

## Redescription of *Hadogenes zumpti* Newlands & Cantrell 1985: an unusual rock scorpion (Scorpiones, Ischnuridae) from the Richtersveld, South Africa

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*Hadogenes zumpti* Newlands & Cantrell 1985 (Scorpiones, Ischnuridae), from the Richtersveld, South Africa, is redescribed. This is the only species of *Hadogenes* Kraepelin 1894 in which the adults of both sexes are without a lobe at the base of the movable finger of the chela. The significance of the presence or absence of this lobe as a character within *Hadogenes*, particularly with respect to the taxonomically difficult *Hadogenes tityrus* (E. Simon) species complex, is discussed.

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Scorpions of the genus *Hadogenes* Kraepelin 1894, commonly known as rock scorpions, are restricted to the southern half of the Afrotropical region, where they are widespread and common. All of the approximately thirteen currently recognised species of *Hadogenes* are lithophilous, inhabiting the narrow cracks, crevices and exfoliations of weathered rock outcrops in regions of rugged, mountainous topography. Eco-morphological adaptations which facilitate existence in this specialised habitat include extreme dorsoventral compression, elongation of the metasoma and pedipalps, and stout, spine-like setae, operating in conjunction with highly curved tarsal unguis to provide a vice-like grip on rock surfaces (Newlands 1972a). Species of *Hadogenes* are also characterised by greatly enlarged lateral ocelli relative to the median ocelli, presumably to aid in anterior light perception, and a well-developed superciliary crest to protect the median ocelli from abrasion.

In their re-appraisal of the genus *Hadogenes*, Newlands & Cantrell (1985: 43) mentioned an undescribed species 'to be named *H. zumpti* from the Richtersveld (Newlands, in prep.)' which they included in a key providing diagnostic characters to the currently recognised species of *Hadogenes*. Unfortunately, a formal description of *Hadogenes zumpti* Newlands & Cantrell 1985 was not subsequently published. In this contribution, we provide a formal description of this remarkable species, which is the only member of *Hadogenes* in which the adults of both sexes are without a lobe at the base of the movable finger of the chela. The only other species of this genus in which the lobe is absent are certain species in the *Hadogenes tityrus* (E. Simon) complex (Lawrence 1966; Newlands 1972b, 1980; Newlands & Cantrell 1985). However, in these species, the lobe is absent only in the adult female, whereas the lobe is present in the adult males of all members of the *H. tityrus* complex. We conclude with a discussion of the importance of the presence or absence of this lobe as a character within *Hadogenes*, particularly with respect to the taxonomically difficult *H. tityrus* species complex.

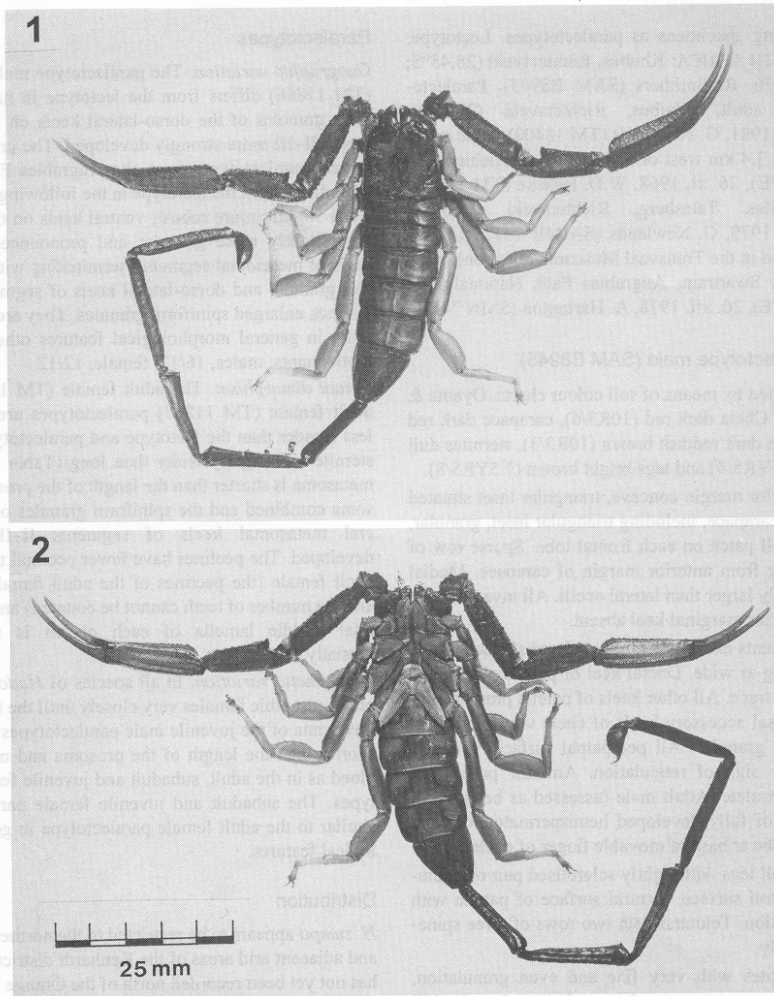
### *Hadogenes zumpti* Newlands & Cantrell

*Hadogenes zumpti* Newlands & Cantrell 1985: 43

#### Diagnosis

*H. zumpti* can be distinguished from all other species of *Hadogenes* by the absence of a lobe at the base of the movable finger of the chela in the adult male (Figures 1-2). This lobe is absent in the subadults and juveniles of all species of *Hadogenes*, but appears during the final instar of those species in which it is present in the adults. In the lectotype male (SAM B8945) and paralectotype male (TM 11866) of *H. zumpti*, maturity was assessed by the presence of fully developed hemispermatophores and testes. The elongated metasoma of these specimens, a secondary sexual characteristic only acquired in the final instar male (Lamoral 1979; Newlands 1980), is a further indication that they are adult. The adult status of the female paralectotype (TM 18400) was established by the gravid condition of this specimen at the time of capture and its subsequent parturition.

The phylogenetic affinities of the new species are presently equivocal. Morphologically, it appears to be most closely related to the *H. tityrus* species complex, in which the adult females of some species are without a lobe at the base of the movable finger, and in which the pedipalps of others, notably *Hadogenes lawrencei* Newlands, are extremely elongated (Lawrence 1966; Newlands 1972b, 1980; Newlands & Cantrell 1985). *H. zumpti* can be readily distinguished from all members of this species complex by the length of the metasoma of the adult male, which is nearly twice the length of the prosoma and mesosoma combined. In contrast, the metasoma of adult males of the *H. tityrus* complex is considerably shorter than the length of the prosoma and mesosoma combined. The elongated metasoma of the adult male *H. zumpti* is a morphological character shared with *Hadogenes phyllodes* (Thorell) and all other species of *Hadogenes* with the exception of *Hadogenes bicolor* Purcell and members of the *H. tityrus* species complex (Newlands, 1980).



Figures 1–2 Lectotype male of *Hadogenes zumpti* Newlands & Cantrell 1985 (SAM B8945). 1. Dorsal view. 2. Ventral view.

Despite the morphological evidence, *H. zumpti* appears to be most closely related to *H. phyllodes* on the basis of chromosome number and the electrophoretic banding patterns of venom proteins (Newlands 1980; Newlands & Cantrell 1985). Chromosomal preparations (methods provided in Newlands & Cantrell 1985) were attempted with testicular tissue from the preserved lectotype (SAM B8945), with negative results. Chromosomal preparations of nerve and glandular tissue from two juvenile specimens (SAIMR 1312 and SAIMR 1340) yielded negative results for SAIMR 1312, and a single spread for SAIMR 1340. The chromosome number of  $2n = 60$  must therefore be regarded as a preliminary finding. *H. phyllodes* collected from several localities in the northern Cape yielded chromosome counts of  $2n = 72$  (Newlands & Cantrell 1985). In contrast, members of the *H. tityrus* species complex have the highest chromosome numbers reported for scorpions, three members exhibiting chromosome counts of

$2n = 132$ ,  $2n = 168$  and  $2n = 174$ , respectively (Newlands & Cantrell 1985).

#### Etymology

The new species has been named in honour of the late Prof. F.K.E. Zumpt, for his contribution in the field of medical entomology.

#### Material examined

The type specimens examined by Newlands (1980) and Newlands & Cantrell (1985) are lodged in the following collections: South African Museum, Cape Town (SAM); Transvaal Museum, Pretoria (TM); National Museum of Namibia, Windhoek (SMN). Newlands & Cantrell (1985) did not designate a holotype from the type series. Accordingly, an adult male specimen has been selected as the lectotype of *H. zumpti*

and the remaining specimens as paralectotypes. Lectotype: male adult, SOUTH AFRICA: Khubus, Richtersveld (28.45°S; 16.99°E) ca 1956, R. Smithers (SAM B8945). Paralectotypes: female adult, Khubus, Richtersveld (28.45°S; 16.99°E), 13. ii. 1981, G. Newlands (TM 18400); male adult, female subadult, 3.4 km west of Numees Mine, Richtersveld (28.28°S; 16.96°E), 26. xi. 1968, W.D. Haacke (TM 11866–11867); juveniles, Tatasberg, Richtersveld (28.31°S; 17.29°E), 5. iv. 1979, G. Newlands (SAIMR 1312, SAIMR 1340: now lodged in the Transvaal Museum collection); male juv, female juv, Swartrant, Au-grabies Falls National Park (28.55°S; 20.27°E), 20. xii. 1978, A. Harington (SMN 745).

#### Description of lectotype male (SAM B8945)

**Colour** (determined by means of soil colour charts, Oyama & Takehara 1970): Chela dark red (10R3/6), carapace dark red (10R3/6), tergites dark reddish brown (10R3/3), sternites dull reddish brown (5YR5/4) and legs bright brown (7.5YR5/8).

**Carapace:** Anterior margin concave, triangular inset situated far back. Entire carapace, including triangular inset, granular, except for a small patch on each frontal lobe. Sparse row of fine setae arising from anterior margin of carapace. Medial ocelli only slightly larger than lateral ocelli. All invaginations present, but anterior marginal keel absent.

**Pedipalps:** Segments extremely elongated and slender. Chela five times as long as wide. Dorsal keel of patella absent and without vestigial trace. All other keels of patella present. Finger keel and dorsal accessory keels of chela very prominent although weakly granular. All pedipalpal surfaces granular and without any sign of reticulation. Anterior process of patella almost obsolete. Adult male (assessed as being adult by the presence of fully developed hemispermatophore and testes) without lobe at base of movable finger of chela.

**Legs:** Femur of all legs with lightly sclerotised pair of granular keels on ventral surface. Ventral surface of patella with irregular granulation. Telotarsi with two rows of three spine-like setae ventrally.

**Mesosoma:** Tergites with very fine and even granulation, imparting a matt appearance to these sclerites. Sternite VII and tergite VII slightly longer than wide. Sternite VII with distinct postero-lateral oval depressions and median keels. Distal apex of sternite VII with distinct notch.

**Metasoma:** Metasomal segment I higher than wide. Dorsolateral keels of metasomal segments II–III each terminating distally with an enlarged, spiniform granule; all other metasomal segments without spiniform granules distally. Metasomal segment V with weakly granular keels. Ventral surface of vesicle covered with barely discernable granulation. Dorsal surface of vesicle virtually straight in lateral profile.

**Trichobothria:** Neobothriotaxic major, type C (Figures 3–11) with the following segment totals: femur 3, patella 92 and chela 93. Total number of trichobothria per pedipalp, 188.

**Pectines:** First proximal middle lamella of each pecten with mesial margin angular. Pectinal teeth present along entire posterior margin of pectines. Pectinal teeth: 16/17.

**Hemispermatophore:** As in Figures 12–13. Doubled hook in proximal half of distal lamina.

**Measurements:** As in Table 1.

#### Paralectotypes

**Geographic variation.** The paralectotype male from Numees (TM 11866) differs from the lectotype in having the spiniform granules of the dorso-lateral keels on metasomal segments II–III more strongly developed. The juvenile male and female paralectotypes from the Au-grabies Falls area (SMN 745) differ from the lectotype in the following characteristics: chela slightly more robust; ventral keels on the femur of the legs slightly more granular and pronounced; dorso-lateral keels of metasomal segment I terminating with a weak tooth-like granule; and dorso-lateral keels of segments II–III with distinct, enlarged spiniform granules. They are similar to each other in general morphological features other than pectinal tooth counts: males, 16/17; female, 12/12.

**Sexual dimorphism.** The adult female (TM 18400) and subadult female (TM 11867) paralectotypes are proportionally less slender than the lectotype and paralectotype males, with sternite VII slightly wider than long (Table 1). In both, the metasoma is shorter than the length of the prosoma and mesosoma combined and the spiniform granules on the dorso-lateral metasomal keels of segments II–III are weakly developed. The pectines have fewer pectinal teeth in the subadult female (the pectines of the adult female are damaged and the number of teeth cannot be counted) and the first proximal middle lamella of each pecten is slightly obtuse mesially.

**Ontogenetic variation.** In all species of *Hadogenes*, juvenile males resemble females very closely until the final instar. The metasoma of the juvenile male paralectotypes of *H. zumpti* is shorter than the length of the prosoma and mesosoma combined as in the adult, subadult and juvenile female paralectotypes. The subadult and juvenile female paralectotypes are similar to the adult female paralectotype in general morphological features.

#### Distribution

*H. zumpti* appears to be restricted to the northern Richtersveld and adjacent arid areas of the Kenhardt district (Figure 14). It has not yet been recorded north of the Orange River.

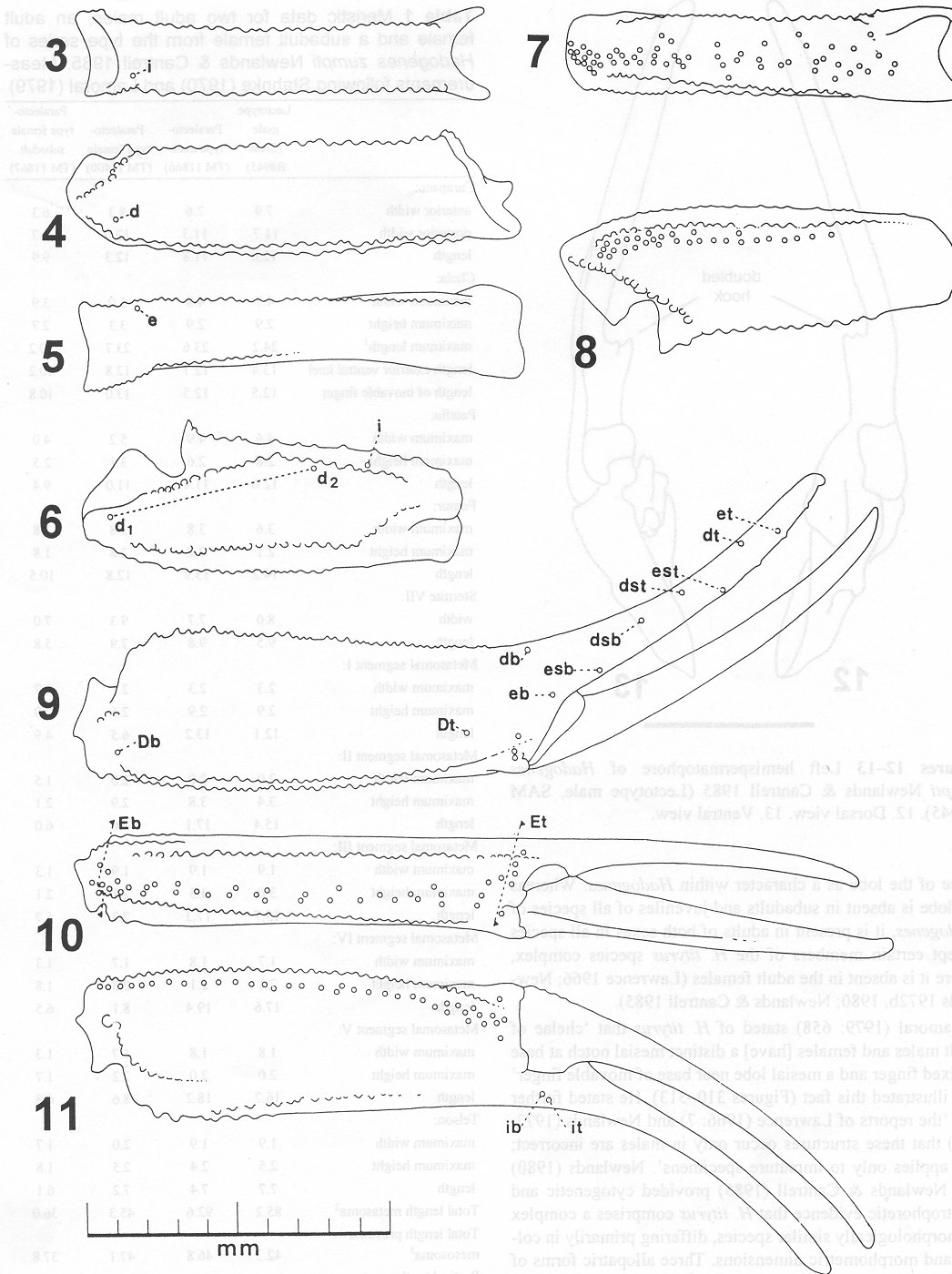
#### Ecology

In common with all other species of *Hadogenes*, *H. zumpti* is an obligately lithophilous scorpion, inhabiting the narrow cracks, crevices and exfoliations of weathered granite outcrops. It is restricted to regions of rugged, mountainous topography in the Upland Succulent Karoo (56) and Orange River Nama Karoo (51) vegetation types, receiving a rainfall of 150–350 mm p.a. (Hoffman 1996).

In the northern Richtersveld, the new species is sympatric with species of the *H. tityrus* complex, and with the lithophilous *Uroplectes schlechteri* Purcell. It has not yet been found sympatrically with *H. phyllodes*, although the latter is sympatric with species of the *H. tityrus* complex in parts of its range (Lamor 1979; Newlands 1980).

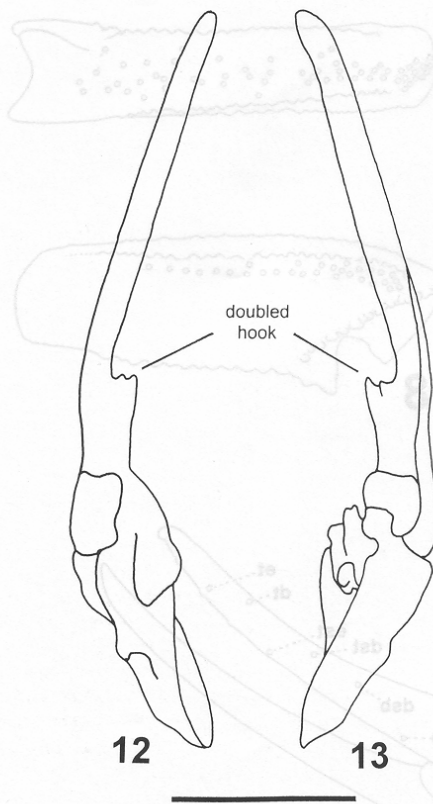
#### Discussion

The discovery of *H. zumpti*, in which the lobe of the movable finger of the chela is absent in adults of both sexes, has placed renewed emphasis on the diagnostic and phylogenetic impor-



**Figures 3–11** Distribution of trichobothria on the right-hand pedipalpal segments of *Hadogenes zumpti* Newlands & Cantrell 1985 (Lectotype male, SAM B8945). Trichobothrial notation after Vachon (1973). 3. Inferior view of femur. 4. Dorsal view of femur. 5. Exterior view of femur. 7. Dorsal view of patella. 8. Ventral view of patella. 9. Dorsal view of chela. 10. Exterior view of chela. 11. Inferior view of chela.





Figures 12–13 Left hemispermatophore of *Hadogenes zumpti* Newlands & Cantrell 1985 (Lectotype male, SAM B8945). 12. Dorsal view. 13. Ventral view.

tance of the lobe as a character within *Hadogenes*. Whereas the lobe is absent in subadults and juveniles of all species of *Hadogenes*, it is present in adults of both sexes in all species except certain members of the *H. tityrus* species complex, where it is absent in the adult females (Lawrence 1966; Newlands 1972b, 1980; Newlands & Cantrell 1985).

Lamoral (1979: 658) stated of *H. tityrus* that 'chela of adult males and females [have] a distinct mesial notch at base of fixed finger and a mesial lobe near base of movable finger' and illustrated this fact (Figures 310–313). He stated further that 'the reports of Lawrence (1966: 7) and Newlands (1972: 134) that these structures occur only in males are incorrect; this applies only to immature specimens'. Newlands (1980) and Newlands & Cantrell (1985) provided cytogenetic and electrophoretic evidence that *H. tityrus* comprises a complex of morphologically similar species, differing primarily in colour and morphometric dimensions. Three allopatric forms of *H. tityrus* that were karyotyped differed considerably in chromosome number, suggesting that three distinct species were involved. This finding was further substantiated by consistent differences in the venom protein banding patterns of these forms. In some of these, the lobe is clearly absent from the

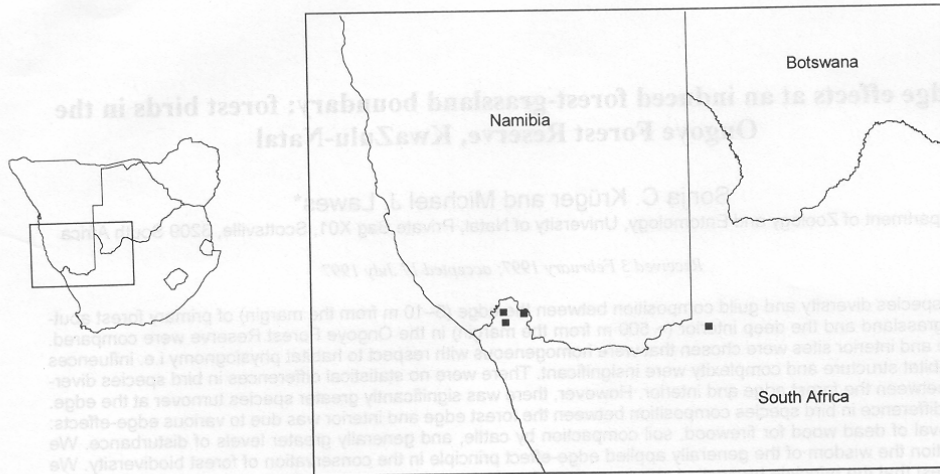
**Table 1** Meristic data for two adult males, an adult female and a subadult female from the type series of *Hadogenes zumpti* Newlands & Cantrell 1985. Measurements following Stahnke (1970) and Lamoral (1979)

	Lectotype male (SAM B8945)	Paralecto-type male (TM 11866)	Paralecto-type female (TM 18400)	Paralecto-type female subadult (TM 11867)
<b>Carapace:</b>				
anterior width	7.9	7.6	8.3	6.3
posterior width	11.7	11.3	12.0	8.7
length	12.0	11.8	12.3	9.9
<b>Chela:</b>				
maximum width	4.7	4.8	5.0	3.9
maximum height	2.9	2.9	3.3	2.7
maximum length <sup>1</sup>	24.2	23.6	23.7	20.2
length exterior ventral keel	13.4	12.7	12.8	10.2
length of movable finger	12.5	12.5	13.0	10.8
<b>Patella:</b>				
maximum width	4.6	4.9	5.2	4.0
maximum height	2.8	2.6	3.1	2.5
length	12.0	11.4	11.0	9.4
<b>Femur:</b>				
maximum width	3.6	3.8	3.8	2.8
maximum height	2.1	2.2	2.8	1.8
length	14.2	13.9	12.8	10.5
<b>Sternite VII:</b>				
width	8.0	7.7	9.3	7.0
length	9.5	9.8	7.9	5.8
<b>Metasomal segment I:</b>				
maximum width	2.3	2.3	2.1	1.7
maximum height	2.9	2.9	2.6	2.0
length	12.1	13.2	6.5	4.9
<b>Metasomal segment II:</b>				
maximum width	2.0	2.0	2.0	1.5
maximum height	3.4	3.8	2.9	2.1
length	15.4	17.1	7.6	6.0
<b>Metasomal segment III:</b>				
maximum width	1.9	1.9	1.9	1.3
maximum height	3.0	3.3	2.8	2.1
length	15.7	17.3	7.3	5.7
<b>Metasomal segment IV:</b>				
maximum width	1.7	1.8	1.7	1.3
maximum height	2.1	2.1	2.3	1.8
length	17.6	19.4	8.1	6.5
<b>Metasomal segment V:</b>				
maximum width	1.8	1.8	1.7	1.3
maximum height	2.0	2.0	2.2	1.7
length	16.7	18.2	8.6	6.8
<b>Telson:</b>				
maximum width	1.9	1.9	2.0	1.7
maximum height	2.5	2.4	2.5	1.8
length	7.7	7.4	7.2	6.1
Total length metasoma <sup>2</sup>	85.2	92.6	45.3	36.0
Total length prosoma + mesosoma <sup>3</sup>	42.3	46.8	47.1	37.8
<b>Pectinal tooth count (left/right)</b>				
	16/17	16/17	—	12/12

<sup>1</sup> Measured from base of condyle to tip of fixed finger

<sup>2</sup> Sum of metasomal segments I–V and telson

<sup>3</sup> Sum of carapace and tergites I–VII



**Figure 14** Map showing the distribution of *Hadogenes zumpti* Newlands & Cantrell 1985 in the Richtersveld and Kenhardt district of the Northwestern Province, South Africa.

movable finger of the adult female. For example, the lobe was found to be absent in adult females (in a gravid condition) of two allopatric forms of *H. tityrus* collected from several localities in the Richtersveld: a small, translucent form and a larger, dark brown-black form. In contrast, the lobe is known to be present in adult females of two allopatric Namibian forms: a small yellow form from Awasis Mountain and a larger, dark brown-black form widespread in southern Namibia (illustrated by Lamoral 1979). The presence or absence of a lobe on the movable finger of the adult female may therefore provide one means of discriminating between certain members of the *H. tityrus* species complex. Similarly, the shape of the lobe, i.e. the degree of development of the lobe and corresponding notch on the fixed finger of the chela, may provide additional diagnostic characters within the complex, as has been found among other closely related species of *Hadogenes* and species of *Liocheles* Sundevall (Prendini, pers. obs.).

The absence of a lobe on the movable finger of the adult female appears to be the plesiomorphic condition in *Hadogenes*, as revealed by outgroup comparison with other genera of Ischnuridae, e.g. *Cheloctonus* Pocock, *Iomachus* Pocock, *Liocheles* Sundevall and *Opisthacanthus* Peters, where the lobe is also absent from the movable finger of the adult female. Accordingly, the presence of a lobe in the adult female would be synapomorphic for the remaining species of *Hadogenes*. However, the absence of a lobe on the movable finger of the adult male appears to be autapomorphic for *H. zumpti*. The absence of a lobe on the movable finger of the adult male is also autapomorphic for another ischnurid, *Liocheles karschii* (Keyserling) from Papua New Guinea.

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