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New locality and host records of two chigger mite species (Acariformes: Trombiculidae) from Morocco

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Original research

ABSTRACT

Two chigger mite species, *Ericotrombidium tarentolae* (Vercammen-Grandjean & Langston, 1976) and *Neotrombicula orycti* Taufflieb, 1960, have been recorded outside their type localities and on two species of geckos from the genus *Quedenfeldtia* Boettger for the first time. One new subjective synonym has been established on the base of examination of type specimens and additional materials — *Neotrombicula orycti* Taufflieb, 1960 (syn.: *Neotrombicula lemni* Taufflieb, 1960, **n. syn.**).

Keywords chiggers; parasites of reptiles; fauna; taxonomy; North Africa

Introduction

Morocco is one of the best-studied African countries as regards chigger mite fauna. Until the present, 23 localities have been sampled and 30 chigger species were recorded there (Stekolnikov 2018b). However, 28 of these 30 species are still known only from their original descriptions. Two species, *Brunehaldia brunehaldi* (Vercammen-Grandjean, 1956) and *Schoutedenichia (Platytrichia) dipodilli* Vercammen-Grandjean, 1958 were described from Morocco (Vercammen-Grandjean 1956, 1958) and later recorded, respectively, in Turkey and Egypt (Stekolnikov & Daniel 2012) and in Spain (Pereira-Lorenzo 1993). *Straelensia variocula* Brown, 2006 was described from both Morocco and Burkina Faso (Brown 2006), but is still known only from its type series. Moreover, the larger half of the chigger species known in Morocco (20 of 30) were collected only in Casablanca or its vicinities (Nfifikh forest, Oued Cherrat, and Tit Mellil). Thus, the knowledge of the chigger fauna in the country should be regarded as fragmentary.

During the recent survey of the parasites of geckos (Er-Rguibi *et al.* 2021), samples of the Trombiculidae were collected from two species of the genus *Quedenfeldtia* Boettger in the Agadir and Marrakech provinces of Morocco. In the present paper, we give results of their identification. In addition, reviews of some chigger collections performed recently by one of us (AAS) allowed a confirmation of our identifications by the comparison with type series, a correction of the literature data on the deposition of types, and resulted in the establishment of one new synonym.

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Material and methods

The mites were collected in two localities, from two species of geckos. Oukaïmeden (31°12'19" N, 7°51'44" W; altitude 2700 m) is a ski resort located in the Atlas Mountains, in the Marrakech province of Morocco. It is characterized by fractured rock outcrops and stone walls with mountain vegetation consisting of plants of alpine and boreal origin (Alaoui Haroni *et al.* 2008). The region presents a Mediterranean climate, with mean annual rainfall around 500–600 mm/year. Mean temperature ranging from 22 °C in the warmest month (July) to –4 °C in the coldest one (January), with 82 to 139 days of frost per year (Alaoui Haroni *et al.* 2008). Snowfall occurs mainly between November and March in Oukaïmeden plateau (sometimes snow cover remains until the end of May) (Bouazza *et al.* 2016). A sample of chiggers was collected from adult geckos (16 males and 18 females) of *Quedenfeldtia trachyblepharus* (Boettger) (Squamata: Sphaerodactylidae) in May 2019. The groups of bright-orange mites were attached at front and hind legs, the back, the abdomen, the eyes, vent and tail of the hosts. The chiggers were collected gently with the use of tweezers and fixed in absolute ethanol.

Bigoudine town, Barrage Abdelmoumen (30°40'9" N, 9°11'6" W; altitude 625 m) is located in the Atlas Mountains, in the Agadir province of Morocco. The locality was characterized by mountain rock crevices, boulders and stone walls with cracks. The climate is typically Mediterranean, characterized by extreme variation in daily and monthly temperatures. Mean daily air temperatures ranged from 2 °C in winter to 32 °C in summer. Precipitation averaging 519 mm/year (M'Hirit *et al.* 1998). The vegetation is a sparse forest where argan trees (*Argania spinosa*), juniper trees (*Juniperus phoenicea*), and jujube trees (*Zizyphus lotus*) are accompanied with cultivated plants such as eucalyptus (*Eucalyptus* sp.), olive trees (*Olea europaea*) and almond trees (*Prunus dulcis*). In addition, glaucous tobacco (*Nicotiana glauca*) was the dominant tree around the barrage. Chiggers were collected from adult geckos (5 males and 2 females) of *Quedenfeldtia moerens* (Chabanaud) (Squamata: Sphaerodactylidae) in March 2019, as described above.

Mites were mounted on microscope slides using Berlese's medium (Walter and Krantz 2009). The slides were examined under a Leica DM 2500 compound microscope (Leica Microsystems GmbH, Wetzlar, Germany) using differential interference contrast (DIC). Microphotographs were taken by means of a Leica DMC 4500 digital camera, morphological drawings were prepared using a drawing tube. Measurements were taken using an ocular micrometer, on a MBI-3 microscope (LOMO plc, Saint Petersburg, Russia) with phase contrast optics.

The new material is deposited at the Zoological Institute RAS (ZIN, Saint Petersburg, Russia). Type materials were examined by AAS in Muséum d'Histoire Naturelle (MHNG, Geneva, Switzerland) and Muséum National d'Histoire Naturelle (MNHN, Paris, France), under microscopes Zeiss Axioskop (Carl Zeiss AG, Oberkochen, Germany) using DIC, ocular micrometer, and a drawing tube. A preliminary calibration by a stage micrometer was done for each of these microscopes.

We have used the specific chigger terminology summarized by Goff *et al.* (1982), which is prevailing in the taxonomy of these mites, easily comparable with the common terminology for Prostigmata, but has some advantages due to a greater conformity with the specific details of chigger morphology. The index DS is the number of dorsal idiosomal setae, which include humeral setae (shifted anterior marginal setae of the row C) and setae of the posthumeral rows (C except humeral setae, D, E, F, etc.), but exclude setae situated on the scutum. The V is the number of ventral idiosomal setae excluding sternal and coxal. Measurements of legs (pa, pm, and pp) are being taken from the proximal end of coxa to the distal end of pretarsus, excluding claws. Other abbreviations are explained in the caption to the Table 1. Diagnostic formulas (SIF, fPp, and fD) are explained by Goff *et al.* (1982) and Stekolnikov (2018b).

Results

***Ericotrombidium tarentolae* (Vercammen-Grandjean & Langston, 1976) (Fig. 1A – C)**

Leptotrombidium (*Ericotrombidium*) *tarentolae* Vercammen-Grandjean & Langston (1976)
(original designation)

Ericotrombidium tarentolae Stekolnikov (2018b)

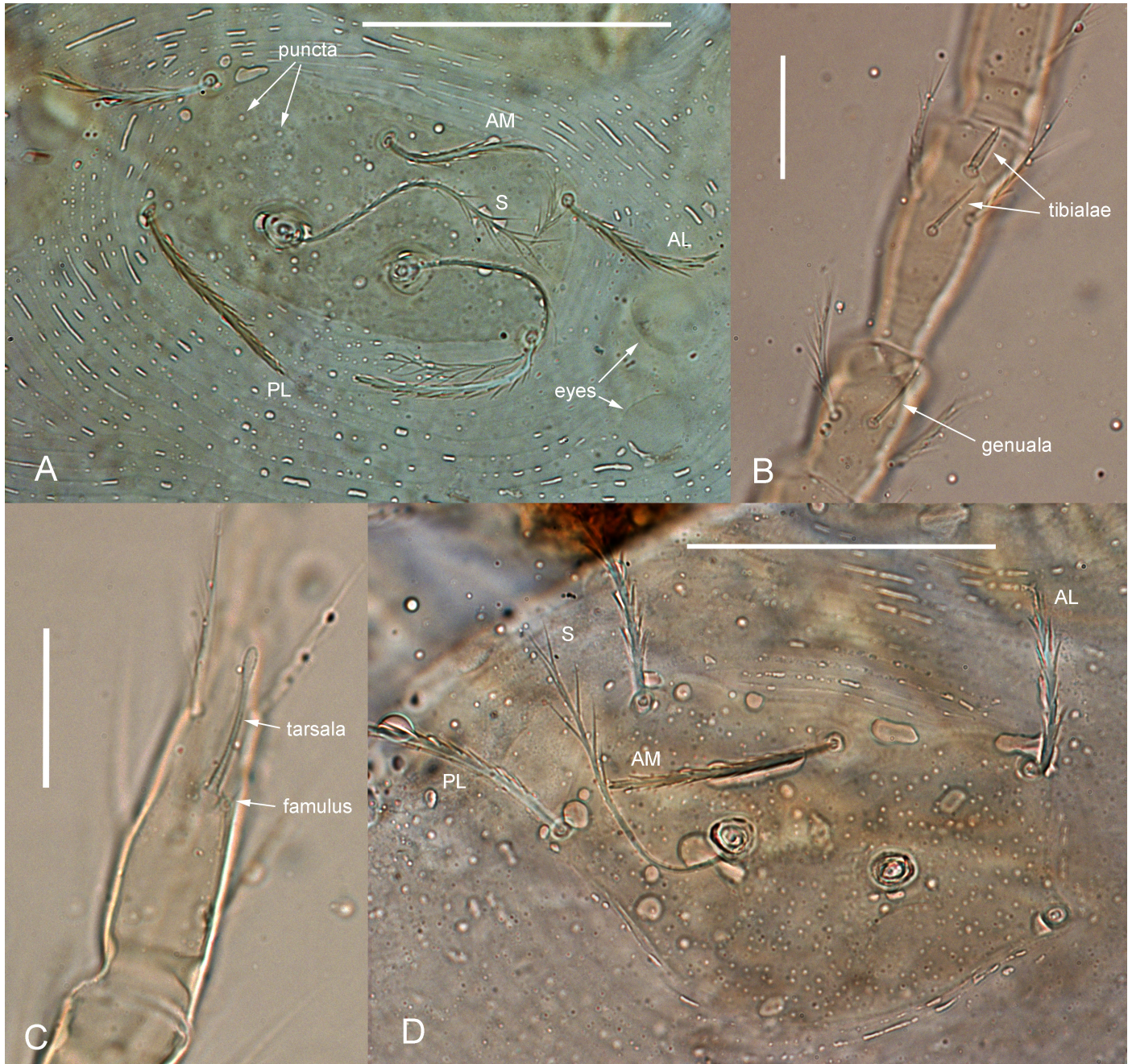


Figure 1 *Ericotrombidium tarentolae* (Vercammen-Grandjean et Langston, 1976), larva ZIN 17115 (A – C): A – scutum; B – genu and tibia II, dorsal aspect; C – tarsus II, dorsal aspect. *Neotrombicula orycti* Taufflieb, 1960, larva ZIN 17121: D – scutum. Abbreviations: AL – anterolateral scutal seta; AM – anteromedian scutal seta; PL – posterolateral scutal seta; S – sensillum. Scale bars: A, D – 50 μ m; B, C – 20 μ m.

Material examined — Five larvae (ZIN 17114 – 17118) from *Quedenfeldtia moerens* (Chabanaud) (Squamata: Sphaerodactylidae), MOROCCO, Agadir province, Bigoudine town, Barrage Abdelmoumen, 30 Mar. 2019, collected by Omar Er-Rguibi, El-Mustapha Laghzaoui, and Abdessamad Aglagane.

Type deposition — According to the original description (Vercammen-Grandjean & Langston 1976), type series of this species was deposited in Musée Royal de l'Afrique Centrale (MRAC, Tervuren, Belgium). Currently, holotype and 53 paratypes are deposited in MHNG (Stekolnikov 2019), while only 11 non-type specimens from the type locality are deposited in MRAC (Stekolnikov 2018b).

Diagnosis — SIF = 7BS-B-3-2111.0000; fPp = B/B/NNN(b); fD = 2H-8-6-6-4-2-(0-2); DS = 28 – 30; V = 24 – 26; NDV = 52 – 55; Ip = 846 – 893 (765 – 800 according to original description); scutum rectangular, with sparse large puncta; flagelliform sensilla covered with small cilia in proximal half and with 15 – 17 branches in distal half; sensillary (trichobothrial) bases at level or anterior to level of PL (by 3 – 5 µm); PL > AL > AM; marginal setae of 1st row slightly longer than humeral setae (36 – 40 vs. 31 – 34 µm); microtarsala I (ε) distal to tarsala I (ω); microtarsala II (ε) at level of tarsala II (ω); tarsala II thin, with inflated tip (bulbapex); distal tibiala II (φ) expanded, much thicker than proximal tibiala. Standard measurements given in Table 1.

Remarks — This species was known only from its type locality (Morocco, Casablanca) and the type host, *Tarentola mauritanica* (L.) (Squamata: Phyllodactylidae). Here, it is for the first time recorded in Agadir Province and on *Quedenfeldtia moerens*.

The difference by the lengths of legs between the new material and the type series according to the original description (846 – 893 vs. 765 – 800) could be an example of intraspecific variation or of a bias caused by differences in the mode of measuring, which can present specifically in the case of legs' length (Stekolnikov *et al.* 2019).

Noteworthy is the presence of the tarsala II having inflated tip in *E. tarentolae*. According to the observation of Loomis (1964), it is a characteristic of the chigger species from different genera parasitizing lizards. He suggested that the expanded tip of this chemoreceptor plays a role in the detection of the lizard hosts.

***Neotrombicula orycti* Taufflieb, 1960 (Figs 1D, 2)**

Neotrombicula roubaudi var. *orycti* Taufflieb (1960a) (original designation)

Neotrombicula orycti Stekolnikov (2018b)

Neotrombicula roubaudi var. *lemni* Taufflieb (1960a) (original designation), n. syn.

Neotrombicula lemni Stekolnikov (2018b)

Type material examined — Holotype larva of *N. orycti*, MNHN 59D 11, ex *Oryctolagus cuniculus* (L.), Maroc (MOROCCO), [19]58; paratype larva of *N. orycti*, MHNG, ex *O. cuniculus*, Maroc, forêt de Nefikh (MOROCCO, Nfikh forest), [19]58; holotype larva of *N. lemni*, MNHN 59E 16, ex *Rattus rattus* (L.), Cherrat, Maroc (MOROCCO, Oued Cherrat), [19]58; paratype larva of *N. lemni*, MHNG, Maroc, B. Cherrat (MOROCCO, Oued Cherrat), [19]59.

Additional material examined — Seven larvae (ZIN 17119 – 17125) from *Q. trachyblepharus*, MOROCCO, Marrakech province, Oukaïmeden, 28 May 2019, collected by Omar Er-Rguibi, El-Mustapha Laghzaoui, and Abdessamad Aglagane.

Type deposition — The original descriptions of *N. orycti* and *N. lemni* did not include an information on the type designation (Taufflieb 1960a). Currently, the holotype and 10 paratypes of *N. orycti* are deposited in MNHN (59D 1 – 11) and three paratypes are deposited in MHNG. The holotype and 11 paratypes of *N. lemni* are deposited in MNHN (59E 1, 5 – 8, 10 – 16) and three paratypes are deposited in MHNG.

Diagnosis — SIF = 7BS-N-3-3111.1000; fPp = B/B/NNB; fD = 2H-(6 – 9)-(6 – 8)-(6 – 7)-(4 – 8)+(5 – 12); DS = 33 – 40; V = 27 – 32; NDV = 65 – 72 (56 – 80 according to original descriptions of *N. orycti* and *N. lemni*); Ip = 650 – 858 (641 – 888 according to original

descriptions); scutum pentagonal, with rounded posterior margin, with moderate number of small puncta; flagelliform sensilla (trichobothria) with ca. 7 branches in distal half; sensillary (trichobothrial) bases anterior to level of PL (by 3 – 6 μm); $\text{PL} > \text{AL} > \text{AM}$ or $\text{PL} > \text{AM} > \text{AL}$; microtarsala I (ε) distal or proximal to tarsala I (ω); tarsala I longer than tarsala II (26 vs. 18 μm). Standard measurements given in Table 2.

Remarks — *Neotrombicula roubaudi* (Vercammen-Grandjean, 1956) was described from Tit Mellil and from Nfifikh forest (Morocco, Casablanca-Settat region), where it was collected from *Apodemus sylvaticus* (L.) (syn.: *Sylvaemus sylvaticus hayi*), *Lemniscomys barbarus* (L.), *Mus spicilegus* Petényi (Rodentia: Muridae), and *Eliomys munbyanus* (Pomel) (Rodentia: Gliridae). Later Taufflieb (1960a) described two varieties of *N. roubaudi*, which were raised to species by Stekolnikov (2018b) with their original author and date, according to ICZN Code, Art. 45.6.4 (ICZN 1999). All three species, *N. roubaudi*, *N. orycti*, and *N. lemni* were found

Table 1 Standard measurements (in μm) and numbers of setae (DS, V, NDV) for *Ericotrombidium tarentolae*. Abbreviations: AW — distance between anterolateral scutal setae; PW — distance between posterolateral scutal setae; SB — distance between sensillary bases; ASB — distance from the level of sensillary bases to extreme anterior margin of scutum; PSB — distance from the level of sensillary bases to extreme posterior margin of scutum; SD — length of scutum (ASB + PSB); P-PL — distance from the level of posterolateral scutal setae to extreme posterior margin of scutum; AP — distance between antero- and posterolateral scutal seta on one side; AM — length of anteromedian scutal seta; AL — length of anterolateral scutal setae; PL — length of posterolateral scutal setae; S — length of sensilla; H — length of humeral setae; D_{\min} — length of the shortest dorsal idiosomal seta; D_{\max} — length of the longest dorsal idiosomal seta; V_{\min} — length of the shortest ventral idiosomal seta; V_{\max} — length of the longest ventral idiosomal seta; pa — length of leg I; pm — length of leg II; pp — length of leg III; Ip — sum of leg lengths (pa + pm + pp); TaIIIL — length of leg tarsus III; TaIIIW — width of leg tarsus III; DS — number of dorsal idiosomal setae; V — number of ventral idiosomal setae; NDV — DS + V.

	New material, n = 3		Type series, n = 16 (original description)	
	Range	Mean	Range	Mean
AW	61-63	62	55-64	60
PW	66-71	68	64-71	67
SB	18-22	20	20-25	23
ASB	25-26	26	26-29	27
PSB	11-13	11	10-12	11
SD	36-39	37	36-40	38
P-PL	6-11	9	-	-
AP	23-23	23	24-28	25
AM	23-26	25	25-28	27
AL	29-31	29	28-34	31
PL	35-37	36	37-40	38
S	63-63	63	62-70	66
H	31-34	32	35-38	36
D_{\min}	24-27	26	30-33	32
D_{\max}	36-40	38	38-41	39
V_{\min}	22-23	22	25-29	27
V_{\max}	32-33	33	33-39	36
pa	286-317	301	266-281	274
pm	259-266	263	237-244	241
pp	301-311	305	262-277	270
Ip	846-893	869	765-800	785
TaIIIL	79-88	83	-	-
TaIIIW	14-14	14	-	-
DS	28-30	29	-	28
V	25-26	25	-	24
NDV	53-55	54	-	52

in Nfifikh forest and in Oued Cherrat (a wadi located ca. 23 km NE of Nfifikh forest), on *L. barbarus*, *Rattus rattus*, *Dipodillus campestris* (Loche) (Rodentia: Muridae), *Oryctolagus cuniculus* (Lagomorpha: Leporidae), and on an inexactly identified passerine bird (“Rouge-gorge”). Both *N. lemni* and *N. roubaudi* were also recorded on *E. munbianus*, *A. sylvaticus*, *Mus spretus* Lataste (Rodentia: Muridae), and on *Mustela nivalis numidica* Pucheran (Carnivora: Mustelidae); the latter species was also recorded on another bird host (“Mésange”, i.e. Paridae gen. sp.).

Taufflieb (1960a) examined and measured rather large samples of these species. He took measurements of scutum for 32 *N. lemni* and 24 *N. orycti* specimens; legs were measured for 161 specimens of *N. lemni*, 58 *N. orycti*, and 115 *N. roubaudi*; the number of idiosomal setae was counted for 148 *N. lemni* and 76 *N. orycti*. Although ranges of quantitative characters were overlapped for the three species, the following two differences seem significant. The number of idiosomal setae is lower in *N. roubaudi* than in two other species (NDV = 50 – 58 vs. 56 – 74 in *N. lemni* and 64 – 80 in *N. orycti*). The legs are shorter in *N. lemni* than in two other species (I_p = 641 – 800 vs. 775 – 888 in *N. orycti* and 798 – 922 in *N. roubaudi*). Taufflieb also noted that the usual arrangement of setae in first two posthumeral rows is 6-6 in *N. roubaudi*, 6-8 in *N. lemni*, and 8-8 in *N. orycti*. In addition, the microtarsala (famulus, ϵ) of the leg I is situated at level or slightly distal to tarsala (ω) in *N. roubaudi*, distal to tarsala in *N. lemni*, and proximal to tarsala in *N. orycti* (Taufflieb 1960a).

We should note that using NDV and I_p allows almost exact discriminating of *N. roubaudi* from *N. orycti* + *N. lemni*: the combination of the latter two species is characterized by NDV > 58 or, if NDV = 56 – 58, then $I_p \leq 800$. On the contrary, distinguishing between *N. orycti* and

Table 2 Standard measurements (in μm) and numbers of setae (DS, V, NDV) for *Neotrombicula orycti* and *N. lemni*. Abbreviations as in Table 1.

	<i>Neotrombicula orycti</i>		<i>Neotrombicula lemni</i>		<i>N. orycti</i> , new material (n = 6)	
	Holotype	Paratype	Holotype	Paratype	Range	Mean
AW	71	70	72	70	61-69	66
PW	92	79	86	81	77-84	80
SB	32	28	29	29	25-28	27
ASB	28	31	28	26	25-27	26
PSB	29	31	29	31	27-29	28
SD	57	61	57	57	53-55	54
P-PL	23	-	26	-	23-25	24
AP	29	27	26	25	24-27	26
AM	28	34	34	38	34-40	37
AL	35	41	40	40	31-33	32
PL	48	50	52	56	41-45	43
S	-	59	55	70	-	-
H	48	51	52	54	45-49	46
D _{min}	37	38	40	43	32-36	34
D _{max}	38	46	45	55	40-42	41
V _{min}	26	23	26	29	23-28	25
V _{max}	40	43	42	43	37-40	38
pa	265	311	245	210	281-286	283
pm	231	252	200	197	230-248	240
pp	258	295	242	243	270-292	281
I_p	754	858	686	650	781-824	804
TaIII L	77	72	79	67	68-76	72
TaIII W	22	18	18	16	14-15	14
DS	38	40	33	36	-	35
V	27	32	32	29	-	30
NDV	65	72	65	65	-	65

N. lemni by those characters seems unreliable. For example, the holotypes of *N. orycti* and *N. lemni* has the same arrangement of setae in first three rows, 6-8-6 (Fig. 2), and identical NDV (65); the only significant quantitative difference between them is $I_p = 754$ vs. 686 (Table 2). Meanwhile, as was demonstrated for *Hirsutiella zachvatkini* (Schluger, 1948), a difference in the length of legs can characterize intraspecific ecological groups of chiggers, associated with different host species (Moniuszko *et al.* 2015).

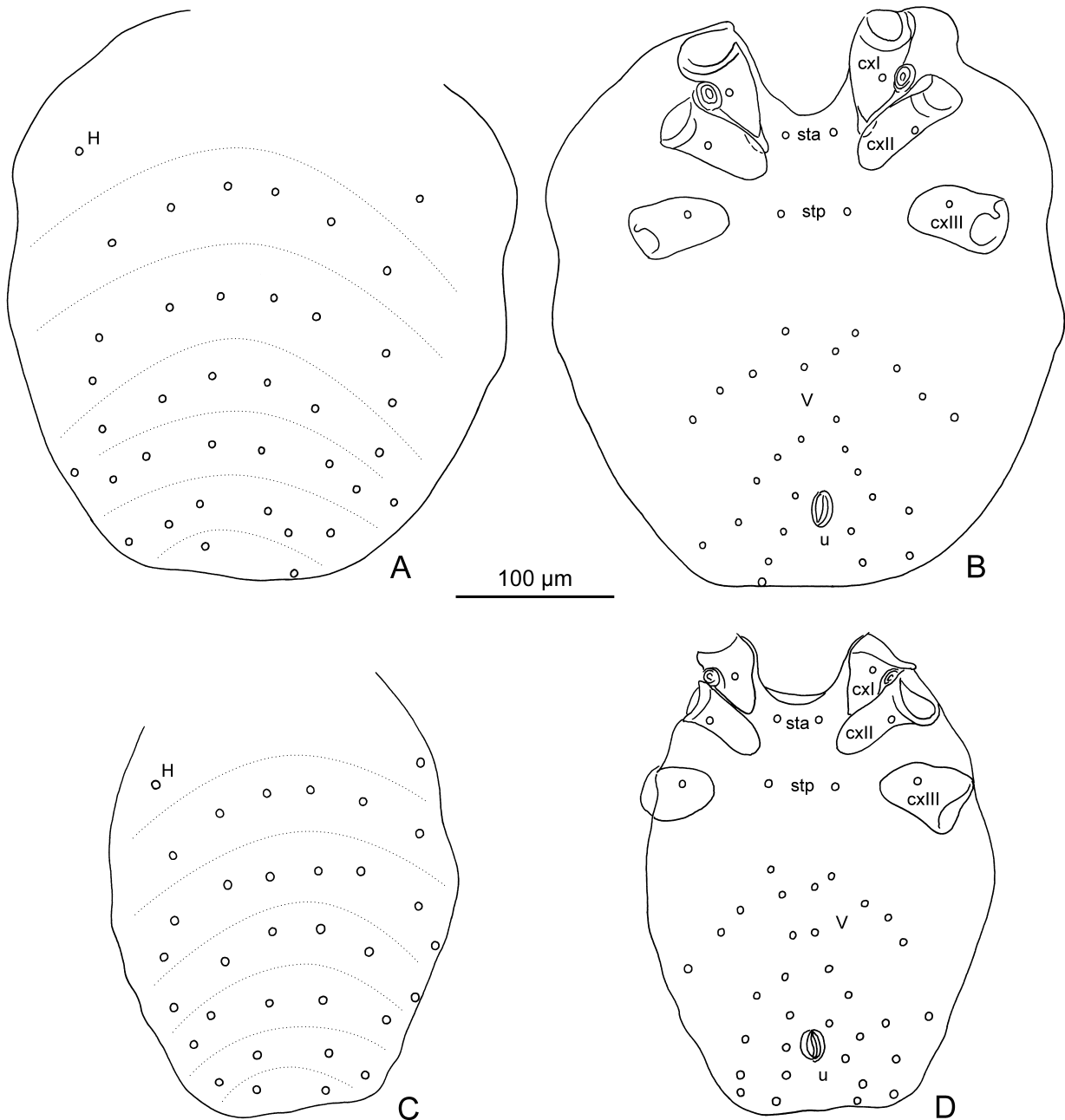


Figure 2 *Neotrombicula orycti* Taufflieb, 1960, holotype larva: A – dorsal idiosomal setae; B – ventral aspect of idiosoma. *Neotrombicula lemni* Taufflieb, 1960, holotype larva: C – dorsal idiosomal setae; D – ventral aspect of idiosoma. Abbreviations: cxI – leg coxa I; cxII – leg coxa II; cxIII – leg coxa III; H – humeral seta; sta – anterior sternal setae; stp – posterior sternal setae; V – ventral idiosomal setae; u – uropore (anus).

The position of microtarsala I in relation to the tarsala I is usually treated as a stable taxonomic character (Stekolnikov & González-Acuña 2012; Stekolnikov 2013). We suppose that in *N. orycti* it is variable. In the examined additional material, microtarsala I is situated distal to tarsala I, like in *N. lemni*, while all other characters (including Ip and the presence of eight setae in 1st posthumeral row) fit the diagnosis of *N. orycti*. Therefore, we conclude that *N. lemni* cannot be unambiguously discriminated from *N. orycti*, and synonymize the former species with the latter.

In the additional material, $AM > AL$, while in all four examined type specimens of *N. orycti* and *N. lemni* $AL > AM$. Since measurements of setae were not given in the original descriptions of these species, significance of this difference is unclear.

Here, *N. orycti* is for the first time recorded in Marrakech province and on a reptile host.

Discussion

The predominance of new species descriptions over finds of previously described species signifies a remarkable insufficiency in the taxonomy of chigger mites. The high rate of the Moroccan chigger species known only from their original descriptions (26 of 30, by the results of the present paper) corresponds to the similar data overall the African continent. Among 443 species known from Africa up to 2018, 73% have not been recorded outside their type localities (Stekolnikov 2018b). Although a taxonomic foundation for the identification of a larger half of African chiggers has been laid many decades ago by the works of Vercammen-Grandjean (1958, 1965, 1966), Vercammen-Grandjean & Langston (1976), and Taufflieb (1964, 1965, 1966), faunistic reports on African chiggers almost absent after 1970s, up to the paper of Stekolnikov (2018a), where 19 species have been recorded in new countries and/or on new hosts, and nine of them have been found outside their type localities for the first time. Our new data on the distribution and hosts for the species from the genera *Ericotrombidium* Vercammen-Grandjean and *Neotrombicula* Hirst is especially important, since some representatives of these genera can parasitize humans and domestic animals in Europe (Stekolnikov *et al.* 2014, 2016; di Meo *et al.* 2017; Areso Apesteguía *et al.* 2019; Ramilo *et al.* 2020), Africa (Taufflieb 1960b), and Western Asia (Stekolnikov & Kar 2015).

The “varieties” of *N. roubaudi* described by Taufflieb (1960a) represent an example of closely related sympatric forms of chigger mites that can be separate species or intraspecific ecological groups; Stekolnikov & Matthee (2019) discussed this phenomenon in some details. We suppose that *N. orycti* and *N. lemni* are rather indistinct forms of the same species, while *N. roubaudi* is possibly a separate species; however, this question requires further investigations.

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