

Research article

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A new species of *Hortipes* (Araneae, Corinnidae), the first spider with an insertable retrolateral tibial apophysis on the male palp

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Abstract. *Hortipes gigapophysalis* (Araneae, Corinnidae) is a new species described from both sexes from montane forest on Mt Nimba, eastern Guinea. The species is remarkable for its long, whip-shaped retrolateral tibial apophysis (RTA) on the male palp. The structure apparently has an insertable function as the epigyne of the female contains a separate set of ducts starting from a central concavity that is unique in the genus. This duct system is apparently meant to receive the supple RTA. This type of structural arrangement has never previously been found in spiders.

Keywords. genitalia, morphology, Corinnidae, Guinea, Mt Nimba.

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Introduction

With almost 70 known species, *Hortipes* Bosselaers & Ledoux, 1998 is one of the largest Afrotropical genera (Bosselaers & Jocqué 2000a). Most of the species live in the litter layer of dense forests and woodlands, hence its very wide distribution from West Africa to Ethiopia in the north and to large parts of South Africa in the south. However, the genus is entirely absent from miombo woodland and is therefore an excellent example of an Afrotropical spider genus with this type of distribution. The genus is also remarkable as an example of the range of complexity of genitalia that is met with in many spider genera. In *Hortipes*, the genitalia range from quite simple structures as in *H. silvarum* Ledoux & Emerit, 1998 to complex configurations such as in *H. sceptrum* Bosselaers & Jocqué, 2000a. The genus can therefore be considered as suitable for testing the evolution of genitalia in the context of sexual selection hypotheses (e.g. Eberhard & Huber 1998; Huber 1995a; Jocqué 2002).

The present paper describes a new species in the genus that has a remarkable male palp provided with a very long retrolateral tibial apophysis (RTA) unlike any that has been found in spiders so far.

Material and Methods

Specimens were observed and measured with a Leica M10 stereomicroscope. Photographs of the habitus were taken with a Leica MZ16 using the LAS automontage software. The female epigyne was detached from the abdomen, temporarily mounted in a clearing mixture of methyl salicylate and cedukol (Merck, Darmstadt) and observed with a Leitz Dialux 22 microscope and subject to automontage with the Syncroscopy software. For SEM photos, a palp was dried in HMDS, gold coated and examined and photographed with a JEOL 6480 LV scanning electron microscope. The format for leg spination follows Platnick & Shadab (1975), amended for ventral spine pairs according to Bosselaers & Jocqué (2000b). The spine row sequences run from the base of segments towards the tip. Leg spine numbers between brackets refer to spines present in some instances and absent in others. All measurements are in millimeters.

A phylogenetic analysis was performed under implied weighting (Goloboff 1993) using the computer programmes PAUP 4.0 beta 10 (Swofford 2002), and TNT 1.1 (Goloboff *et al.* 2003, 2008) run on a dual-core Intel iMac under a Windows XP virtual machine (VMware Fusion 2, VMware, Inc., 3401 Hillview Avenue, Palo Alto, CA 94304, USA; Bugnion *et al.* 2000). For this purpose, the characters and data from Bosselaers & Jocqué (2000a: 11-24) were used, with scores added for *H. gigapophysalis* (1:1, 2:1, 3:1, 4:1, 5:1, 6:1, 7:2, 8:2, 9:0, 10:0, 11:1, 12:0, 13:1, 14:0, 15:0, 16:0, 17:0, 18:0, 19:0, 20:0, 21:0, 22:1, 23:1, 24:1, 25:1, 26:0, 27:1, 28:1, 29:1, 30:1, 31:1, 32:0, 33:?, 34:0, 35:?, 36:0, 37:0, 38:2, 39:3, 40:1, 41:2, 42:0, 43:0, 44:0, 45:1, 46:?, 47:?, 48:?, 49:?, 50:?, 51:0, 52:1, 53:0, 54:7, 55:?, 56:?, 57:?, 58:?, 59:?, 60:0, 61:0, 62:0, 63:0, 64:0, 65:0, 66:0, 67:0, 68:1, 69:0, 70:0, 71:0, 72:0, 73:0, 74:1, 75:0, 76:1, 77:0, 78:0, 79:0, 80:0, 81:1, 82:0, 83:2, 84:1, 85:1, 86:1, 87:0, 88:0, 89:0, 90:2). Moreover, the scoring for character 44, which had been inadvertently inverted in Bosselaers & Jocqué (2000a: table 1), was rectified, and an extra character state was added to character 54 in order to score *H. gigapophysalis*. Bremer support values (Bremer 1988, 1994) for the preferred consensus tree, expressed as fit values, were calculated in TNT using **Analyze / suboptimal**, followed by **Analyze / Traditional search / tree bisection reconnection (TBR)** and **Trees / Bremer Supports**, retaining trees suboptimal up to 10 units of fit (TNT values, see Jocqué & Bosselaers 2011: 274) and combining various numbers of replications (between 1 and 100) with various numbers of trees saved per replication (between 200 and 20000, inversely related to the numbers of replications) until the solution stabilized.

Abbreviations

CL	=	carapace length
CW	=	carapace width
do	=	dorsal
DTA	=	distal tegular apophysis
dv	=	dorso-ventral stretch of secondary tube system
E	=	embolus
HMDS	=	hexamethyldisilazane (CAS 999-97-3)
MA	=	median apophysis
MRAC	=	Royal Museum for Central Africa
mt	=	metatarsus
PAUP	=	phylogenetic analysis under parsimony
pdv	=	position of dorsoventral stretch
pl	=	prolateral
plv	=	prolateral ventral
rl	=	retrolateral
rlv	=	retrolateral ventral
RTA	=	retrolateral tibial apophysis

ti = tibia
TL = total length
vt = ventral terminal

Results

Class Arachnida Cuvier, 1812
Order Araneae Clerck, 1757
Family Corinnidae Karsch, 1880
Genus *Hortipes* Bosselaers & Ledoux, 1998

Hortipes gigapophysalis sp. nov.

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Figs 1-5

Diagnosis

Males of *H. gigapophysalis* are easily recognized by the long, winding RTA; the female is characterized by the central depression and the separate duct systems in the epigyne. These characters are unique in the genus.

Etymology

The species is called *gigapophysalis* in view of the extraordinarily long retrolateral tibial apophysis on the male palp.

Type material

Holotype

♂ (MRAC 239507): GUINEA, Mt. Nimba, Station de pompage Zié, alt. 1250 m, 07° 40' N - 008° 22' W, 03 Feb. 2012, hand collecting by A. Henrard, C. Allard, P. Bimou and M. Sidibé near Zié river, forest.

Paratypes

2 ♂♂ (MRAC 239104) and, together with holotype, 1 ♀ (MRAC 239482): GUINEA, Mt. Nimba, Pierre Richaud, Kaiser 1, alt. 1480 m, 07° 39' N - 008° 22' W, 7 Oct. 2011, hand collecting by A. Henrard and D. Vandenspiegel, at the entrance (± 4 m inside) of disused humid adit, under wood log.

Description

Male

MEASUREMENTS. Total length 2.21 carapace 1.07 long, 0.87 wide; length of fe: I 0.89, II 0.92, III 0.72, IV 1.07.

LEG SPINATION. Fe: I plv 1-1-1 rlv 1-1-1; II plv 1-1-1 rlv 1-1-1; ti: I plv 1-1-1-1-1 rlv 1-1-1-1-1-1; II plv 1-1-1-1-1-1 rlv 1-1-1-1-1-1; IV pl 0-1-0 rl 0-1-0; mt: I plv 1-1-1 rlv 1-1-1; II plv 1-1-1 rlv 1-1-1; IV pl 1-0-1 rl 1-0-1 vt 2.

COLORATION. Carapace and legs yellow, with an orange tinge; sternum pale yellow, chelicerae, labium and endites yellow. Abdomen pale. (Fig. 1A-C).

PALP (Figs 2A-B, 4A-F). Tibia with central constriction. RTA very long, slender and coiled, narrowing from base to tip; cymbium subcircular, proximally with deep retrolateral fold, with few straight setae along retrolateral margin and group of chemosensory setae at distal dorsal tip; sperm duct appears at base of embolus, runs along retrolateral, posterior and prolateral margins of tegulum, fairly broad over

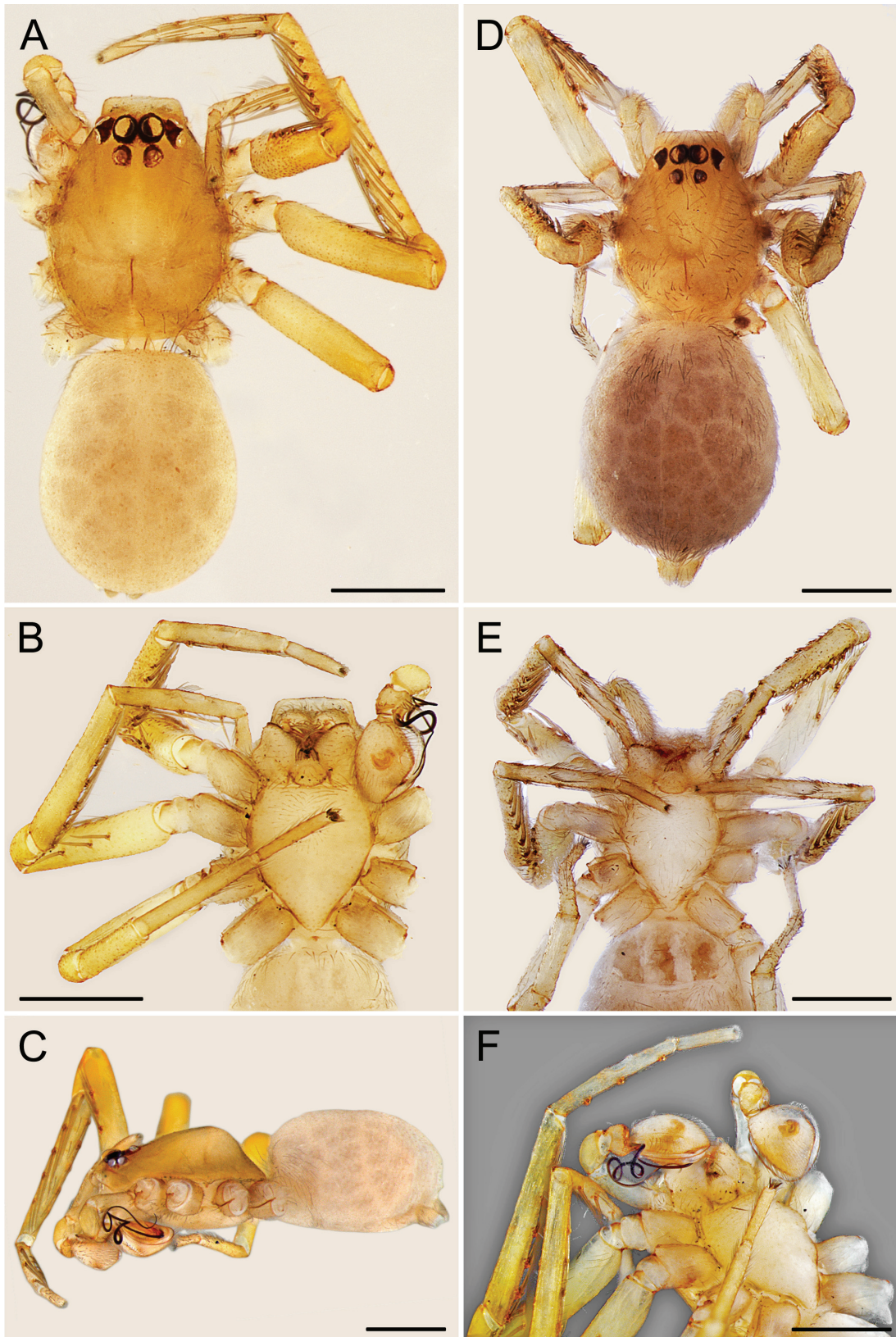


Fig. 1. *Hortipes gigapophysalis* sp. nov. **A.** Male habitus, dorsal view. **B.** Male prosoma, ventral view. **C.** Male habitus, lateral view. **D.** Female habitus, dorsal view. **E.** Female prosoma, ventral view (epigyne removed). **F.** Male prosoma, ventrolateral view.

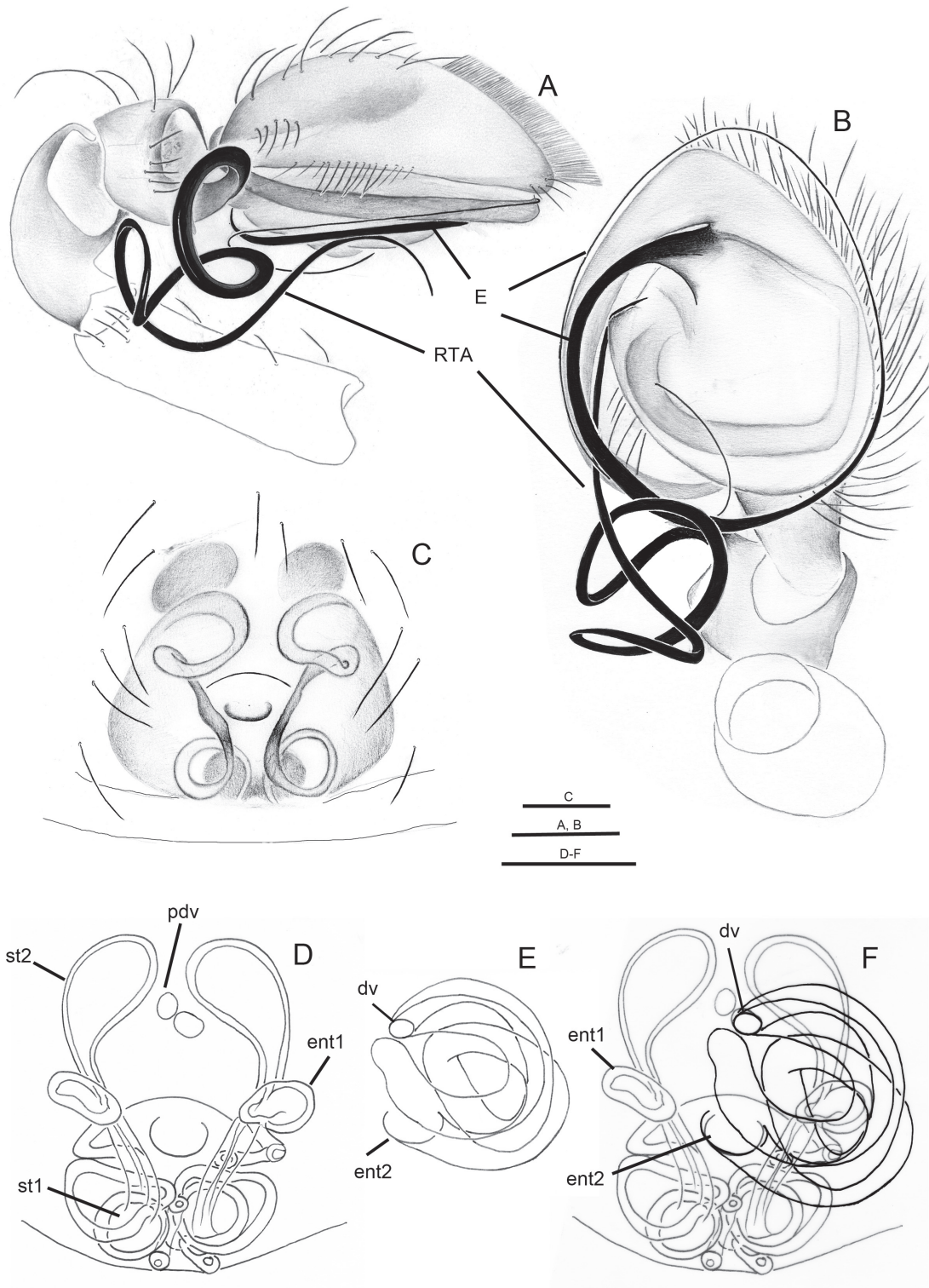


Fig. 2. *Hortipes gigapophysalis* sp. nov. **A.** Male palp, lateral view. **B.** idem, ventral view. **C.** Epigyne, ventral view. **D.** Epigyne, cleared, dorsal view, second system omitted. **E.** idem, primary system omitted. **F.** idem, both systems combined. **E:** embolus, ent1: entrance of insemination duct, ent2: entrance of secondary duct system, dv: dorso-ventral stretch of secondary duct system, pdv: position of dorso-ventral stretch, RTA: retrolateral tibial apophysis, st1: spermathecae 1, st2: spermatheca 2. Scale bars: 100 µm.

entire course except last quarter strongly narrowed before entering E; E originating at distal end of tegulum directed retrolaterad, very long, whiplike, looped over slightly more than some 500°. True MA, being an articulated tegular process inserted on a flexible membrane (Bonaldo 1997: 166) absent, but tegulum distally with membranous, translucent DTA, directed retrolaterad, curved back over 90° ending near posterior margin of cymbium.

Female

MEASUREMENTS. Total length 2.54; carapace 1.15 long, 0.85 wide; length of fe: I 0.95, II 1.00, III 0.81, IV 1.11.

LEG SPINATION. Fe: I plv 1-1-1-(1) rlv 1-1-1; II plv 1-1-1 rlv 1-1-1-1-(1); ti: Palp do 1-0-0; I plv 1-1-1-1-1 rlv 1-1-1-1-1-1; II plv 1-1-1-1-1-1 rlv 1-1-1-1-1-1; mt: I plv 1-1-1 rlv 1-1-1; II plv 1-1-1 rlv 1-1-1; IV pl 0-0-1 rl 0-0-1 vt 2.

COLORATION. Carapace, legs and chelicerae pale orange; sternum pale. Abdomen pale (Fig. 1D-F).

GENITALIA. Epigyne with a central concavity and with convoluted tubes visible in transparency. Two funnel-shaped openings leading into a system of wide, very simple, thin-walled tubes, with blind ends (Fig. 2C-F). Thick-walled insemination ducts starting from slit-shaped lateral openings leading to two sets of spermathecae. Anterior pair oval, opening posteriorly into ducts leading towards posterior, globular pair. The systems are separate and there is no connection between them (Figs 2C-F, 3A-B).

Variability

Male paratypes (n=2) TL: 2.16 and 2.03; CL 1.10 and 0.89; CW 0.89 and 0.85. Spination identical.

Distribution

High altitude gallery forest (> 1200 m) on Mt Nimba, Guinea.

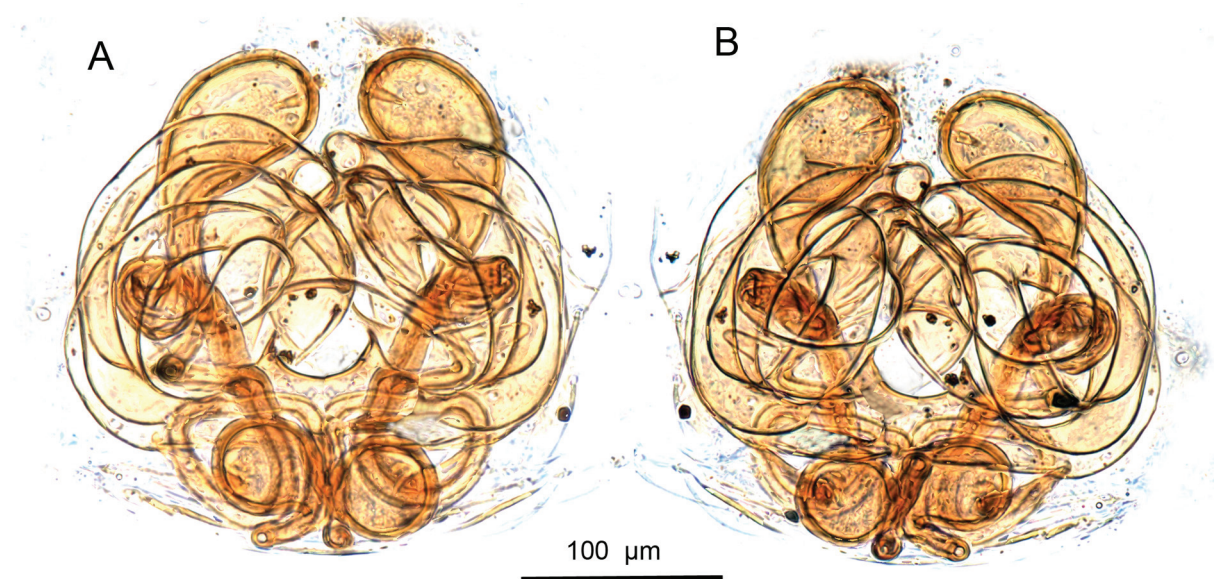


Fig. 3. *Hortipes gigapophysalis* sp. nov. **A.** Epigyne cleared in methyl salicylate, ventral view. **B.** idem, dorsal view.

Discussion

The RTA is usually a solid, strongly sclerotized structure. Its main function was long thought to be internally stabilising the expanded male palp during copulation, which means that the RTA locks either specific sclerites of the bulbus or between the bulbus and cymbium in order to arrest further rotation or movement (Huber 1995a: 151; Sierwald & Coddington 1988: 264). However, the RTA has been found to fulfill many different functions. Huber (1994) mentions four different functions for the RTA in one

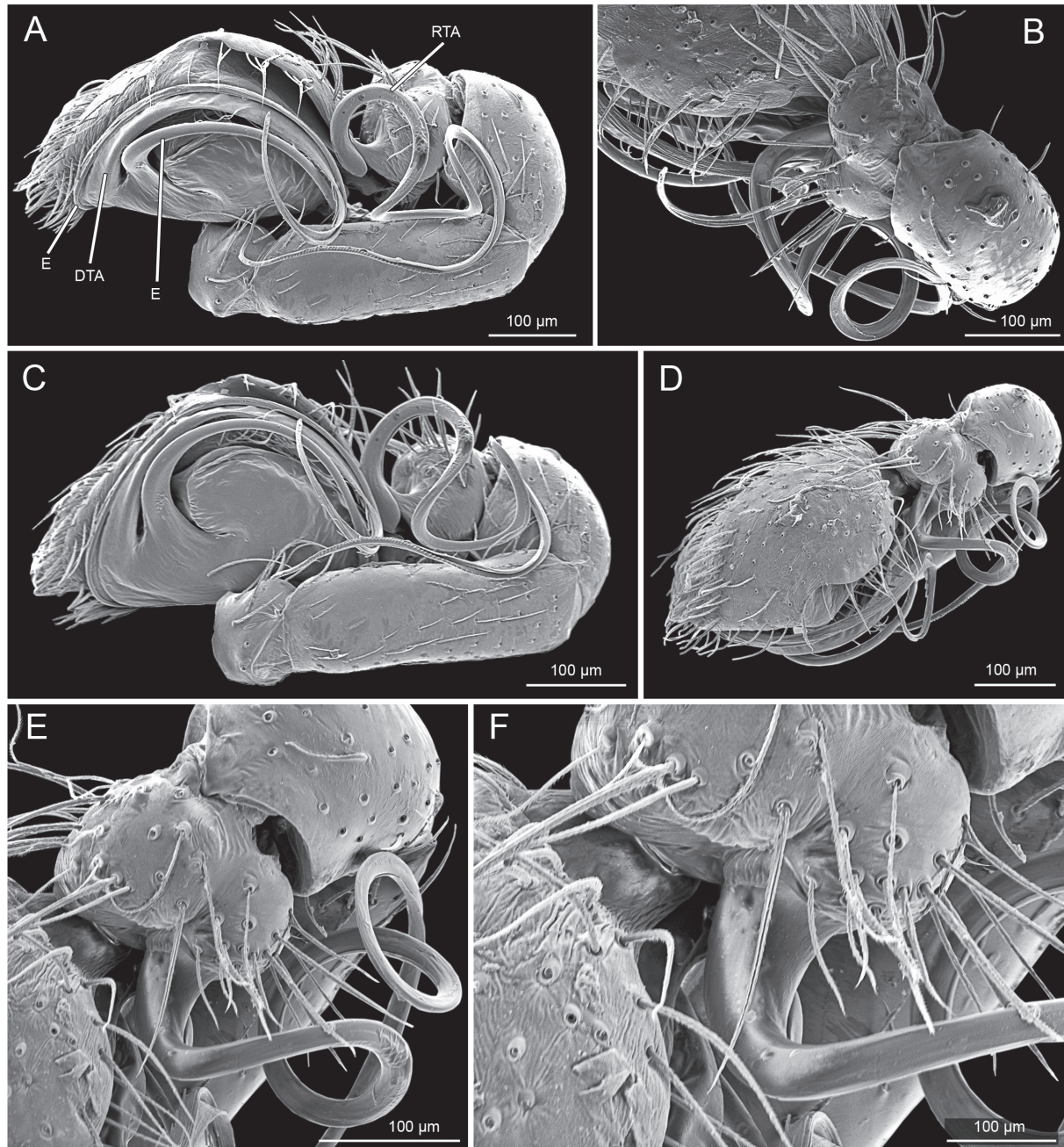


Fig. 4. *Hortipes gigapophysalis* sp. nov. **A.** Male palp, retrolateral view. **B.** Male palpal patella and tibia, dorsal view. **C.** Male palp, ventral view. **D.** idem, dorsal view. **E.** Male palpal tibia and patella, dorsolateral view. **F.** Detail of previous. E: embolus, DTA: distal tegular apophysis, RTA: retrolateral tibial apophysis.

single spider family (Agelenidae). In *Tetrax denticulata* (Olivier, 1768), the RTA fixes the male palp to the female epigyne; in *Histopona torpida* (C.L. Koch, 1834) the role of the RTA is unclear, since the patellar apophysis arrests the male bulb internally; in *Agelena gracilis* and *Agelenopsis spp.* the RTA locks the male palp internally in two different ways, as described below (Gering 1953; Osterloh 1922). Jäger (2006: 58) confirms this diversity in function, showing that the RTA anchors in the epigastric furrow in Sparassidae but anchors in the epigyne in Gnaphosidae. Huber (1995a) points out that the function of the RTA is highly species specific and may be involved in mate choice by physical contact during copulation (1995a: 152), rather than internally stabilising the male palp. Huber (1995a, 1995b: 698, fig. 5) demonstrated that the RTA is used to fix the male pedipalp to the female epigyne for six species from six different families of the RTA-clade (Coddington & Levi 1991). Huber (1995a: 159-160) also states that most data inferring that the RTA arrests the male bulb internally during copulation are doubtful for methodological reasons. Either the authors used artificially expanded genital bulbs, or they studied genital bulbs fixed in copula, but sprung away from the epigyne. The vast majority of research using reliable methodology (observations of animals *in copula*, sections of animals fixed *in copula*) led to the conclusion that the RTA fixes the male pedipalp to the female externally. Such fixation to the female epigyne may be necessary because of the lack of innervation of the male bulb (Eberhard & Huber 1998).

Huber cites the studies of Osterloh (1922) and Gering (1953) as exceptions to this generalisation, and lists them in his table 1 as an RTA that arrests the genital bulb internally in *Agelena gracilis* C.L. Koch, 1841 and *Agelenopsis spp.* Giebel, 1869, respectively. More specifically, Osterloh (1922: 348) states that the RTA is inserted between the palpal bulb (“Kapsel”) and the palpal terminal sclerites (“Stema”) in copula, and that only the terminal sclerites (“Alles, was zum Stema gehört”) are introduced into the

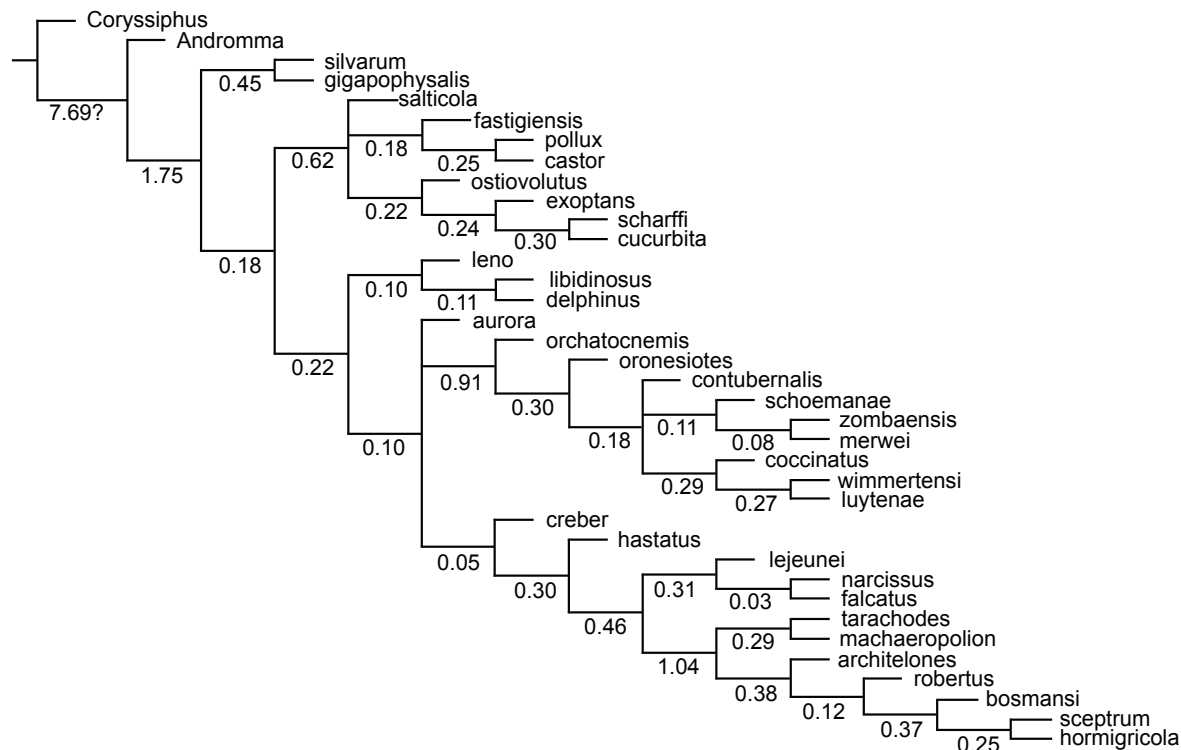


Fig. 5. Cladogram obtained from the character matrix in Bosselaers & Jocqué (2000) with inclusion of *H. gigapophysalis*. Strict consensus of 18 trees of fit -53.061 (PAUP values), obtained under implied weighting. Bremer support values are shown under the branches.

epigyne. Locking of the male palpus to the epigyne in these two species is performed by the patellar apophysis, not the RTA (1922: 390). Gering (1953: 13) states: “*The ectoproximal margin of the cymbium has a weakly produced depression, which normally is somewhat more heavily pigmented and sclerotized than the surrounding area (figs 11-12, 39). The tibial process rests in this depression when the palpus is locked.*” We can conclude that neither author clearly advocates that the RTA is introduced into the internal female genital organs. In Gnaphosidae the RTA, a “primary anchoring device to the epigynal pocket” (Senglet 2004: 87) does not take part in intromission, which takes place after the palpus is fixed (Senglet 2004: 91).

However, in the present contribution, an RTA is described which has exactly this very unusual function: intromission into the female genital organs. To the best of our knowledge, such a use of the RTA has never been mentioned before. As the RTA of *H. gigapophysalis* sp. nov. is very long, thin and supple, it is very unlikely that it is used as a rigid locking device as described above. Its analogy with the embolus, a long whiplike, supple structure, made us suspect that it might be an insertable sclerite. Detailed study of the epigyne indeed reveals the presence of two independent tubular systems. The first is the usual insemination duct starting at a lateral slit-like entrance and leading to two sets of spermathecae (Fig. 2C, D). The second is composed of wide, very simple, thin-walled tubes starting from funnel-shaped entrances in a central concavity, ending blind at the end of several bends without connection with the first system (Fig. 2E, F). It is assumed that the second system is meant to receive the RTA.

Hortipes is a genus with an amazing genitalic variability. Nevertheless, not a single species with an RTA that is clearly insertable in the female genitalia has been described to date. Among the known species (Bosselaers & Jocqué 2000a; Ledoux & Emerit 1998), only a few species of the *orchatocnemis* clade (node 12 in Bosselaers & Jocqué 2000a, fig. 4) have vulvae that, in view of their weakly sclerotised entrance chamber (Bosselaers & Jocqué 2000a: 14, character 65) show possible evidence of additional sclerites being inserted during copulation. *H. merwei* Bosselaers & Jocqué, 2000, for example, has an elaborate lobed entrance chamber (Bosselaers & Jocqué 2000a: fig. 20e) that seems especially suited for insertion of the exceptionally large, flexible and coiled MA of the male palp (Bosselaers & Jocqué 2000a: fig. 19a, b). Jäger (2012: figs 19, 23) describes *Sinopoda* vulvae with similar thin-walled sacs. In this genus, these sacs proved to be expandable, but Jäger does not mention any role for them. The entrance chamber of *H. aelurisiepae* Bosselaers & Jocqué, 2000, also has peculiar thin-walled lobes, lateral in this case, that might receive an additional palpal sclerite from the unknown male. However, none of the *Hortipes* species described to date have an RTA of considerable length that matches a vulvar structure in which it could be inserted. Moreover, as a result of the fact that the *Hortipes* species of western Africa are very poorly sampled (Bosselaers & Jocqué 2000a: map 1), no intermediate stages are known between the genitalia of the species already described and the insertable RTA of *H. gigapophysalis* sp. nov. Based on leg spination and genitalic structure, *H. gigapophysalis* sp. nov. seems closest to *H. hesperoecius* Bosselaers & Jocqué, 2000 and *H. silvarum*. Repeating the cladistic analysis of *Hortipes* species known from both sexes (Bosselaers & Jocqué 2000a), including *H. gigapophysalis* sp. nov., confirms this (Fig. 5): *H. gigapophysalis* sp. nov. turns out to be the sister species of *H. silvarum* and is situated at the base of the *Hortipes* clade in the strict consensus of 18 trees of fit -53.061 (PAUP values), obtained under implied weighting (Fig. 5). In the strict consensus of 1656 shortest trees of length 265 obtained under equal weighting, the *salticola* clade (node 3 in Bosselaers & Jocqué 2000a, fig. 4) holds a still more basal position within *Hortipes*, but the sister species relationship between *H. silvarum* and *H. gigapophysalis* is confirmed. However, although *H. silvarum* has a relatively slender and apically coiled RTA (Bosselaers & Jocqué 2000a: fig. 12e, f), it has no vulvar tubes in which the RTA could be inserted (Bosselaers & Jocqué 2000a: fig. 13d). Only more extensive sampling of the forest litter layer of tropical western Africa may produce the as yet unknown *Hortipes* species allowing to reconstruct the phylogeny of this most unusual genitalic development.

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