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A new mite species of the genus *Neottialges* (Acariformes: Hypoderatidae) from the black stork *Ciconia nigra* (Ciconiiformes: Ciconiidae) in Portugal

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Original research

ABSTRACT

Deutonymphs of hypoderatid mites (Astigmata: Hypoderatidae) are subcutaneous parasites of various groups of birds and some rodents. A new hypoderatid mite species, *Neottialges* (*Caloenectes*) *ciconiae* n. sp., is described from the black stork, *Ciconia nigra* (Ciconiiformes: Ciconiidae), in Portugal. The new species is most similar to but differs from *N. (C.) distinctus* Fain and Lawrence, 1986 in having smaller prodorsal and hysteronotal shields not encompassing bases of setae *si*, *se*, *cp*, *c2*, *e2* and *h1*, the area between genital papillae completely sclerotized and fused with sclerotized area of coxal fields III, IV, and by the absence of the postanal shield. A new combination, *N. (C.) ellipticus* (Nitzsch) n. comb. is proposed for *Hypoderas ellipticus* Nitzsch in: Giebel (1861), described from *Ciconia alba* Linnaeus and formerly treated as a *species inquirenda*.

Keywords Hypoderatidae; *Neottialges*; systematics; parasites; *Ciconia nigra*

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Introduction

Astigmatan mites of the family Hypoderatidae are mainly associated with birds and occasionally with some rodents. At the stage of deutonymph, also referred in astigmatan mites to as *hypopus*, these mites are subcutaneous or visceral tissue parasites, while remaining stages of their life cycle are commensals inhabiting nests of the corresponding vertebrate hosts (Fain and Bafort 1967; OConnor 1982, 1985; Wurst and Havelka 1997; Krantz and Walter 2009; Mironov and Kivganov 2010; Mironov and OConnor 2013). The most surprising feature of these mites is that the deutonymph, which is the main (or in some genera the only) feeding stage in the life cycle, lacks any mouthparts and even a mouth opening. The feeding process of hypoderatid deutonymphs was for a long time an enigma. It was suggested that they probably uptake tissue fluids of their hosts taking them directly through the body cuticle (Mironov and Kivganov 2010). In the course of feeding, which can take a year until the next reproductive period of hosts, deutonymphs grow greatly by the way of neosomy that causes strong changes in their general appearance, particularly in the size and form of the idiosoma, the pattern of cuticular sclerotization, and relative position of legs and idiosomal setae. Recent investigation has shown that genital papillae are apparently nutrient-intake organs adsorbing liquid materials from host to mite (Alberti *et al.* 2016).

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Other active stages of hypoderatids living in bird's nests are saprophages or aphares. The full life-cycle has been described only for the four species, *Apodidectes verrucosus* Mironov and OConnor, 2013, *Hypodectoides propus* (Nitzsch, 1861), *Suladectes hughesae antipodus* Fain and Clark, 1994, and *Tytodectes strigis* (Gené, 1845) (Fain and Bafort 1966, 1967, Fain and Clark 1994, Wurst and Havelka 1997; Mironov and OConnor 2013). In the genera *Apodidectes* Mironov and OConnor, 2013 and *Tytodectes* Fain, 1966, the larva, protonymph, tritonymph, and adults have the appearance of typical free-living astigmatans such as Acaridae, with well-developed legs and normally developed mouthparts. Moreover, it was shown that *Tytodectes* mites can omit the deutonymphal stage and complete a full generation in the nest (Wurst and Havelka 1997), indicating that these stages do feed in the nest of their hosts. In contrast to that, in the genus *Hypodectoides*, the tritonymph, protonymph, and larva are strongly reduced (calyptostases) and represented by sack-like cuticle shells lacking legs and mouthparts and are obviously unable to feed. Adults of *H. propus* have normally developed legs but very odd mouthparts — in females, chelicerae are vestigial and in males, they are strongly hypertrophied (Fain and Bafort 1967). Therefore it is still unknown, whether adult hypoderatids with modified chelicerae are capable of feeding.

The family Hypoderatidae currently includes over 80 species arranged in 24 genera and two subfamilies. The subfamily Hypoderatinae (about 75 species in 22 genera) includes mites associated with birds (Fain 1967; OConnor 1985; Fain and Lukoschus 1986; Mironov and Kivganov 2010; Mironov and OConnor 2013). A comprehensive taxonomic revision of most species known at that time from deutonymphs associated with birds was given by Fain (1967). To date, representatives of this subfamily have been recorded from avian hosts of 14 orders as classified by Gill and Donsker (2018). Five species in two genera, restricted to certain desert and borrowing rodents, constitute the second subfamily, Muridectinae, known from deutonymphs only (Fain 1968; Fain and Lukoschus 1977, 1978). Most hypoderatid species are known only from deutonymphs, while adult and/or tritonymphal stages have been described for a few species from 11 genera. Mironov and Kivganov (2010) provided a list of species for which non-deutonymphal stages are known. Because of the large gap in the knowledge of adult morphology, the taxonomic system of hypoderatids is generally based on the morphological structures of deutonymphs.

In the present paper we describe a new species of the genus *Neottialges* Fain, 1966 based on deutonymphs collected from the black stork, *Ciconia nigra*, in Portugal.

Material and methods

The individual black stork, from which hypoderatid mites were collected, was found near the Alqueva Dam (at the border of Beja and Évora Districts, Portugal). It was transported to Lisbon Recovery Center of Sylvatic Animals (LxCRAS) by the Instituto de Conservação da Natureza e Florestas, I.P. (ICNF) personnel, Lisbon, Portugal, where it was treated for three days. After that, the bird died and was delivered by LxCRAS personnel to the Faculty of Veterinary Medicine, University of Lisbon. Several mite specimens were found under the skin of this bird during the process of necropsy and parasitological examination (at the Pathology Laboratory of the Faculty of Veterinary Medicine, University of Lisbon, Portugal), fixed in 96 % ethanol and then mounted on microslides in Hoyer's medium (Krantz and Walter 2009). Mites were studied and figured using a Leica DM2500 microscope with DIC and equipped with a *camera lucida*.

The description of new species follows the modern format used for hypoderatid mites of the genus *Neottialges* and related genera (Fain and Clark 1994; Mironov and Kivganov 2010; Mironov and OConnor 2013). The idiosomal chaetotaxy is that of Grandjean (1939a) as modified by Griffiths *et al.* (1990) and Norton (1998); the leg chaetotaxy is that of Grandjean (1939b). All measurements in descriptions are in micrometers. Classification and Latin names of birds follow Gill and Donsker (2018). Abbreviations used in access number and depositories

of type specimens: FMV — Faculty of Veterinary Medicine, University of Lisbon, Lisbon, Portugal; UMMZ — Museum of Zoology, University of Michigan, Ann Arbor, USA; ZISP — Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

Systematics

Family Hypoderatidae Murray, 1877

Subfamily Hypoderatinae Murray, 1877

Genus *Neottialges* Fain, 1966

Type species: *Neottialges* (*Neottialges*) *geopeliae* Fain, 1966, by original designation.

The genus *Neottialges* was established by Fain (1966) and originally included six species; at present, including the new species described below, it incorporates 35 species and is the most speciose within the family (Fain 1966, 1967, 1969; Fain and Amerson 1968; Pence 1971, 1973; Pence and Courtney 1973; Fain and Kigaye 1976; Fain and Domrow 1978; Fain and Lawrence 1979, 1986; Young and Pence 1979; OConnor 1985; Fain and Lukoschus 1986; Pence and Duncan 1995; Pence and Newman 1997; Pence *et al.* 1997; Mironov and Kivganov 2010; De Liberato *et al.* 2017). Fain (1966, 1967) recognized originally three subgenera within this genus: *Caloenectes* Fain, 1966, *Neottialges* s. str., and *Pelecanectes* Fain, 1966. Later, Fain and Lukoschus (1986) established two more subgenera, *Ardeidectes* Fain and Lukoschus, 1986 and *Heronidectes* Fain and Lukoschus, 1986. Adult mites are known only in a few species from each subgenus, except *Caloenectes*, whose adults are not yet known. The latest key to deutonymphs of most known species was given by Fain and Lawrence (1986); for major references for previously described *Neottialges* species see Mironov and Kivganov (2010).

Representatives of the genus *Neottialges* are presently known from birds of the orders Accipitriformes, Ciconiiformes, Charadriiformes, Columbiformes, Falconiformes, Musophagiformes, and Pelecaniformes (Fain 1967; Fain and Lawrence 1986; Fain and Lukoschus 1986; Mironov and Kivganov 2010). Of previously known species of this genus, three species of the subgenus *Caloenectes* have been described from storks (Ciconiiformes: Ciconiidae): *Neottialges* (*Caloenectes*) *distinctus* Fain and Lawrence, 1986 from the Maguari stork, *Ciconia maguari* (Gmelin, JF), *N.* (*C.*) *ellipticus* (Nitzsch in: Giebel (1861)) n. comb. from the white stork *C. ciconia* Linnaeus, and *N.* (*C.*) *mycteriae* Pence, 1973 from the wood stork, *Mycteria americana* Linnaeus, and painted stork, *M. leucocephala* (Pennant) (Giebel 1861; Fain 1967, 1973; Pence 1973; Fain and Lawrence 1986). *Neottialges ellipticus* was originally described in the genus *Hypoderas* Nitzsch, 1861 (now *Hypodectes*). Since the illustration of this species was rather schematic, Fain (1967) in his revision of hypoderatids parasitizing birds treated this mite as a *species inquirenda*; however the size and general shape of idiosoma, proportion of legs and their segments allow this mite to be referred to the genus *Neottialges*.

Neottialges (*Caloenectes*) *ciconiae* n. sp.

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(Figures 1–3)

Type material — Holotype deutonymph (FMV 2001) and 10 deutonymph paratypes from *Ciconia nigra* (Linnaeus) (Ciconiiformes: Ciconiidae), Portugal, border of Beja and Évora Districts, Alqueva Dam, 38°11'51"N, 7°29'47"W, 23 March 2018, collected by ICNF (Instituto de Conservação da Natureza e das Florestas, I.P.) personnel.

Depositories — Holotype and 3 paratypes — FMV, remaining paratypes in UMMZ and ZISP.

Description — Deutonymph (holotype, range for 10 paratypes in parentheses). Idiosoma ovate, with very short and wide rostral extension, length 1040 (950–1050), greatest width 500 (600–450). Median area of dorsal side of idiosoma occupied by roughly punctate prodorsal

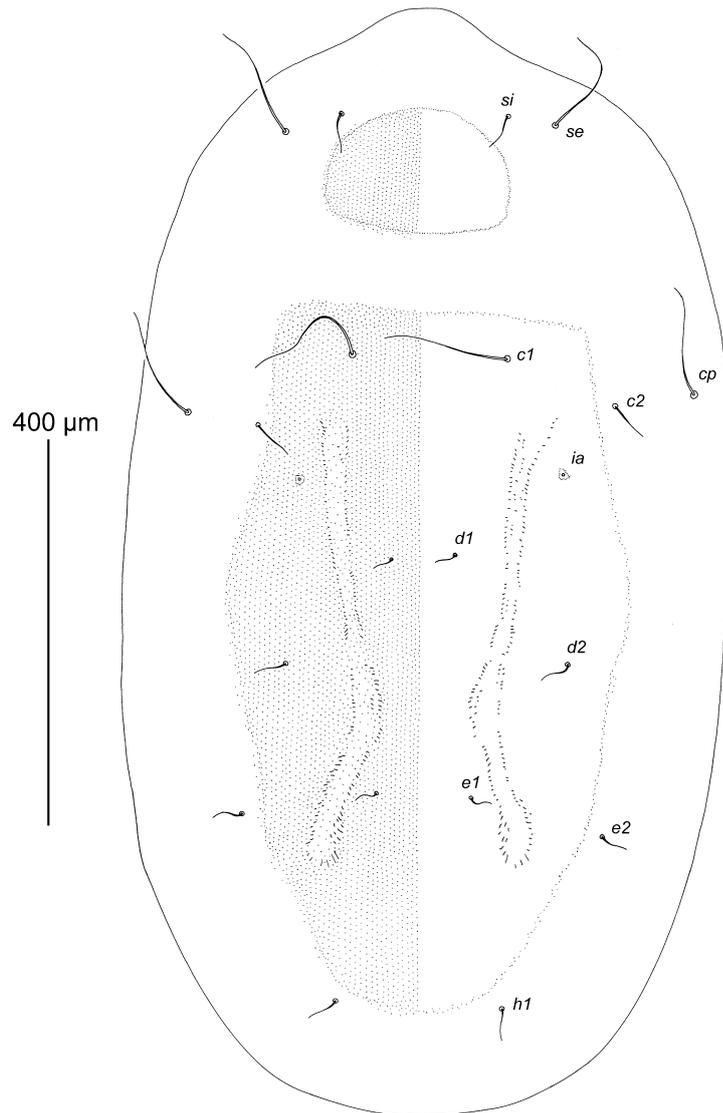


Figure 1 *Neottialges (Caloenectes) ciconiae* n. sp., dorsal view of deutonymph.

and hysteronotal shields with blurred and indistinct borders (Figure 1). Sejugal furrow not expressed dorsally. Prodorsal shield transversely ovate in form, occupying central part of propodosoma, not encompassing bases of scapular setae *si* and *se*. Setae *si* situated slightly anterior to level of setae *se*; distances between scapular setae: *se:se* 260 (215–260), *si:si* 170 (125–170); length of setae: *se* 115 (110–120), *si* 30 (20–30). Hysteronotal shield occupying only median area of hysterosoma, anterior margin straight, posterior margin rounded, surface with a pair of poorly sclerotized longitudinal bands. Setae *cp* situated dorsally. Setae *c2* posterior to level of setae *cp*. Setae *c1*, *d1*, *d2* and *e1* situated on hysteronotal shield, setae *cp*, *c2*, *e2*, and *h1* situated off hysteronotal shield. Cupules *ia* situated posteromesal to setae *c2*; cupules *im*, *ip* and *ih* indistinct. Four pairs of hysterosomal setae (*cp*, *c1*, *c3*, and *h3*) elongate and comparable in length to scapular setae *se*; remaining setae of dorsal side of hysterosoma and ventral setae of posterior end of opisthosoma very thin and not exceeding 50 long; length of long hysterosomal setae: *cp* 120 (100–140), *c1* 130 (90–130), *c3* 110 (100–120), *h3* 140 (130–150).

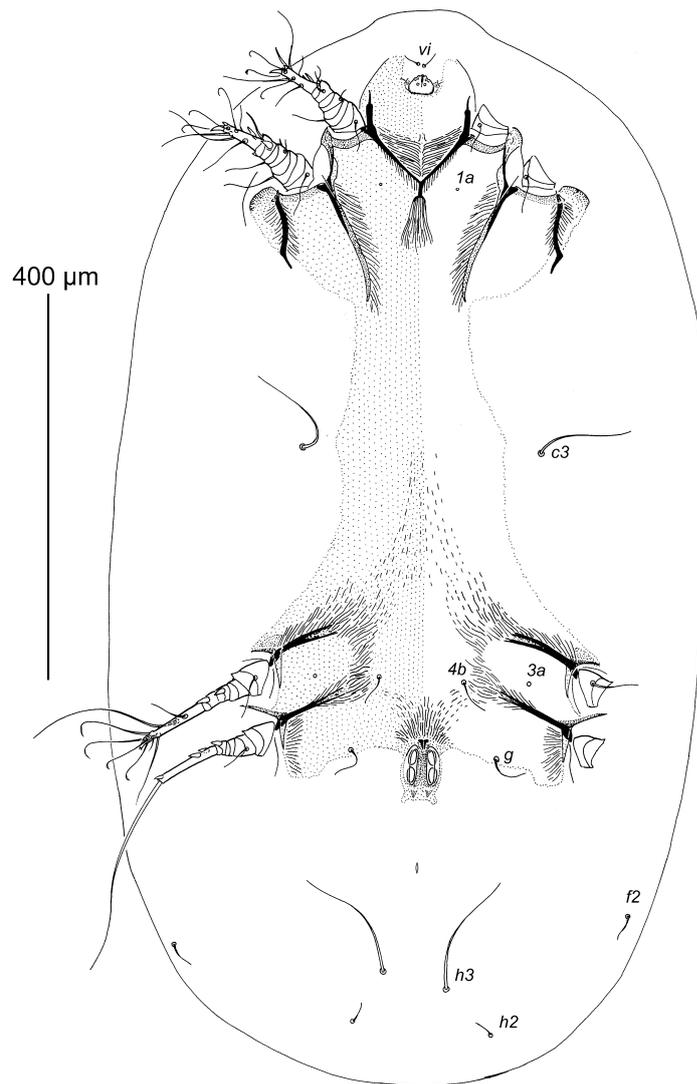


Figure 2 *Neottialges (Caloenectes) ciconiae* n. sp., ventral view of deutonymph.

Gnathosoma situated ventrally, reduced to small trapezoidal sclerite 15 (15–17) long and 28 (25–28) wide at base, with two pairs of rudimentary setae represented by alveoli (Figures 2 and 3A). Vertical setae *vi* filiform, about 15 long, situated ventrally near anterior end of gnathosomal plate. Supracoxal setae *scx* situated near lateral margins of gnathosomal plate in small invaginations. Sternum 20 (12–20) long, much shorter than free parts of epimerites I. Coxal fields I, II and IV open; coxal fields III closed. Inner tips of epimerites III, IV with irregular pennate striation. Bases of trochanters I–IV flanked by narrow sclerotized bands. Coxal setae *1a* and *3a* rudimentary, represented by alveoli. Genital field ovate, situated at level of trochanters IV, well outlined. Genital apodeme rudimentary, represented by a pair of small inverted L-shaped sclerites anterior to genital papillae; surface between papillae poorly sclerotized (Figure 3B). Genital papillae ovate, small, anterior and posterior pairs similar in size, length 15 (13–15). Anal opening rudimentary, distant from genital papillae. Coxal setae *4b* 45 (30–45) long, situated at midlevel of coxal fields III, genital setae *g* 40 (35–50) long. Postanal shield absent, setae *h2* and *h3* situated on soft tegument.

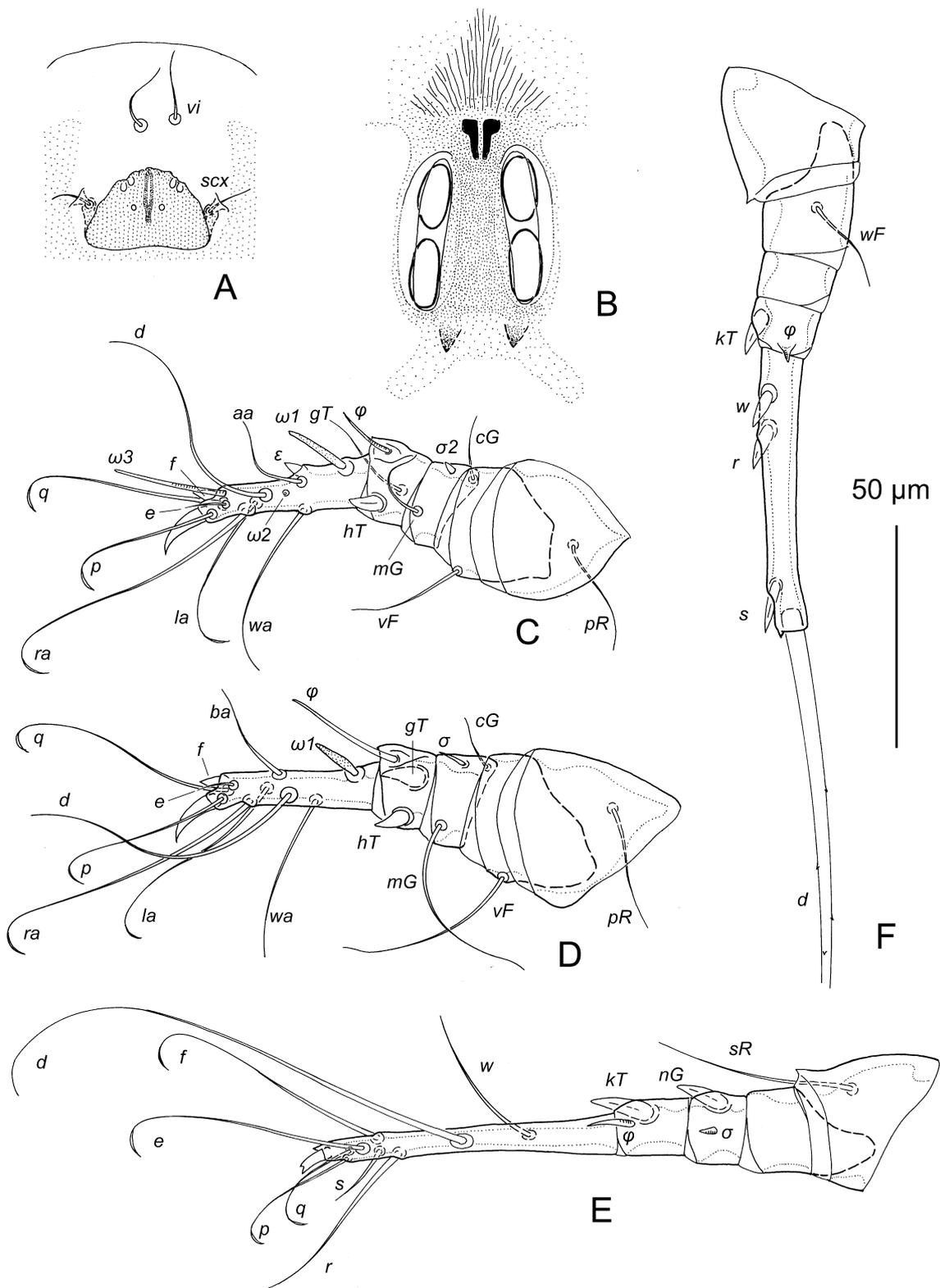


Figure 3 *Neottialges (Caloenectes) ciconiae* n. sp., details of deutonymph. A – gnathosomal plate, B – genital papillae, C–F – dorsal view of legs I–IV, respectively.

Leg segments normally developed, tarsi I, II approximately 1.5 times longer than corresponding tibiae and genua, tarsi III, IV 2.3–2.5 times longer than corresponding tibiae and genua. Length of legs excluding trochanters: I 87 (85–88), II 92 (90–92), III 125 (120–128), IV 110 (105–115); length of tarsi: I 37 (35–40), II 42 (37–42), III 68 (62–70), IV 65 (58–68). Tarsus I with setae *aa*, *d*, *wa* long filiform with simple tips; setae *la*, *ra*, *p*, *q* long filiform with foliate distal tips, seta *e* short filiform, seta *f* spine-like, solenidion $\omega 1$ distinctly punctate and slightly tapering apically; solenidion $\omega 3$ elongate, situated apically; famulus ε spine-like, situated at midlevel of tarsus, at same level as setae *aa* and *wa*; solenidion $\omega 2$ vestigial, situated anterior to base of seta *aa* (Figure 3C). Tarsus II similar in structure to tarsus I (except for absence of seta *aa* and famulus and presence of *ba*), solenidion $\omega 1$ punctate and slightly thickened in basal third (Figure 3D). Tarsus III strongly elongate and straight, with small apical spine, with 8 setae: seta *d* long filiform, exceeding the length of segment; setae *w*, *r* filiform, nearly half as long as segment; setae *e*, *f*, *p*, *q*, filiform with foliate apices; seta *s* short spiculiform (Figure 3E). Tarsus IV with small apical spine and with 4 setae of uncertain homology: apical seta (possibly *d*) represented by macroseta, nearly 3 times longer than leg IV and with small sparse barbs in basal part; two spine-like setae (possibly *w*, *r*) situated basally, and thin spine-like seta (possibly *s*) situated subapically (Figure 3F). Empodial claws of tarsi I, II shorter than half-length of corresponding tarsi, acute and slightly curved apically, both 12 (11–13) long; empodial claw of tarsus III bidentate apically and slightly curved, 10 (8–10) long. Tibia I with longitudinal dorsal crest, seta *gT* long filiform, seta *hT* thick spine-like, solenidion φ subequal in length to solenidion $\omega 1$ of tarsus I. Tibia II similar to tibia I except both setae *gT* and *hT* spine-like, solenidion φ twice as long as solenidion $\omega 1$ of tarsus II. Tibia III with seta *kT* thick, spine-like, solenidion φ short, about 2/3 the length of this segment. Tibia IV with seta *kT* thick, spine-like and solenidion φ about 1/3 the length of this segment. Genu I with setae *mG*, *cG* filiform, solenidion $\sigma 2$ a very short and blunt spine. Genu II with seta *mG* filiform, seta *cG* as on tarsus I, and solenidion σ spiculiform. Genu III with seta *nG* thick spine-like, with solenidion σ small, spiniform. Femoral setae *vFI*, *vFII*, and *wFIV* filiform, shorter than corresponding legs. Setae *pR* of trochanters I, II subequal in length to corresponding tarsi, seta *sR* of trochanter III shorter than corresponding tarsus. Leg setation (solenidia in parentheses): tarsi 10(3)-9(1)-8-4, tibiae 2(1)-2(1)-1(1)-1(1), genua 2(1)-2(1)-1(1)-0, femora 1-1-0-1, trochanters 1-1-1-0.

Differential diagnosis — Among previously known species, *Neottialges* (*Caloenectes*) *ciconiae* n. sp. is most similar to *N. (C.) distinctus* Fain and Lawrence, 1986 in having the median dorsal sclerotization of the idiosoma represented by separate prodorsal and hysteronotal shields, the median sclerotized bridge connecting the ventral propodosomal sclerotized area (fused coxal fields I, II) and ventral hysterosomal sclerotized area (coxal fields III, IV), and only two long pairs of hysteronotal setae (*c1* and *cp*). *Neottialges* (*Caloenectes*) *ciconiae* differs from the latter species by the following features: the bases of setae *si*, *se* are not encompassed by the prodorsal shield, hysteronotal setae *cp*, *c2*, *e2* and *h1* are situated off the hysteronotal shield, the area between the genital papillae is completely sclerotized, and its anterior end is fused with the sclerotized area of coxal fields III, IV, and the postanal shield on the ventral side of opisthosoma is absent. In deutonymphs of *N. (C.) distinctus*, the bases of setae *si*, *se* are encompassed by the prodorsal shield, hysteronotal setae *cp*, *c2*, *e2* and *h1* are situated on the hysteronotal shield, the area between the genital papillae is sclerotized only medially, and its anterior end is separated from the sclerotized area of coxal fields III, IV, and the ventral side of the opisthosoma bears a rhomboid postanal shield encompassing the bases of setae *h2* and *h3*.

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