral view. 3. dorsal view. 4. posterior view. Robert Nielsen del. Scale 1 mm.



Figs. 5-6. *Chelojulus sculpturatus* n. sp. ♂, Clearwater Co. 5. gnathochilarium. 6. midbody leg, posterior view. c: cardo, is: interior sensillum of lingual lobe, p: postmentum, pm: promentum. Scale 0.5 mm.

Posterior gonopods (Figs. 14-15) with a well-developed sternum extending to lateral sides of coxal parts; flanges from sternum projecting forwards and closely applied to lateral sides of anterior gonopod coxae; each posterior gonopod uniramous, with oral furrow for accommodation of posterior branch of anterior gonopod telopodite, furrow delimited by flanges with finely serrate edges, mesal flange shorter than lateral flange; mesal margin of gonopod with hump carrying 2-3 setae; several short distal mesal setae, a single lateral seta; apex of gonopod with two long distad spines and 3-5 similar but retrorse spine, one of the distad spines with a tiny basal accessory spine.



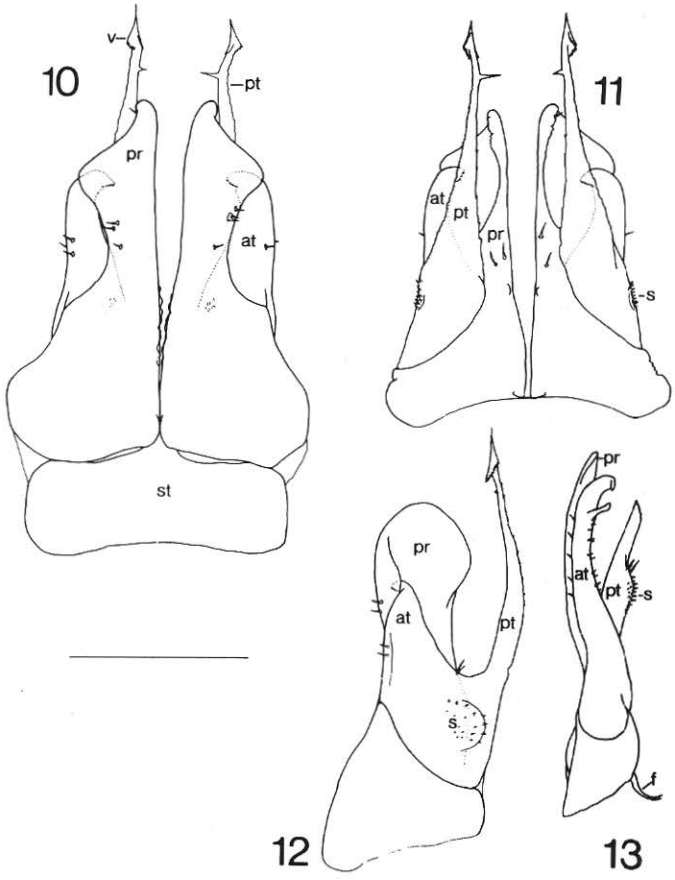
Figs. 7-9. *Chelojulus sculpturatus* n. sp. ♂, Latah Co. (a smaller ♂ than that shown in Fig. 6). 7. first pair of legs, anterior view. 8. second pair of legs and penis, posterior view. 9. right leg of fifth pair, posterior view. a: prefemoral apophysis, b: soft, setose femoral area. Scale 0.5 mm.

Female sexual characters

First and second pairs of legs (Fig. 16) with very short prefemora, otherwise similar to ensuing legs. Vulval invaginations short, vulvae resting within segment III. Vulvae (Fig. 17) subspherical; operculum longer than bursa, with several short oral setae and hoodlike apex partly covering apex of bursa; bursa with several apical setae, aperture apical, internal structure difficult to interpret, a chamber with sinuous margins perhaps representing the receptaculum seminis.

Distribution: Northern Idaho, in altitudes from about 1000 to about 1500 m. No information on habitat.

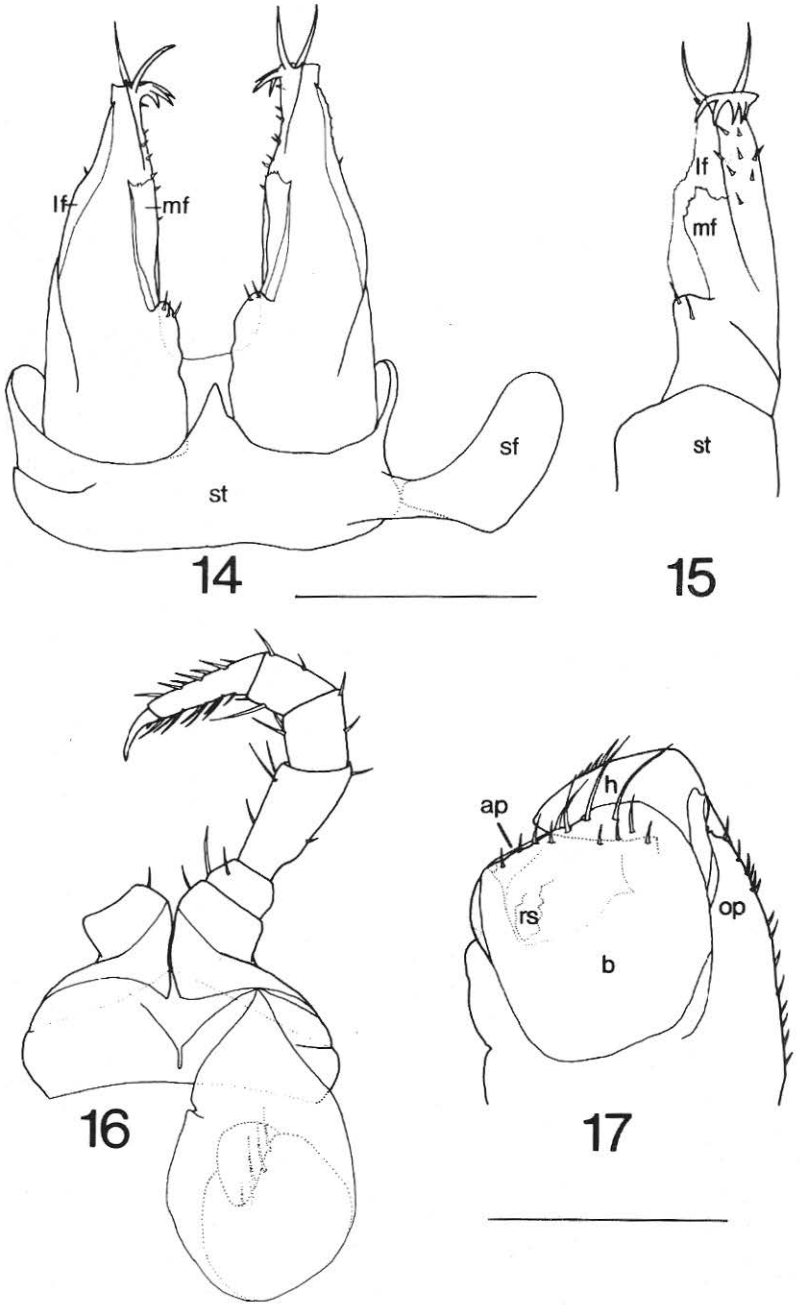
Postembryonic development: *C.sculpturatus* appears to be a "slow-growing" species in terms of segments added per moult. There is a drastic decrease in number of apodous segments from stadium 6 RO to 8 RO: no specimen in stadio 8



Figs. 10-12. *Chelojulus sculpturatus* n. sp. ♂, Clearwater Co., anterior gonopods. 10. anterior view. 11. posterior view. 12. right anterior gonopod, lateral view. Fig. 13. *Telsonemasoma microps* Enghoff, 1979 ♂ paratype, right anterior gonopod, lateral view. at: anterior branch of telopodite, f: flagellum, pr: coxal process, pt: posterior branch of telopodite, s: spinose field, st: sternum, v: "velum". Scale 0.25 mm (10-12), 0.125 mm (13)

RO etc. has more than one apodous segment, preanal ring excluded (the apodous segments in a given stadium will become podous in the next, see Sahli (1969). The largest specimen has no apodous segments, an unusual condition in the Julida. Mature males in the material range from 7 through 12 RO, and no juvenile or intercalary males have been seen. This suggests that mature males may moult directly into another mature stadium, as in *Nemasoma varicorne* C. L. Koch (Enghoff, 1976). All studied specimens are adults, but some of the smallest females may be physiologically immature although they possess apparently fully developed vulvae.

Etymology: The specific name refers to the strongly sculptured body segments.



Figs. 14-15. *Chelojulus sculpturatus* n. sp. ♂, Clearwater Co., posterior gonopods. 14. anterior view. 15. left posterior gonopod, mesal view. lf: lateral flange, mf: mesal flange, sf: sternal flange, st: sternum. Scale 0.25 mm.

Figs. 16-17. *Chelojulus sculpturatus* n. sp. ♀, Clearwater Co. 16. second pair of legs with left vulva, posterior view. 17. right vulva, mesal view. ap: aperture of bursa, b: bursa, h: opercular hood, op: operculum, rs: ?receptaculum seminis. Scale 0.5 mm (16), 0.25 mm (17).

DISCUSSION

Chelojulus sculpturatus is at first glance profoundly different from all other Julida, but there can be no doubt about its ordinal position: The gnathochilarium is symphyognathous, and the prementum has no setae. These are the two known autapomorphies for Julida (Enghoff, 1981). Enghoff (1981) also listed three potential autapomorphies for the Chorizognatha (Chorizognatha include all Juliformia except Julida — the monophyly of Chorizognatha is far from certain): loss of frontal setae, loss of metazonal setae, and loss of a deviating sensillum on the lingual lobe. *C. sculpturatus* has frontal and metazonal setae, and a deviating lingual sensillum,: it thus agrees with the julidan groundplan in these characters as well.

The prominant metazonal carinae in *C. sculpturatus* remind of those found in certain chorizognathan groups. Such carinae have certainly evolved several times within the Chorizognatha, and *C. sculpturatus* obviously represents just an additional case of independently evolved carinae.

Establishment of the position of *C. sculpturatus* within the Julida is hampered by the unmodified first male legs. Enghoff (1981) divided the Julida into two monophyletic groups on the basis of first male legs modifications: Parajuloidea with enlarged clasper-like first legs, and the non-parajuloid families with a tibial outgrowth. The few julidan genera with unmodified male legs were shown to be derived from ancestors with the second type of modification. Certain characters indicate that the same is true of *C. sculpturatus:*

The mandibles have only four pectinate lamellae in *C. sculpturatus*. This character is supposed to be a synapomorphy for Blaniuloidea+Nemasomatoidea+ Juloidea (Enghoff, 1979a, 1981). Within this group, a sister-group relationship is supposed to exist between Blaniuloidea (mainly characterized by the apomorphy: male legs with flattened setae) and Nemasomatoidea+Juloidea (characterized by the apomorphy: male legs with soft ventral pads) (Enghoff, 1981). Here again, *C. sculpturatus* escapes evaluation, having neither flattened setae nor soft pads. The only modification of male legs in *C. sculpturatus* is found in the unique fifth legs. The soft ventral area on the fifth femora is hardly homologous with the soft pads found in many Nemasomatoidea+Juloidea, since this area is setose in *Chelojulus* and the soft pads are always devoid of setae.

The branched, handlike posterior teeth of the pectinate lemellae, found in *C. sculpturatus*, were regarded by Enghoff (1979a, 1981) as an autapomorphy for the Nemasomatoidea. However, similar branched teech occur in several blaniulid genera (Enghoff, 1981) so this character is of limited value in the attempt to establish the systematic position of *C. sculpturatus.*

The most conclusive character of *C. sculpturatus* is its big biramous anterior gonopod telopodites. These telopodites are generally small and simple in julidan millipedes; in many groups they are strongly reduced in size, and in some they are altogether absent (e.g. most Julidae). Biramous telopodites have not been described in the Julida but occur in the nemasomatid genus *Telsonemasoma.* In the original description (Enghoff, 1979c) the telopodites of *Telsonemasoma* were described as having a deep lateral concavity separating an anterior and a posterior blade. Re-examination of a paratype of *T. microps* in lateral view (Fig. 13) revealed that the telopodite is actually biramous. This is a strong synapomorphy for *Chelojulus* and *Telsonemasoma.*

There are other potential synapomorphies for these two genera. Thus, the interior sensillum of the lingual lobes is setiform in both. This sensillum is most often lanceolate, both in julidan millipedes and in those non-julidans in which it occurs (see Enghoff, 1981). Setiform sensilla in the Julida are known only from *Chelojulus*, *Telsonemasoma*, and a few parajulids.

The spinose fields on the anterior gonopod telopodites are exceptionally large in *Chelojulus* and *Telsonemasoma*. It is probable that the spinose field represents the vestiges of a second telopodital podomere: A well-developed second podomere is known only in one julidan genus, namely the mongoliulid *Ansiulus* (see illustration in Golovatch (1980), where its position corresponds closely to that of the spinose field in *Chelojulus* and other nemasomatids (in *Telsonemasoma*, the field has an unusually distal position). Possession of a spinose field *per se* may thus be plesiomorphic at this level, but still the large size of the field in *Chelojulus* and *Telsonemasoma* may be apomorphic.

The posterior gonopods of *Telsonemasoma* and *Chelojulus* also show similarities, e.g. in the possession of several stout distal spines. Similar spines occur, however, in several other julidan genera, and their occurrence in these two genera may be insignificant.

A case for a sister-group relationship between *Chelojulus* and *Telsonemasoma* can thus be made, and in my opinion, the characters discussed below do not outweigh the evidence in favour of this hypothesis. This is in particular true of the similarities between *Chelojulus* and *Trichonemasoma* (unmodified first male legs, concave base line of promentum, hood on vulval operculum).

The characters discussed above suggest that the unmodified first male legs in *C. sculpturatus* are derived from modified legs of the "tibial outgrowth type". Perhaps the evolution of the unique fifth legs forceps rendered modification of the first legs superfluous? With a lot of reservation, the occurrence in the type series of a male with vestigial first legs may point in the same direction: *Chelojulus* may still have genes, usually suppressed, for modification of the first male legs. The fifth legs forceps certainly serve to fix the female during copulation — in analogy with the modified mandibles and first legs in other Julida. The forceps probably grip the female's antennae, like the mandibular forceps of Blaniulidae (Mauriès, 1969). The forceps may also be "responsible" for the absence of ventral flattened setae or pads on the male legs. Admittedly, the pads are a somewhat dubious character (Enghoff, 1981) but it may be surmised that an ancestor of *Chelojulus* had pads (which occur in some Nemasomatidae, including *Telsonemasoma).*

The concave base line of the promentum is an unusual feature which was mentioned as a synapomorphy for *Trichonemasoma, Okeanobates,* and *Yosidaiulus* by Enghoff (1979b) but also occurs in the blaniuloid family Zosteractinidae (Enghoff, in press).

The vulvae of *C. sculpturatus* are unusual in having an opercular hood partly covering the apex of the bursa. A hood occurs also in the Paeromopodidae (Brolemann, 1922), and in the nemasomatid genera *Trichonemasoma* (Mauriès, 1966) and *Okeanobates* (Enghoff, 1979b).

Absence of flagella distinguishes *C. sculpturatus* from other Nemasomatidae. Flagella belongs to the groundplan of Julida (Enghoff, 1981) and have been lost by numerous lineages. The function of the flagella has apparently been taken over by the posterior branches of the anterior gonopod telopodites — these branches are almost flagelloid in shape and are accommodated like flagella in oral furrows in the posterior gonopods.

The suggested sister-group relationship between *Chelojulus* and *Telsonemasoma* is zoogeographically satisfying: *Telsonemasoma* is known from Oregon, ca. 500 km W of the localities where *Chelojulus* has been found. It is remarkable that these two genera each display highly aberrant anatomical traits: *Chelojulus* with its forceps, poriferous tubercles, and carinae, *Telsonemasoma* with its "double tail". Further field work in the northwestern United States will perhaps bring forth more relatives of these peculiar millipedes, whose striking apomorphies may warrant the erection of one or more suprageneric taxa. Such an action must, however, await better knowledge of the relationships within the still problematical family Nemasomatidae sensu Enghoff (1981).

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