

## On *Melchisedec*, a new genus of the spider family Oonopidae (Araneae, Dysderoidea)

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### ABSTRACT

A new genus, *Melchisedec*, is established for two new Afrotropical species, *M. thevenot* (type species) and *M. birni*. These spiders are unique among oonopids in having a crest on the ventral pedicel sclerite, and in having very short, scepterlike setae on the distal metatarsi I and II. The male of *M. thevenot* has a long, inward-curved embolus-conductor complex and a sternal pouch. The embolus-conductor complex resembles that of the Australian genus *Grymeus* Harvey, but differs in important details. The genital system of the female is highly complex, and includes two uterine sclerites, two winglike lateral apodemes and a receptaculum with a globular appendix. The receptaculum is much larger than in most other Oonopidae and has an unusual, strongly folded surface.

### INTRODUCTION

Oonopidae are very small (1–3 mm), haplogyne spiders that occur throughout the temperate and tropical regions of the world (Ubick, 2005). They are found in a wide variety of habitats, ranging from deserts and grasslands to mangroves and rain forests (e.g., Baehr et al., 2010; Grismado, 2010). The majority are leaf-litter dwellers, but some are arboreal, while others live in caves (Fannes et al., 2008; Harvey and Edward, 2007).

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Until relatively recently, the Oonopidae were considered to be a fairly small family. However, the Goblin Spider Planetary Biodiversity Inventory (PBI) project (<http://research.amnh.org/oonopidae/index.php>) has shown that oonopids are extremely diverse, in terms of both species richness and morphological disparity (e.g., Platnick and Dupérré, 2009, 2010). More than 2000 species are now estimated to exist worldwide (Ubick and Griswold, in press).

Recently, while sorting the oonopid collection of the Royal Museum for Central Africa (Tervuren), I discovered two species with a strangely modified pedicel. These species could not be assigned to any of the existing oonopid genera. Hence, a new genus, *Melchisedec*, is established to accommodate them. *M. thevenot*, the type species, is described and illustrated in detail, with particular attention being devoted to the pedicel sclerites and the internal female genitalia. Some comments on the morphology and affinities of *Melchisedec* are provided.



FIG. 1. Records of *Melchisedec thevenot* (squares) and *M. birni* (circle).

## MATERIAL AND METHODS

Specimens were examined under a Zeiss KL 2500 stereomicroscope. The descriptions were generated automatically from the Species Descriptive Database of the PBI project. Habitus images were produced using a Leica MZ125 stereomicroscope, a DFC 500 camera and Leica Application Suite (LAS) software. Specimens were immersed in K-Y® brand jelly and a Z-stack of 15–20 images was generated. The Z-stack was subsequently merged into a single montaged image that was processed further in Adobe Photoshop. Montaged images also served as a basis for the drawings. Measurements were taken from a lateral (tibia I length and diameter) or dorsal (other measurements) point of view. The width of the carapace and dorsal scutum was recorded at the widest point while their length was measured along the midline. Total length is the sum of carapace length and dorsal scutum length. Measurements are given in millimeters unless noted otherwise. For SEM, specimens were dehydrated in 95% ethanol and hexamethyldisilazane (Brown, 1993; Nation, 1983) and mounted on a strip of copper tape itself fixed to an SEM stub. After sputter coating with gold for 70 seconds, the specimens were examined under a JEOL 6480 scanning electron microscope. Given the few available specimens of *Melchisedec thevenot*, a single female abdomen was used to study both the external morphology of the scuta and the internal genitalia. The abdomen was bisected horizontally and left overnight at room temperature in a solution of



FIGS. 2–4. *Melchisedec thevenot*, new species. 2. Male, habitus, lateral view. 3. Female, carapace, dorsal view. 4. Same, anterior view. Scale bars: 0.10 mm.

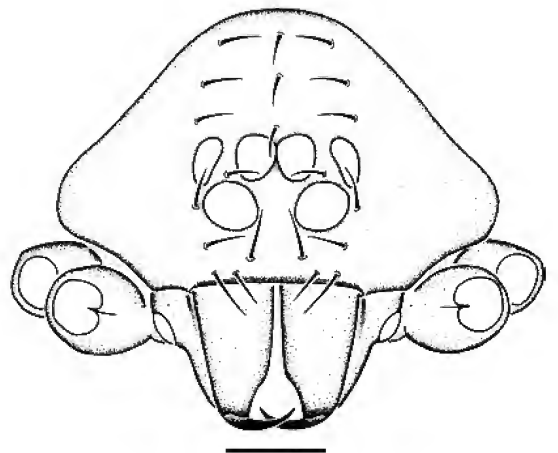
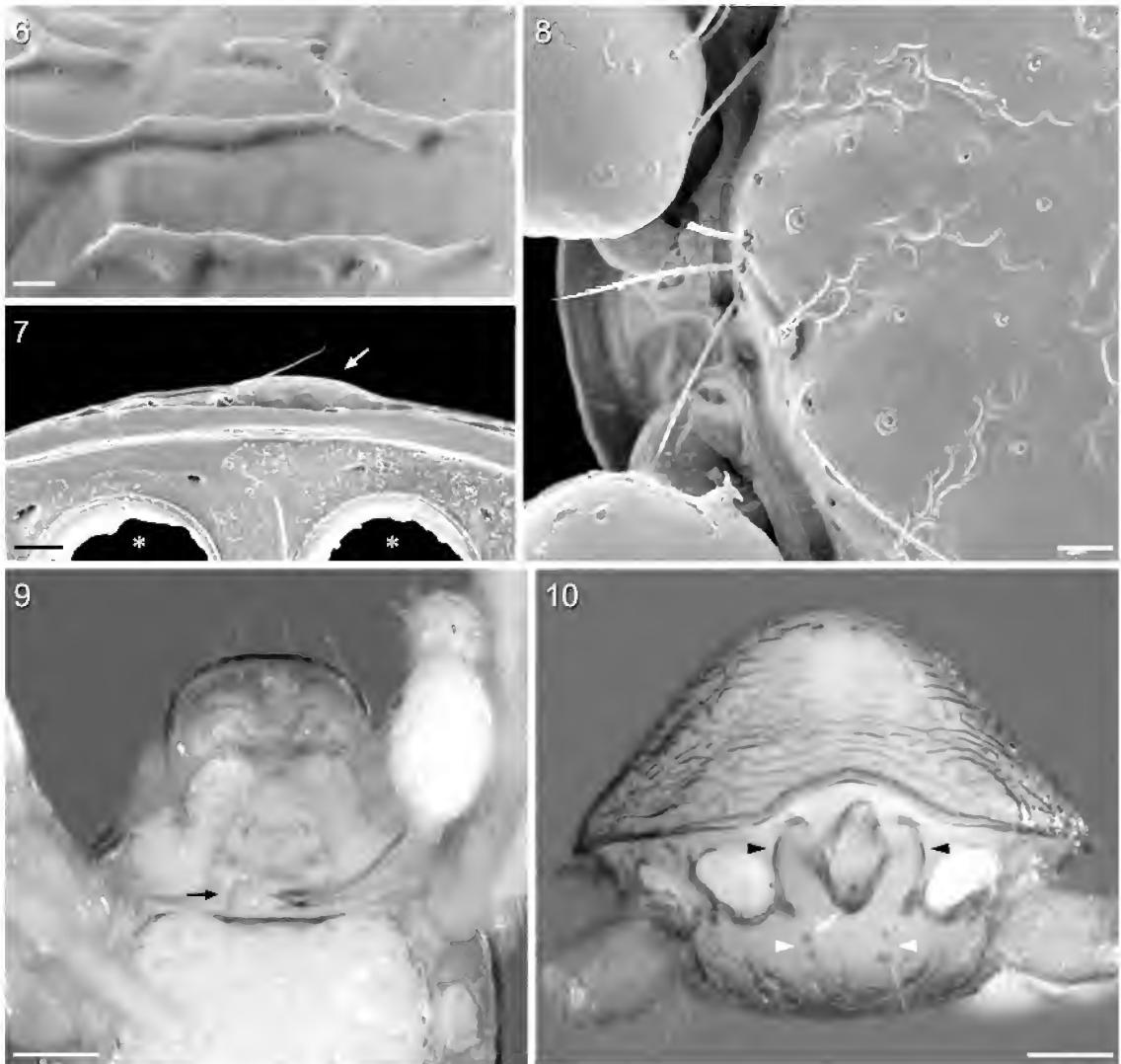
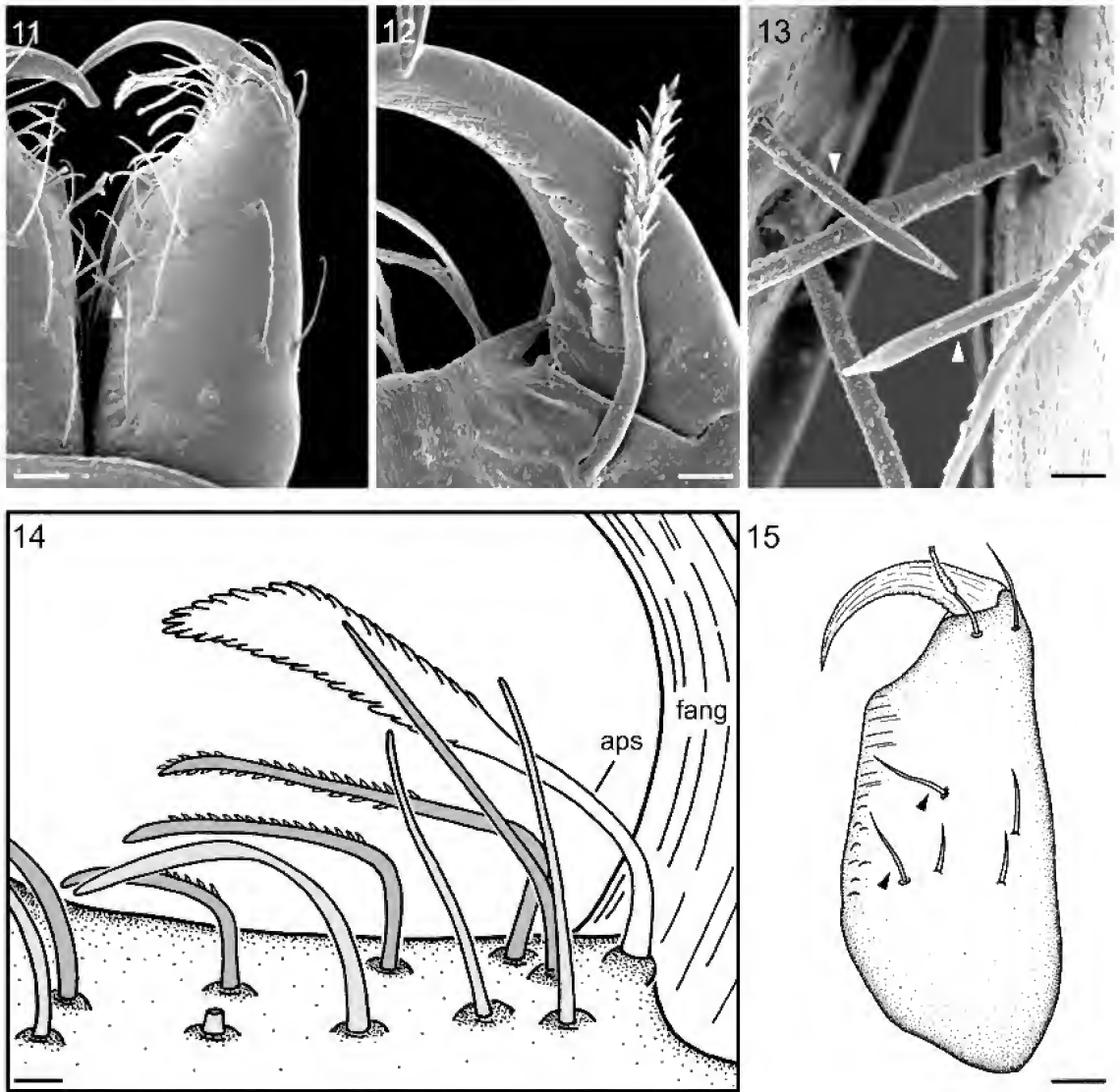


FIG. 5. *Melchisedec thevenot*, new species, female. Carapace, anterior view, showing distribution of setae on clypeus, around the eyes and on top of carapace. Other setae not depicted. Scale bar: 0.10 mm.



FIGS. 6–10. *Melchisedec thevenot*, new species. 6. Female, microsculpture on carapace. 7. Female, carapace-sternum boundary, ventral view. Asterisks: coxal insertions. Arrow: elevated region. 8. Female, right half of sternum, ventral view, showing radial furrows. 9. Male, mouthparts and anterior part of sternum, ventral view. Arrow: pouch. 10. Female, prosoma, posterior view. Black arrowheads: curved ridges. White arrowheads: short rows of setae. Scale bars: 3  $\mu$ m (6), 20  $\mu$ m (7, 8), 80  $\mu$ m (9, 10).

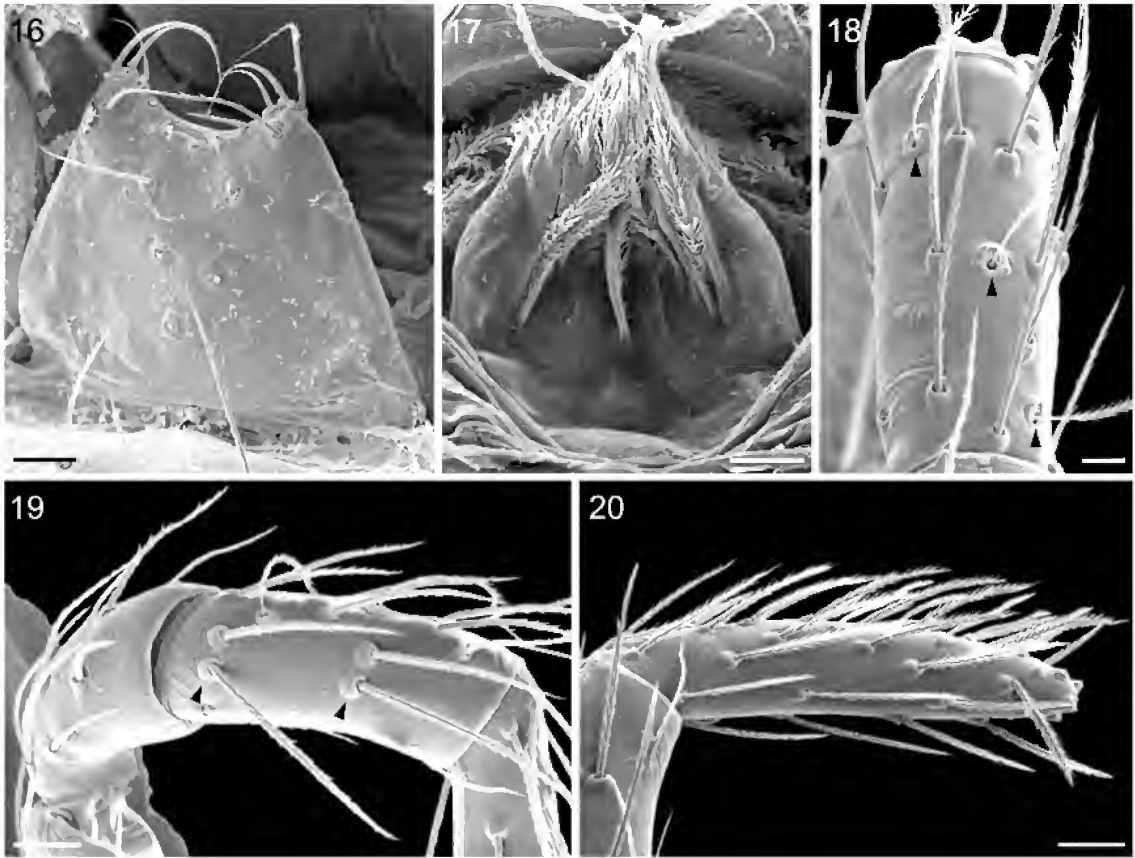
SIGMA P3292 Pancreatin, following Álvarez-Padilla and Hormiga (2008). After digestion, the ventral abdomen was rinsed in water and processed for SEM as described above. In order to examine less accessible internal structures, the ventral abdomen was repeatedly removed from the copper tape, dissected further with a small piece of razor blade and remounted. To study palpal morphology in detail, the right palp of the single male known was removed and prepared for SEM. The specimens have been deposited in the Royal Museum for Central Africa (RMCA, R. Jocqué), Tervuren, Belgium, and in the Nationaal Natuurhistorisch Museum (RMNH, J. Miller), Leiden,



FIGS. 11–15. *Melchisedec thevenot*, new species, female, chelicerae. **11.** Right chelicera, anterior view. Arrowhead: pointed seta. **12.** Fang, posterior view. **13.** Pointed setae (arrowheads). **14.** Setae on promargin, anterior view, showing anterior plumose seta (aps), outer row (light grey) and inner row (dark grey). **15.** Left chelicera, posterior view, showing long, medially directed setae (arrowheads) and spines (medially on paturon). Scale bars: 3  $\mu\text{m}$  (13, 14), 5  $\mu\text{m}$  (12), 20  $\mu\text{m}$  (11, 15).

the Netherlands. The photographs of *M. thevenot* depict specimens from Cameroon. Additional habitus images of *M. thevenot* and *M. birni* are available on the PBI website (species pages).

**TERMINOLOGY:** The embolus-conductor complex (ECC) of *Melchisedec thevenot* resembles that of the genus *Grymeus* Harvey, 1987 (see Discussion); ECC terminology therefore largely follows Harvey (1987) and Burger (2010). Terminology of the female genitalia mostly follows Burger (2010). An exception is made for the sclerites in the walls of the uterus externus, which are here called the anterior and posterior uterine sclerite.



FIGS. 16–20. *Melchisedec thevenot*, new species, female. 16. Labium, posterior view. 17. Labrum, anterior view. 18. Left pedipalp, tibia, dorsal view. Arrowheads: trichobothria. 19. Same, patella and tibia, prolateral view. Arrowheads: pairs of robust setae. 20. Same, tarsus, prolateral view. Scale bars: 15  $\mu$ m (16–18), 25  $\mu$ m (19, 20).

ABBREVIATIONS: ALE = anterior lateral eyes, CL = carapace length, CW = carapace width, DS = dorsal scutum, DSL = dorsal scutum length, DSW = dorsal scutum width, ECC = embolus-conductor complex, ES = epigastric scutum, MRAC = Musée Royal de l'Afrique Centrale, PES = postepigastric scutum, PLE = posterior lateral eyes, PME = posterior median eyes, Ti I l = tibia I length, Ti I l/d = tibia I length/diameter, TL = total length.

## SYSTEMATICS

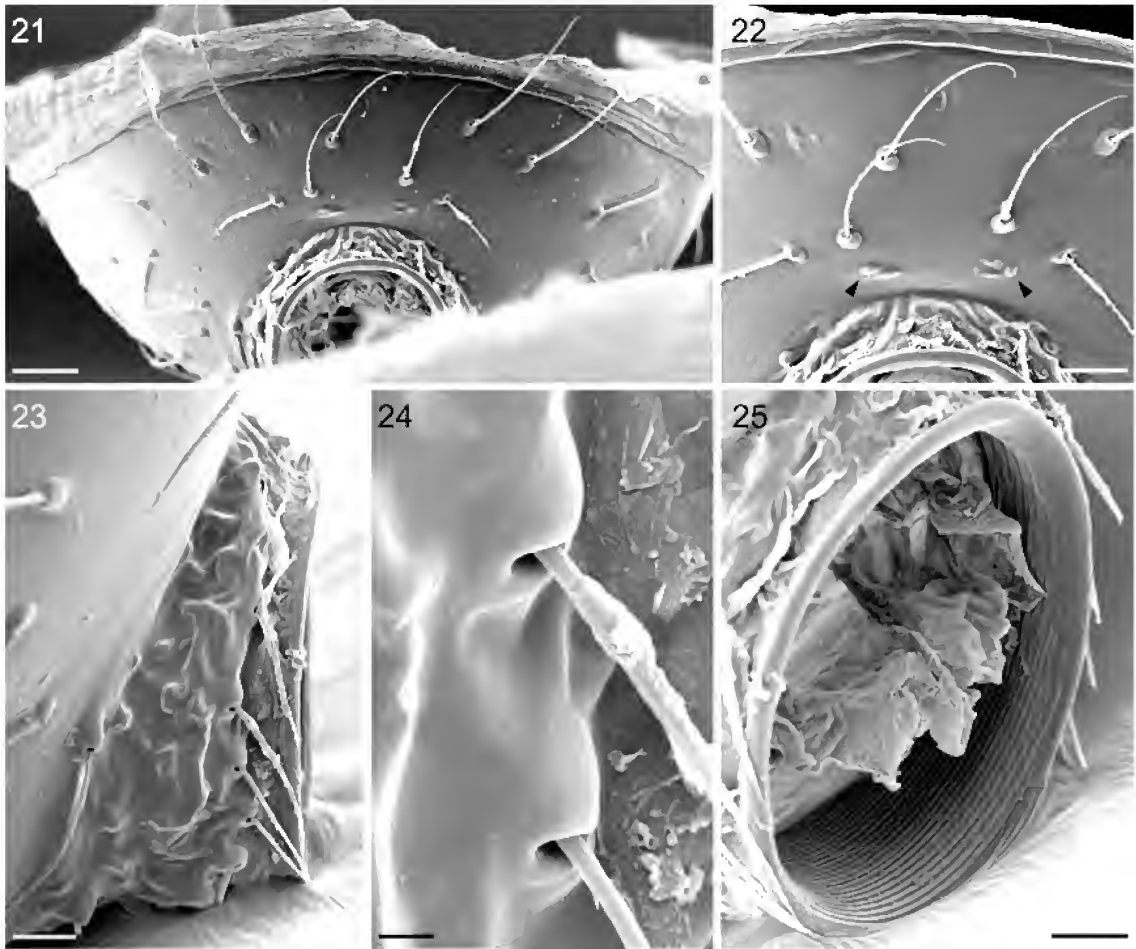
### *Melchisedec*, new genus

TYPE SPECIES: *Melchisedec thevenot*, new species.

ETYMOLOGY: The generic name is a patronym honoring the French author and inventor Melchisédec Thévenot (ca. 1620–1692), an important patron of the new, experiment-oriented science of his day. Gender masculine.

**DIAGNOSIS:** *Melchisedec* can be distinguished from all other oonopid genera by the following combination of features: dorsal and ventral scuta well developed, covering most of abdomen (figs. 2, 26, 27); epigastric furrow situated in middle of abdomen (fig. 26); ventral pedicel sclerite with a crestlike outgrowth that bears a row of transverse ridges (figs. 57, 60, 61); metatarsi I and II with scepterlike setae on both sides of lyriform organ (figs. 42, 43).

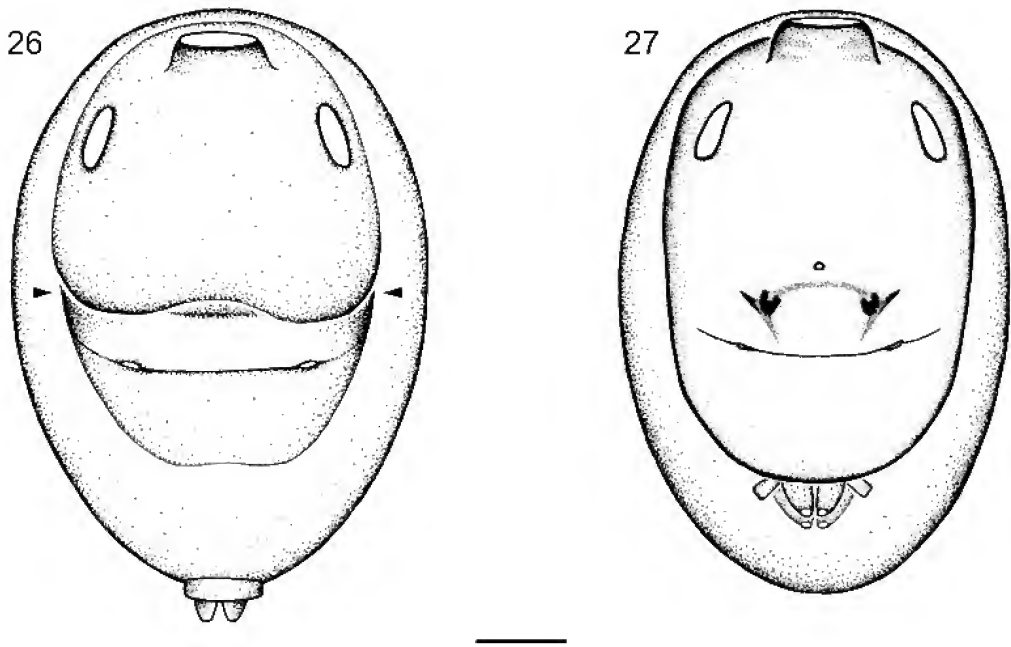
**DESCRIPTION:** Small- to medium-sized (TL 1.17–1.48, CL 0.53–0.61) oonopid spiders with well-developed abdominal scuta. **CEPHALOTHORAX:** Carapace yellow or orange, without any pattern, longer than wide, anteriorly narrowed to approximately 0.5 times its maximum width (fig. 3), pars cephalica elevated (*M. thevenot*; fig. 55) or flat (*M. birni*; fig. 56) in lateral view; anterolateral corners without extensions or projections, posterolateral corners rounded, posterolateral edge without pits, posterior margin not bulging below posterior rim, posterolateral surface without spikes; pars thoracica without depressions or radiating rows of pits; lateral margin straight, rebordered; dorsal surface smooth (fig. 3), each lateral surface completely covered by microsculpture (figs. 6, 55, 56) except for two small, smooth regions located immediately dorsal of the lateral margin; these regions are slightly elevated above the surrounding cuticle (fig. 7). Clypeus high, ALE separated from edge of carapace by more than their diameter (figs. 4, 5), clypeus margin curved downward in front view, without median projection; usually eight needle-shaped setae on clypeus, arranged in typical pattern: four anteromedially projecting setae near margin; two upward-projecting setae situated centrally on clypeus; two medially projecting setae situated anterior of ALE (fig. 5). On dorsal surface of carapace a U-shaped row of approximately 16 setae and a central row of about four setae. Eyes six, well developed, ALE oval, wider than long, PME oval, longer than wide, PLE oval, longer than wide, posterior eye row recurved from above; ALE separated by less than their diameter, ALE-PLE separated by less than ALE radius, PME-PME touching or almost touching, PLE-PME separated by less than PME radius (figs. 3–5); just outside each ALE a medially projecting seta, no setae between ALE, between each PME and PLE a medially projecting seta (fig. 5). Sternum approximately as long as wide, uniformly yellow or orange, fused to carapace; median concavity absent, sickle-shaped structures absent, without pits, without posterior hump, posterior margin not extending posteriorly of coxae IV, anterior corners unmodified. A median band of reticulated microsculpture extends along length of sternum. Radial furrows between coxae I–II, II–III, III–IV; furrows covered with reticulated microsculpture (fig. 8). Abundant setae on sternum; posteriormost setae arranged in two longitudinal rows of 2–3 setae each (fig. 10). Coxal insertions I, II, and III each with two clusters of small openings (fig. 7); coxal insertion IV without clusters. In male *M. thevenot* a pouch behind the labium (fig. 9). A curved, dark-red ridge between each coxal insertion IV and the pedicel (fig. 10). Anterior face of paturon pale grey or orange, unmodified, bearing relatively few setae. Labium same as sternum in sclerotization. Endites converging but tips not touching, anteromedian tip and posteromedian part unmodified, same as sternum in sclerotization. Female palp without spines; patella without row of ridges; tibia longer than patella, on dorsal surface three trichobothria (fig. 18), prolateral surface presenting two pairs of robust setae (fig. 19); tarsus longer than tibia, not expanded (fig. 20). Pedicel with one dorsal and one ventral sclerite. Dorsal sclerite flat, posteriorly drawn out into a point (fig. 57), not fused to prosoma. Ventral sclerite U-shaped,



FIGS. 21–25. *Melchisedec thevenot*, new species, female. 21. Epigastric scutum, anterior view. 22. Same, detail of region above pedicel tube. Arrowheads: tubercles. 23. Pedicel tube, lateral view. 24. Same, detail of setal bases. 25. Pedicel tube, oblique anterior view. Scale bars: 2.5  $\mu\text{m}$  (24), 15  $\mu\text{m}$  (23, 25), 30  $\mu\text{m}$  (22), 60  $\mu\text{m}$  (21).

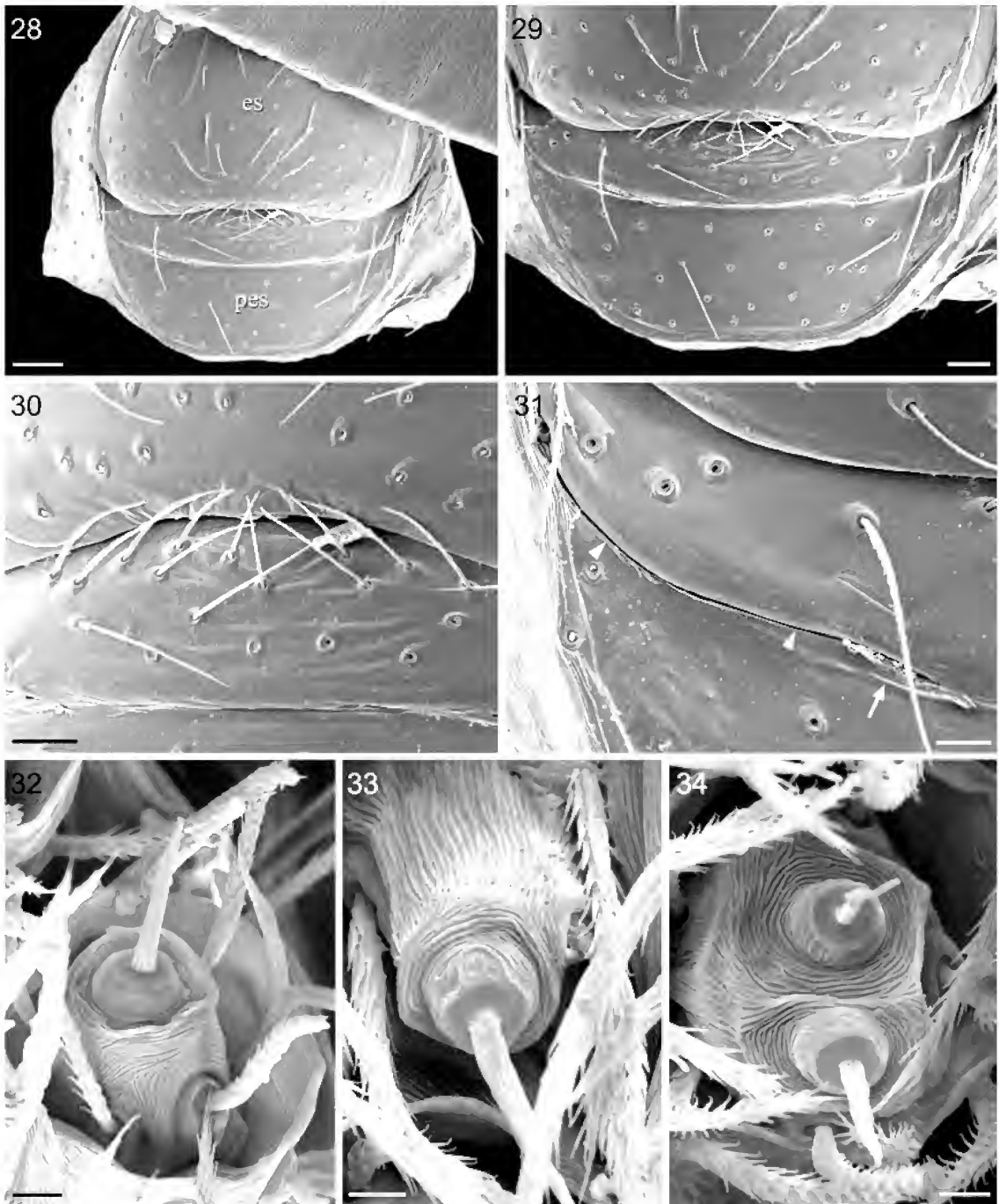
covering ventral and lateral sides of pedicel; anteriorly fused to prosoma; ventral surface forming a crestlike elevation; crest bearing a row of transverse ridges (figs. 57, 60, 61; see Pedicel morphology, below, for more details). ABDOMEN: ovoid in dorsal view, without long posterior extension (fig. 2), interscutal membrane with setae, without rows of small sclerotized platelets. Book lung covers medium sized, elliptical, darker than surrounding scutum, without setae, anterolateral edge without tubercle. Anterior spiracles not discernible with a stereomicroscope. Posterior spiracles connected by groove (figs. 26, 27, 29). Each posterior spiracle with a fine furrow that runs toward lateral margin of PES (fig. 31). Epigastric furrow situated in middle of abdomen (fig. 26). Pedicel tube short, without dorsolateral triangular extensions or fringe of setae (fig. 23). Scutopedicel region without scutal ridges (figs. 21, 22); matted setae on anterior ventral abdomen in pedicel area absent. DS strongly sclerotized, without color pattern, covering all or most of dorsum, not fused to ES, anterior half without



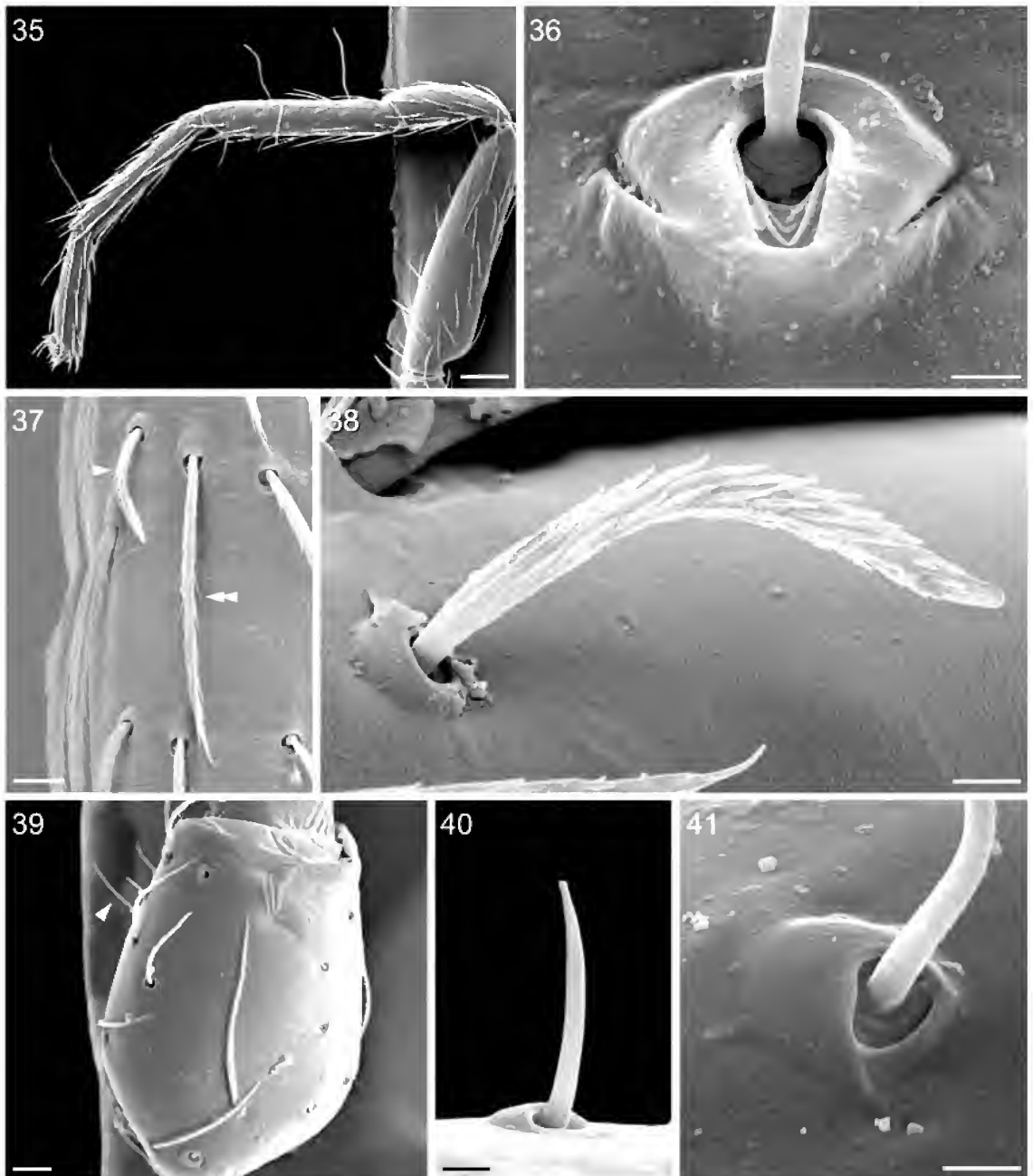


FIGS. 26–27. *Melchisedec thevenot*, new species. 26. Female, abdomen, ventral view. Arrowheads indicate position of epigastric furrow. 27. Male, abdomen, ventral view. Scale bar: 0.10 mm.

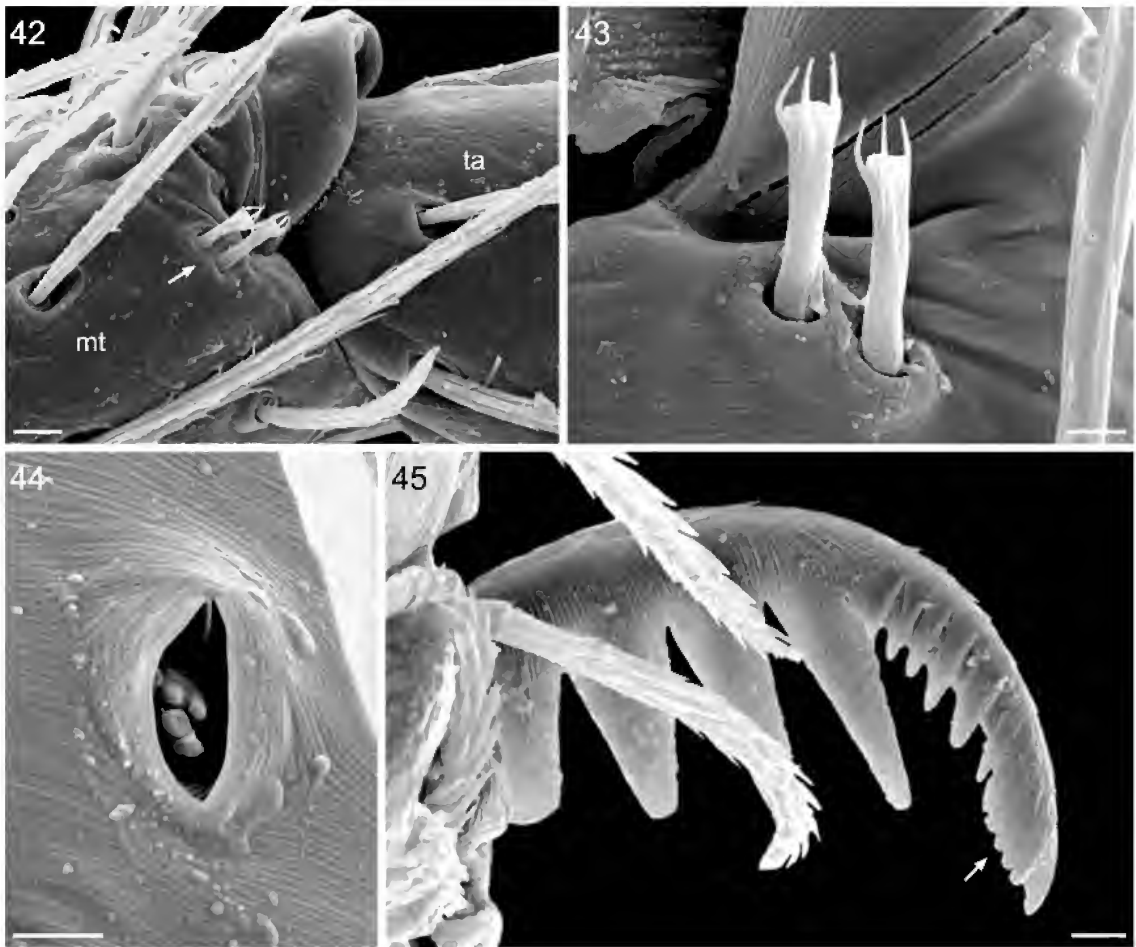
projecting denticles. Relatively few setae on DS, needle shaped. Surface of DS smooth except for sides of anterior half, which are finely reticulate in many individuals. ES strongly sclerotized, surrounding pedicel, not extending far dorsal of pedicel, small lateral sclerites absent. In females posterior margin of ES procurved at middle (figs. 26, 28, 29). PES strongly sclerotized. In females PES considerably shorter than ES, leaving approximately 1/4 of abdomen length uncovered (fig. 26). PES fused to ES in male *M. thevenot* (fig. 27). Spinneret scutum present, incomplete ring with a fringe of about 13 needlelike setae. Anal scutum present, lightly sclerotized. Supraanal scutum absent. LEGS: without spines, patella plus tibia I shorter than carapace; coxae white, other segments yellow; tibia I unmodified; femur IV not thickened, same size as femora I–III. Legs covered with long, needlelike setae (fig. 37). Tarsi and metatarsi with shorter, densely barbed setae interspersed between the needlelike setae (fig. 37); these setae curved in lateral view (fig. 38), their sockets rounder than those of needlelike setae (fig. 37). On the anterior and posterior surface of each coxa a group of 2–3 smooth setae (fig. 39); smooth setae variable in length (fig. 39), consisting of smooth shaft and asymmetrical socket (figs. 40, 41), projecting into the narrow space between adjacent legs. Metatarsi I–II with scepterlike setae on both sides of lyriform organ (figs. 42, 43); scepterlike setae very short, with truncated apex, smooth except for distal ring of fine cuticular extensions (fig. 43); scepterlike setae occurring either as a single, isolated seta or as a closely spaced pair (figs. 42, 43). Metatarsi III–IV usually without scepterlike setae. Each leg with four dorsal



FIGS. 28–34. *Melchisedec thevenot*, new species, female. 28. Epigastric scutum (es) and postepigastric scutum (pes), ventral view. 29. Postepigastric scutum, ventral view. 30. Epigastric region, ventral view. 31. Groove extending laterally from posterior spiracle (arrowheads). Arrow: spiracle. Note slit sense organ above spiracle. 32. Anterior lateral spinneret, posterior view. 33. Posterior median spinneret, posterior view. 34. Posterior lateral spinneret, posterior view. Scale bars: 4  $\mu\text{m}$  (32–34), 15  $\mu\text{m}$  (31), 40  $\mu\text{m}$  (29, 30), 80  $\mu\text{m}$  (28).



FIGS. 35–41. *Melchisedec thevenot*, new species. 35. Female, leg III, lateral view. 36. Female, trichobothrial base from metatarsus II, dorsal view. 37. Female, part of tarsus II, dorsal view. Arrowhead: short, densely barbed seta. Double arrowhead: needlelike seta. 38. Female, short, densely barbed seta, lateral view. 39. Male, coxa II, dorsal view. Arrowhead: group of three smooth setae. 40. Same, smooth seta, lateral view. 41. Same, base of smooth seta, dorsal view. Scale bars: 2  $\mu\text{m}$  (36, 38, 40, 41), 10  $\mu\text{m}$  (37, 39), 70  $\mu\text{m}$  (35).

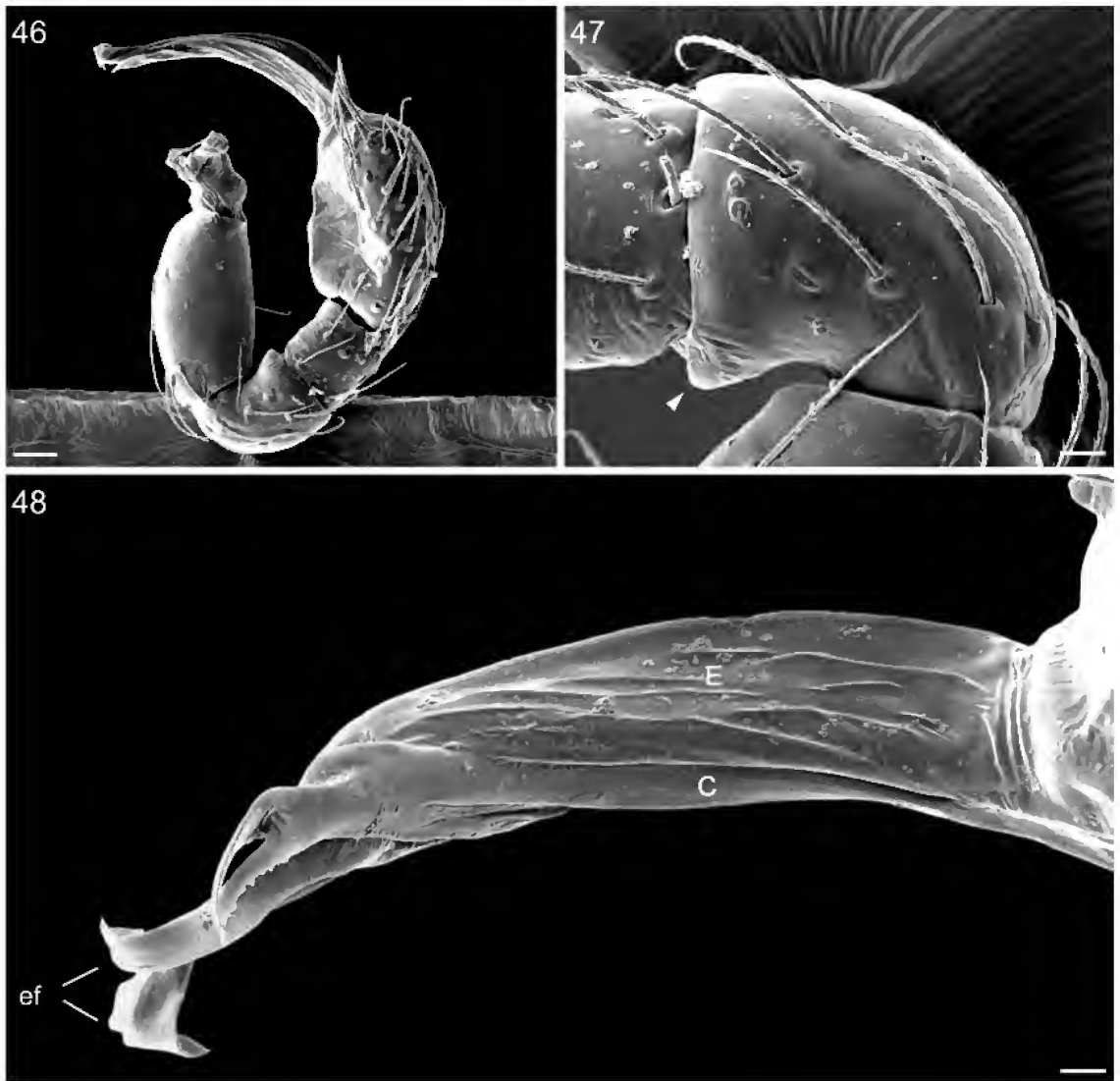


FIGS. 42–45. *Melchisedec*, new genus, females. 42. *M. birni*, new species, metatarsus (mt) and tarsus (ta), leg II, lateral view. Arrow: scepterlike setae. 43–45. *M. thevenot*, new species: 43. Scepterlike setae, leg II, prolateral view. 44. Tarsal organ from leg I, dorsal view. 45. Inner surface of claw, leg III. Arrow: fused distal teeth of median row. Scale bars: 2  $\mu\text{m}$  (43–45), 5  $\mu\text{m}$  (42).

trichobothria: one on proximal tibia, two on distal tibia, one on distal metatarsus (fig. 35). GENITALIA: Females lacking external copulatory structures (figs. 29, 30). Male *M. thevenot* with a long, inward-curved ECC (figs. 46, 48–50).

DISTRIBUTION: Known from Guinea-Bissau, Ivory Coast, Nigeria, Niger, Cameroon, and Ethiopia (fig. 1).

NOTE: *Melchisedec* is found from Guinea-Bissau to Ethiopia (fig. 1). Its distribution thus spans the entire width of the African continent. In spite of this vast geographic range, specimens of *Melchisedec* are exceedingly rare in museum collections. The oonopid collection of the Royal Museum for Central Africa (Tervuren, Belgium), which totals more than 7800 adult spiders, was found to contain only 17 specimens of *Melchisedec* (0.2% of the total). No specimens were found in the collections of the British Museum, the Uppsala University Museum, or the Zoological Museum of the University of Copenhagen.



FIGS. 46–48. *Melchisedec thevenot*, new species, male. **46.** Right pedipalp, dorso-prolateral view. **47.** Palpal patella, prolateral view. Arrowhead: lip. **48.** Embolus-conductor complex, prolateral view. Abbreviations: C, conductor; E, embolus; ef, embolar flanges. Scale bars: 10  $\mu\text{m}$  (47, 48), 30  $\mu\text{m}$  (46).

*Melchisedec thevenot*, new species

Figures 2–41, 43–55, 57, 60, 61, 68–82

TYPES: Female holotype: Cameroon, Faro Game Reserve, 8°23'09.5"N 12°49'59.7"E, Apr. 27, 2007, wooded savannah, canopy fogging, R. Jocqué, K. Loosveldt, L. Baert, and M. Alderweireldt (PBI\_OON 9209 and MRAC 228.972). Paratype: Cameroon, Atlantic Mountains, 8°31'N 12°36'E, Apr. 24, 2007, litter among rocks, sieving, R. Jocqué, K. Loosveldt, L. Baert, and M. Alderweireldt (PBI\_OON 9208 and MRAC 221.480), 1 male. Paratype: Cameroon, Faro



FIGS. 49–50. *Melchisedec thevenot*, new species, male, embolus-conductor complex. 49. Dorsal view. 50. Ventral view. Abbreviations: C, conductor; E, embolus. Scale bars: 15  $\mu$ m.

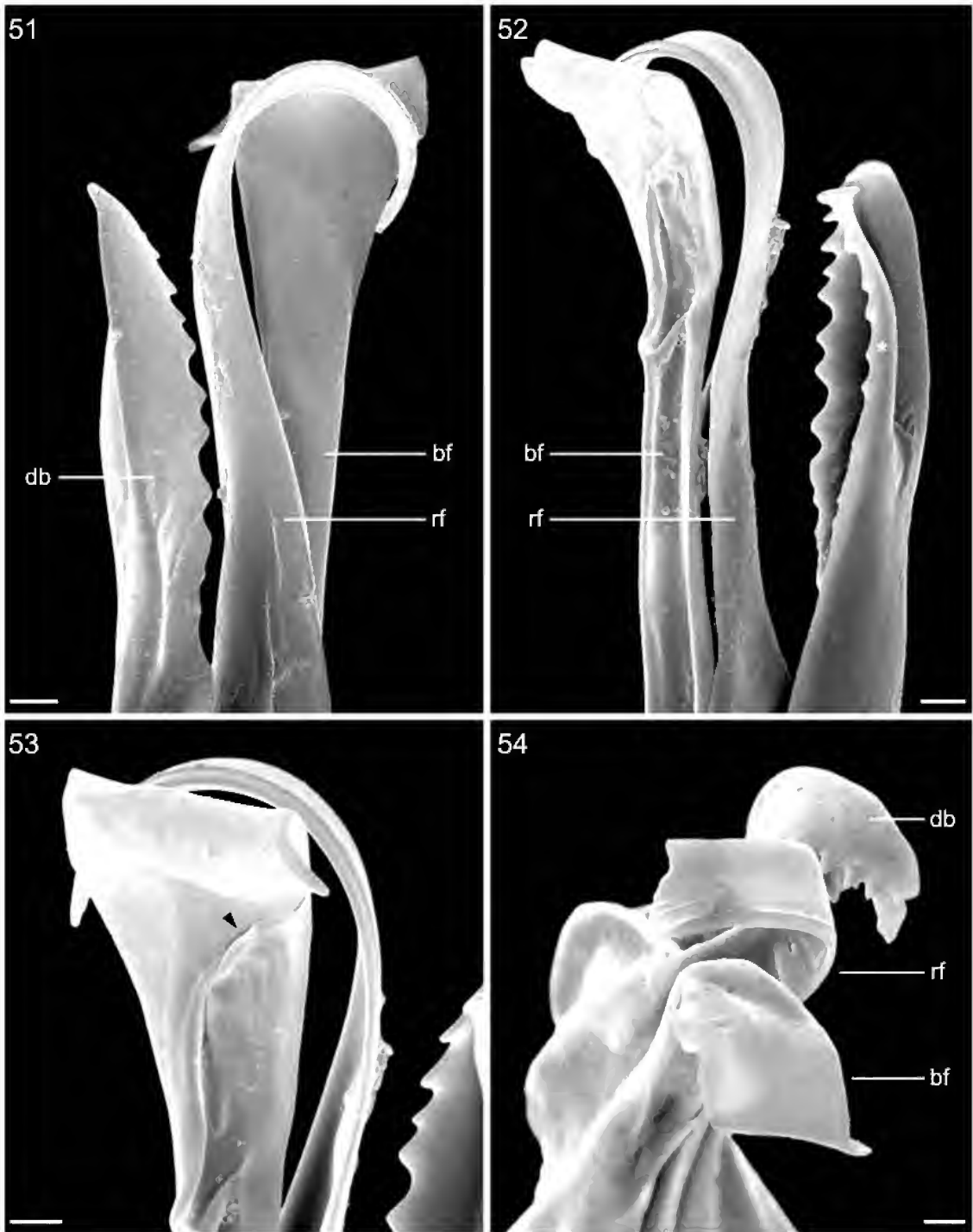
Game Reserve, 8°24'N 12°49'E, Apr. 25, 2007, gallery forest, sieving, same collectors (PBI\_OON 9210 and MRAC 221.441), 1 female.

**ETYMOLOGY:** The specific name is a noun in apposition and refers to Melchisédec Thévenot.

**DIAGNOSIS:** *M. thevenot* can be distinguished from *M. birni* by its more elevated pars cephalica (fig. 55), and by its carapace microsculpture, which consists of widely spaced ridges (figs. 6, 55).

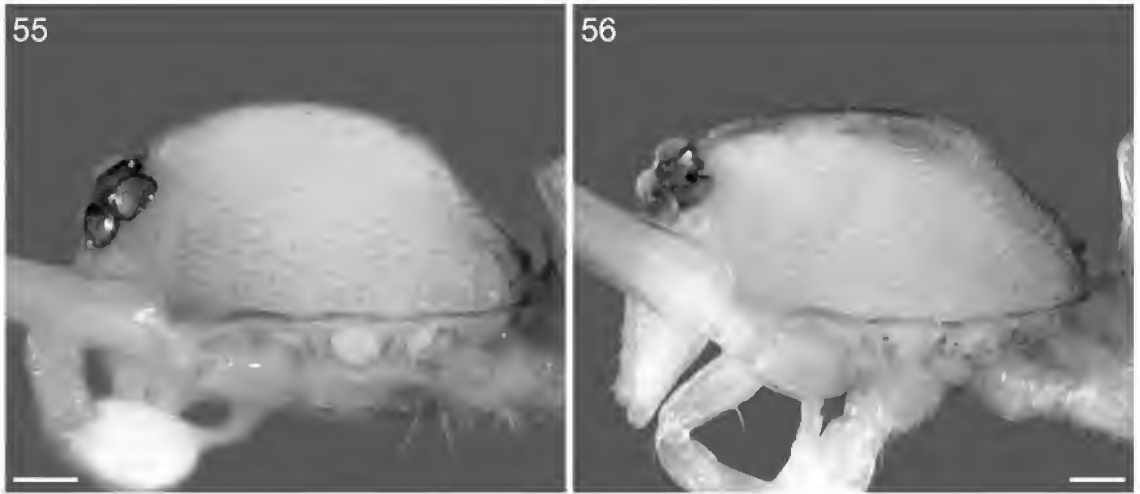
MALE: TL 1.17, CL 0.53, CW 0.43, DSL 0.63, DSW 0.41, Ti I l 0.26, Ti I l/d 5.68. Habitus as in fig. 2. Carapace yellow. Pars cephalica elevated, reaching its highest point at the level of coxal insertion I, thereafter slowly declining (fig. 2). Carapace microsculpture consisting of dark, widely spaced ridges; ridges varying from short and straight to long, meandering, and repeatedly branching (figs. 2, 6, 55). Sternum pale yellow, without hair tufts, with a single pouch situated behind labium (fig. 9); no sclerotized triangles in front of anterolateral corners. Anterior face of paturon light grey. DS light grey, covering entire dorsum. ES and PES pale yellow, fused into single ventral scutum that covers full length of abdomen (fig. 27). Lateral apodemes rather short; a faint brown band connecting anterior ends of apodemes (fig. 27). Left leg II examined with SEM; morphology as in female (see below). Sperm pore small, circular, situated anterior of brown band (fig. 27). Right and left pedipalps symmetrical, not strongly sclerotized, proximal segments yellow, cymbium and bulb white, ECC brown with black tip. Palpal trochanter without ventral projection; femur more than two times as long as trochanter, attaching to patella basally; patella much shorter than femur, not enlarged (fig. 47); tibia approximately as long as patella, with three dorsal trichobothria (structure as on legs). Cymbium approximately as long as bulb (fig. 46); fused to bulb but with clearly defined seam between them; without distal patch of setae; tarsal organ situated on distal third of cymbium, structure as on legs. Bulb distally giving rise to long ECC (figs. 46, 48); bulbal apex not conical. ECC longer than bulb, inward curved (fig. 46), consisting of two elements, a dorsal embolus and a ventral conductor (fig. 48). Dorsal surface of embolus densely grooved (fig. 49). Embolus distally splitting into two embolar flanges (figs. 48–50); one flange is distally broadened, the other is somewhat ribbon shaped (broadened flange, bf, and ribbonlike flange, rf; figs. 51–54). Ventral surface of broadened flange showing fold (fig. 53). Sperm duct opening could not be located with certainty; possibly, the opening is situated at the fold (fig. 53). Conductor distally splitting into a dorsal and ventral branch (figs. 50–52, 54); dorsal branch flat and relatively broad (fig. 51); ventral branch slender, somewhat threadlike (fig. 52), not visible from dorsal point of view. Both branches have a crenulate retrolateral edge (figs. 50–52). Tip of ECC held in sternal pouch (fig. 9).

FEMALE: TL 1.30, CL 0.56, CW 0.46, DSL 0.74, DSW 0.57, Ti I l 0.28, Ti I l/d 4.78. Carapace as in male. Clypeus rebordered. Sternum pale orange. Infracoxal grooves without pores; a slit sensillum on posterior part of each groove. Anterior face of paturon pale yellow, with sparse setae (fig. 11). Cheliceral teeth absent. Cheliceral fang without basal process (fig. 11), tip unmodified; anterior edge of fang smooth, posterior edge serrated near base (fig. 12). A short, apically pointed seta arising from inner surface of each chelicera (figs. 11, 13). Promargin flanked by double row of setae (inner and outer row, fig. 14); each row with about six setae; most setae of inner row bent and with small, triangular teeth on shaft (fig. 14). Between double row and fang base a plumose hair (anterior plumose seta, aps; fig. 14). Posterior surface of paturon with two medially directed setae and three shorter spines (fig. 15). Fang base flanked posteriorly by two hairs (fig. 15), innermost one plumose (posterior plumose seta). At least 17 setae on labium: eight on distal margin, four situated subdistally, five situated medially (fig. 16). Labrum as in figure 17. Serrula with about 24 teeth in single

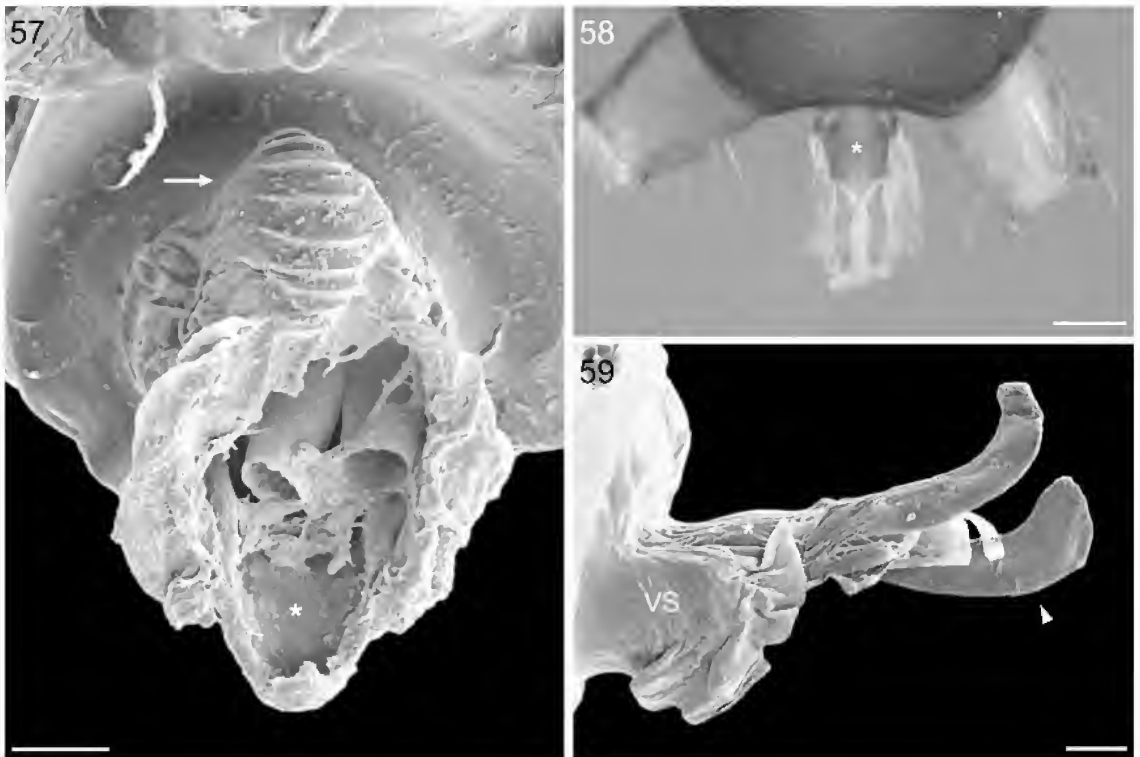


FIGS. 51–54. *Melchisedec thevenot*, new species, male, distal part of embolus-conductor complex. 51. Dorsal view. 52. Ventral view. Asterisk: ventral branch of conductor. 53. Detail of broadened flange, showing fold (arrowhead). 54. Anterior view. Abbreviations: bf, broadened flange; db, dorsal branch of conductor; rf, ribbonlike flange. Scale bars: 4  $\mu$ m.

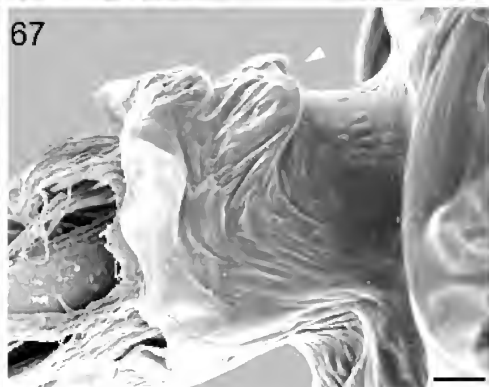
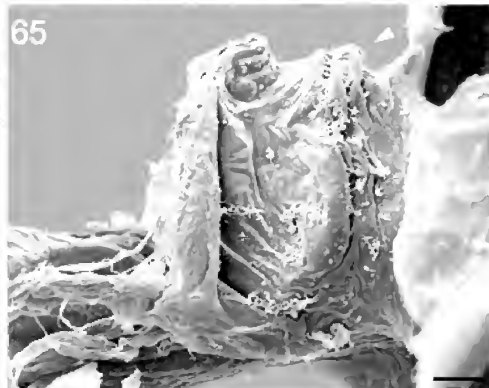
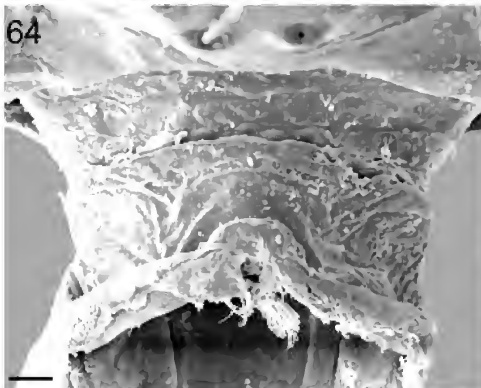
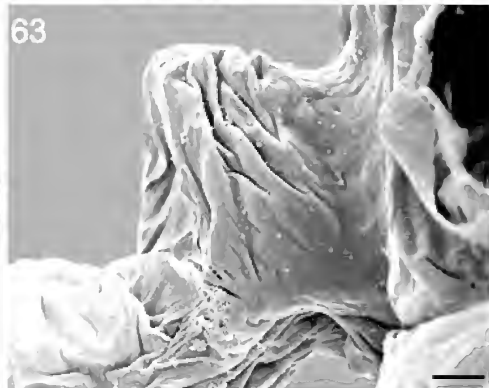
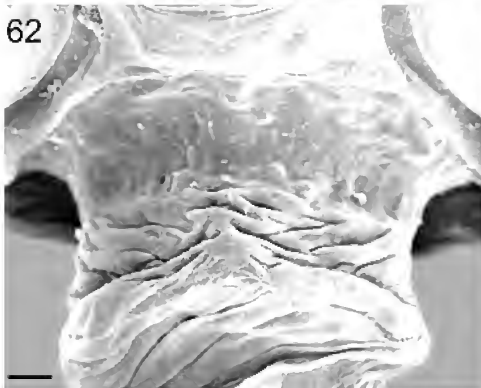
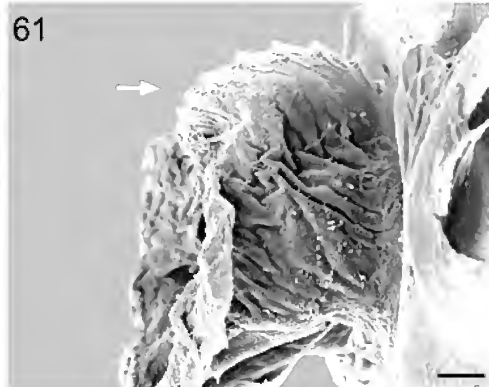
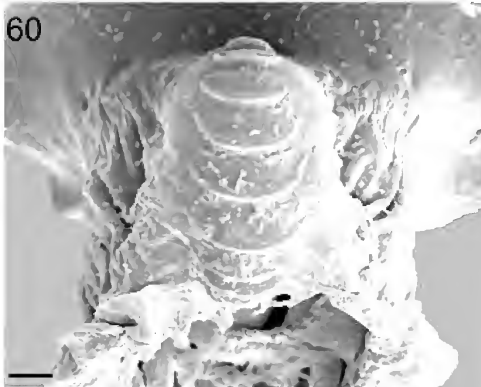




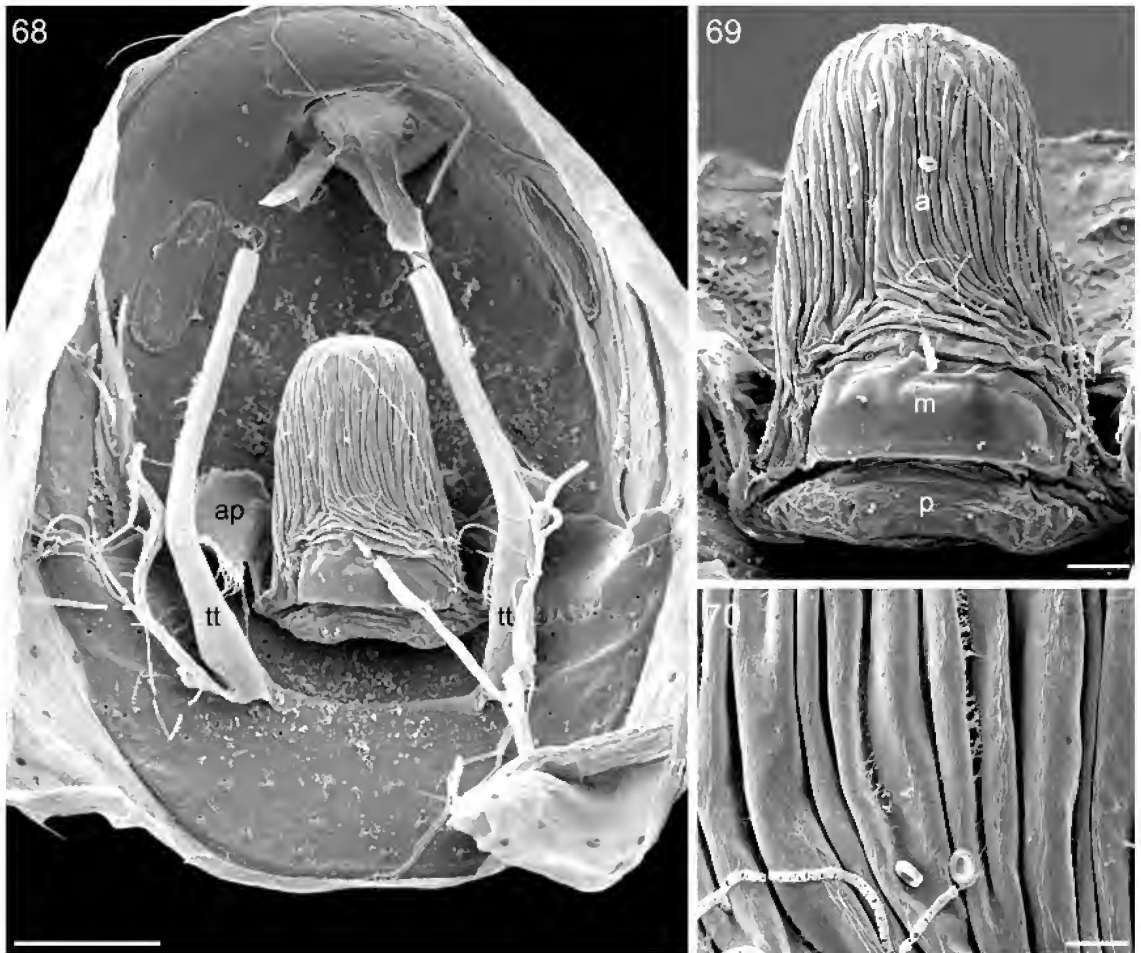
FIGS. 55–56. Carapace, lateral view. 55. *Melchisedec thevenot*, new species, male. 56. *Melchisedec birni*, new species, female. Scale bars: 80  $\mu\text{m}$ .



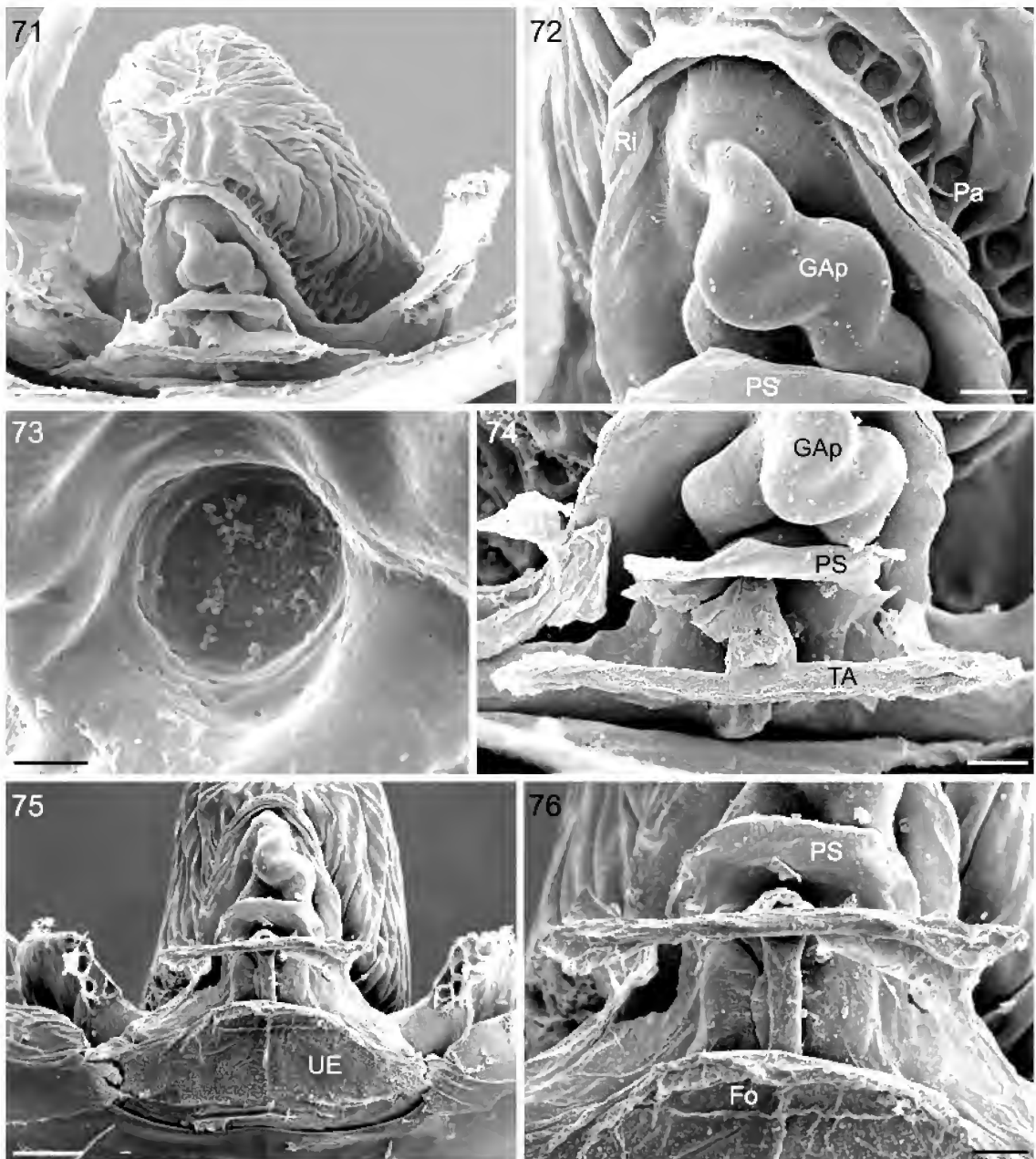
FIGS. 57–59. Pedicellar sclerites. 57. *Melchisedec thevenot*, new species, female, ventral and dorsal pedicel sclerites, posterior view. Arrow: crest. Asterisk: dorsal sclerite. 58. *Antoonops corbulo* Fannes and Jocqué, female, dorsal pedicel sclerite and slender sclerites, dorsal view. Asterisk: dorsal sclerite. 59. Undescribed oonopid, female, ventral and dorsal pedicel sclerites and slender sclerites (arrowhead), lateral view. Asterisk: dorsal pedicel sclerite. Abbreviation: VS, ventral pedicel sclerite. Scale bars: 30  $\mu\text{m}$  (57, 59), 90  $\mu\text{m}$  (58).



FIGS. 60–67. Ventral pedicel sclerite. **60.** *Melchisedec thevenot*, new species, female, ventral view. **61.** Same, lateral view. Arrow: crest. **62.** *Antoonops corbulo* Fannes and Jocqué, female, ventral view. **63.** Same, lateral view. **64.** *Opopaea* species, female, ventral view. **65.** Same, lateral view. Arrowhead: ridge. **66.** Undescribed species, female, ventral view. **67.** Same, lateral view. Arrowhead: bilobed ridge. Scale bars: 10  $\mu$ m.



FIGS. 68–70. *Melchisedec thevenot*, new species, female. **68.** Abdomen, digested, dorsal view, showing internal genitalia and respiratory system. Receptaculum at centre of image. Abbreviations: ap, lateral apodeme; tt, tracheal trunk. **69.** Receptaculum, dorsal view, showing anterior (a), middle (m) and posterior (p) parts. **70.** Same, close-up of folds. Scale bars: 5  $\mu$ m (70), 25  $\mu$ m (69), 100  $\mu$ m (68).



FIGS. 71–76. *Melchisedec thevenot*, new species, female. 71. Receptaculum and uterine sclerites, oblique anterior view. 72. Same, close-up of globular appendix. 73. Image of a single papilla. 74. Uterine sclerites, anterior view. Asterisk: process of anterior uterine sclerite. 75. Receptaculum and uterine sclerites, epigastric scutum removed, ventral view. 76. Same, close-up of uterine sclerites. Abbreviations: Fo, fold in uterus externus wall; GAp, globular appendix; Pa, papillae; PS, posterior uterine sclerite; Ri, ridge; TA, transverse apodeme of anterior uterine sclerite; UE, uterus externus, anterior wall. Scale bars: 2  $\mu\text{m}$  (73), 10  $\mu\text{m}$  (72, 74, 76), 30  $\mu\text{m}$  (71, 75).

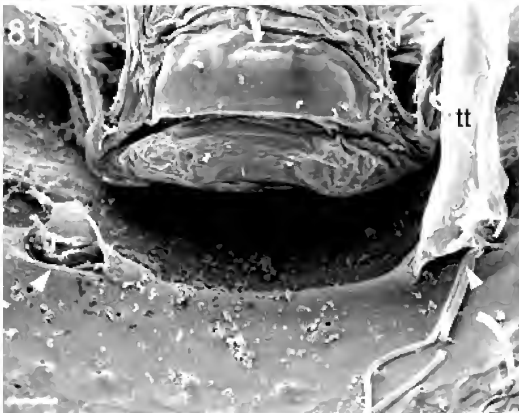
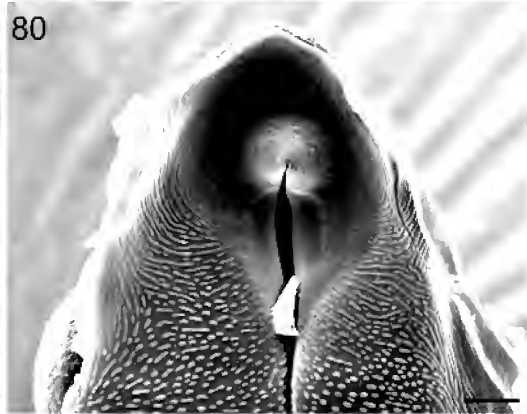
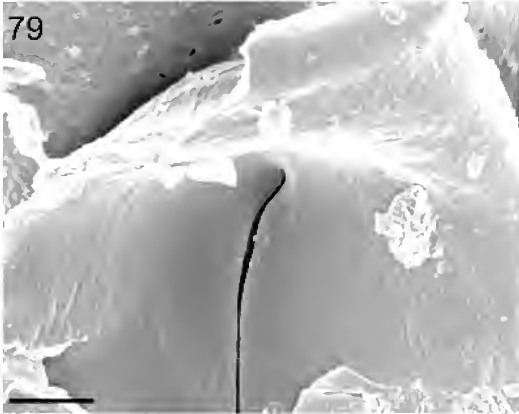
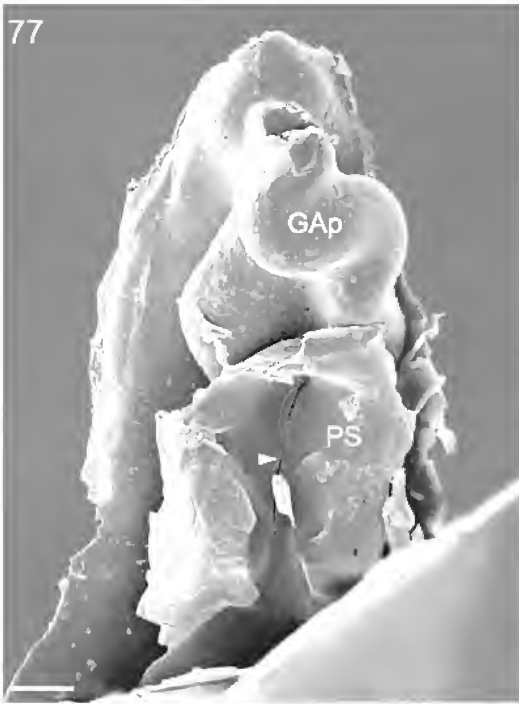
row. Female palp without claw; structure of trichobothria as on legs (fig. 18). Soft portions of dorsum white, without color pattern. Two groups of small, rounded tubercles above pedicel tube (fig. 22). Outer surface of pedicel tube rugose and bearing setae (fig. 23), at least some setae have swollen bases (fig. 24); inner surface of tube closely ridged (fig. 25). DS grey, covering more than 3/4 of abdomen length and entire width. ES and PES pale orange. A slit sensillum anterior to each posterior spiracle (fig. 31). Dense patch of setae anterior to spinnerets absent. Colulus weakly sclerotized, bearing two setae; anterior lateral spinnerets with one spigot (fig. 32); posterior median spinnerets with one spigot (fig. 33); posterior lateral spinnerets with two spigots (fig. 34). The specimen examined by SEM showed a single scepterlike seta on one of the legs III; other leg III and both legs IV devoid of such setae. Distalmost, toward onychium sloping part of tarsus provided with proprioceptor hair. Onychium bearing many setae, some spatulated. Tarsi without inferior claws. Superior claws hirsute and biseriate; lateral row consisting of 4–5 large teeth; median row situated close to claw tip, consisting of up to 10 small teeth, distalmost teeth often fused (fig. 45). Trichobothria: bothrium as in figure 36; no variation in bothrium structure among legs or among positions on a given leg. Tarsal organ pear shaped, receptor lobes exposed, inner surface of walls covered by ridges (fig. 44); no variation in structure among legs. Genitalia: no external copulatory structures (figs. 26, 29, 30); internally a large receptaculum, two uterine sclerites, and broad lateral apodemes (see Internal Female Genitalia and Respiratory System, below, for details).

**OTHER MATERIAL EXAMINED:** **Cameroon:** Faro Game Reserve, 8°24'21.1"N 12°48'20.4"E, Apr. 22, 2007, gallery forest, canopy fogging, R. Jocqué, K. Loosveldt, L. Baert, and M. Alderweireldt (PBI\_OON 9211 and MRAC 228.973), 1 female. Same locality, 8°24'26.9"N 12°48'44.6"E, Apr. 24, 2007, gallery forest, canopy fogging, same collectors (PBI\_OON 9212 and MRAC 228.974), 1 female (used for SEM). **Guinea-Bissau:** Buba, 11°30'N 15°05'W, June 9–11, 1989, A. van Harten (PBI\_OON 9859 and MRAC 228.968), 1 female. Same collection data (PBI\_OON 9860 and MRAC 228.969), 1 female. **Ivory Coast:** Odienné, Saméso, Kourou Kélé, 9°45'N 7°45'W, Mar. 3, 1980, pitfalls, J. Everts (PBI\_OON 9207 and MRAC 174.130), 1 female. **Nigeria:** Wudil, 11°48'38"N 8°50'42"E, Nov. 12, 1976, litter, leg. APB Deeleman, Museum Leiden ex coll. C.L. Deeleman-Reinhold; 2000-704 (PBI\_OON 33824), 1 female. **Ethiopia:** Awash N.P., compound of RAS Hotel, 9°05'00"N 40°00'00"E, Apr. 24, 1986, elev. 1000 m, under stone, A. Russell-Smith (PBI\_OON 33823 and MRAC 228.970), 1 female. Melka Werer, IAR station, 9°33'00"N 40°24'00"E, Feb. 17, 1986, elev. 750 m, litter of *Acacia nilotica* forest, A. Russell-Smith (PBI\_OON 33822 and MRAC 228.971), 8 females.

**DISTRIBUTION:** Known from Guinea-Bissau, Ivory Coast, Nigeria, Cameroon, and Ethiopia (fig. 1).

**NOTE:** The specimens from Guinea-Bissau, Ivory Coast, and Ethiopia are tentatively assigned to *M. thevenot*. These specimens, all females, strongly resemble the female holotype from Cameroon. However, given the large geographical distances involved (fig. 1), it is possible that some of them do not belong to *M. thevenot*. The specific status of these specimens will remain uncertain until males have been collected from the same localities.





FIGS. 77–82. *Melchisedec thevenot*, new species, female. 77. Ventral part of receptaculum wall, excised, outer surface, showing globular appendix (GAp) and posterior uterine sclerite (PS). Arrowhead: slitlike opening. 78. Same, inner surface. Arrowheads: groove. 79. Detail of figure 77, showing distal part of slitlike opening. 80. Detail of figure 78. 81. Ridge between posterior spiracles, posterior view. Arrowheads: spiracles. 82. Same, detail of spongy tissue (asterisk). Abbreviation: tt, tracheal trunk. Scale bars: 5  $\mu\text{m}$  (79, 80, 82), 10  $\mu\text{m}$  (77), 20  $\mu\text{m}$  (78, 81).

### *Melchisedec birni*, new species

Figures 42, 56

TYPE: Female holotype: Niger, near Birni-N’Konni, 13°47’44”N 5°15’19”E, Oct. 30, 1976, leaf litter, Nationaal Natuurhistorisch Museum (RMNH), Leiden, ex coll. C.L. Deeleman-Reinhold; 2000-704 (PBI\_OON 34105).

ETYMOLOGY: The specific name is a noun in apposition taken from the type locality.

DIAGNOSIS: *M. birni* differs from *M. thevenot* in having a flatter pars cephalica and in having reticulate microsculpture (fig. 56).

MALE: Unknown.

FEMALE: TL 1.48, CL 0.61, CW 0.49, DSL 0.87, DSW 0.56, Ti I l 0.30, Ti I l/d 5.88. Only differences with *M. thevenot* are given. Carapace orange, pars cephalica relatively flat in lateral view, lateral surfaces covered with dense, reticulate microsculpture (fig. 56). Sternum pale orange. DS orange, covering full length and width of abdomen. ES and PES orange. Legs and pedipalps of specimen severely bleached. Left legs I and II examined by SEM; scepterlike setae as in *M. thevenot* (fig. 42).

DISTRIBUTION: Known only from the type locality.

### PEDICEL MORPHOLOGY

In *Melchisedec* the ventral pedicel sclerite is peculiarly modified. The ventral surface of the sclerite forms a rounded, crestlike outgrowth (figs. 57, 60, 61); this crest bears a row of transverse ridges (figs. 60, 61). The pedicellar crest is readily visible with a stereomicroscope and appears equally well developed in both sexes.

To investigate whether pedicellar crests are unique to *Melchisedec*, a comparative survey was undertaken. The pedicel of several other oonopid genera was studied by stereo and/or scanning electron microscopy, with particular attention paid to the ventral sclerite. The genera examined included *Antoonops* Fannes and Jocqué, *Triaeris* Simon, and *Opopaea* Simon as well as several undescribed genera from Africa.

In all these genera, there are but two pedicellar sclerites, a dorsal and a ventral one. The dorsal sclerite is flat and shaped as in figure 58, with the posterior part drawn out into a point. When the prosoma is disarticulated from the abdomen, two slender sclerites often remain attached to the dorsal sclerite (figs. 58, 59); these paired sclerites are intraabdominal structures: in life, they are situated partly in the pedicel tube and partly in the anterior abdomen. The ventral pedicel sclerite covers the ventral and lateral sides of the pedicel (figs. 59, 62–67); ante-

riorly the sclerite is fused to the prosoma. In none of the examined species did the ventral sclerite exhibit a crestlike elevation. In most oonopids, the ventral surface of the sclerite is rather featureless (e.g., *Antoonops corbulo* Fannes and Jocqué, figs. 62, 63). However, in some species the sclerite exhibits a ridge. For example, in the two *Opopaea* species that were examined, a low but distinct ridge transverses the sclerite (figs. 64, 65). The members of an undescribed genus were also found to exhibit a ridge, but in this case the ridge is much more pronounced and bilobed (figs. 66, 67).

#### INTERNAL FEMALE GENITALIA AND RESPIRATORY SYSTEM

A female specimen of *M. thevenot* was treated with pancreatin in order to study the internal genitalia and the respiratory system. The enzymatic treatment revealed a large, elongated receptaculum (fig. 68). The receptaculum is about twice as long as wide and extends far anteriorly from the genital opening (figs. 68, 69). Its dorsal surface appears divided in three parts (fig. 69). The large anterior part has a strongly folded surface (figs. 69, 70). The middle and posterior parts are smaller and have, respectively, a smooth surface and a slightly wrinkled surface (fig. 69). The receptaculum is flanked by two winglike lateral apodemes (ap, fig. 68). These apodemes extend medially (fig. 71) and fuse with the ventral surface of the receptaculum, forming an inverted U-shaped ridge (Ri, fig. 72); this ridge has a ropelike appearance (fig. 72). Below the ridge a globular appendix (GAp) arises from the receptaculum (figs. 72, 74). Immediately above the ropelike ridge there is a layer of closely packed papillae (Pa, fig. 72). The papillae are almost perfectly round, with a diameter of approximately 5  $\mu\text{m}$ , and are separated from each other by narrow cuticular ridges (figs. 72, 73). They lack mushroomlike caps, one of the most distinguishing features of papillae (Burger, 2010), but this could be an artifact of the digestion procedure.

Embedded within the posterior wall of the uterus externus (UE) lies a platelike sclerite (posterior uterine sclerite, PS, figs. 72, 74–77). The PS is closely associated with the receptaculum and the GAp (figs. 72, 74). In the anterior wall of the UE lies a T-shaped sclerite (anterior uterine sclerite, figs. 74–76). It consists of two main elements, a stalk and a transverse apodeme (TA; figs. 74–76). The transverse apodeme bears a robust process that presses into the PS (fig. 74). The two uterine sclerites are not visible from a dorsal point of view; even the transverse apodeme is completely hidden from sight by the large receptaculum (fig. 68).

Further dissection of the specimen revealed additional anatomical details. When the epigastric scutum was removed, part of the anterior wall of the UE became visible (figs. 75, 76), showing a prominent fold near the base of the stalk (Fo, fig. 76). In order to examine the morphology of the PS in more detail, the ventral part of the receptaculum wall was excised and mounted (figs. 77, 78). This preparation allowed for a ventral view on the PS (fig. 77), revealing a slitlike opening in the sclerite (figs. 77, 79). The other side of the excised fragment was also scanned (figs. 78, 80), revealing a long narrow groove (arrowheads in fig. 78). Distally the groove becomes slightly wider (fig. 80). The surface near the groove is partly covered with a peculiar microsculpture (fig. 80).



The anterior spiracles lead into rudimentary book lungs that consist of only a single lamella (not shown). The posterior spiracles open into a well-developed tracheal system (figs. 68, 81, 82). The main tracheal trunks (tt) run anteriorly and enter the pedicel (fig. 68). A low ridge links the posterior spiracles (fig. 81); in the specimen studied, spongy tissue appears to emerge from the ridge (fig. 82).

## DISCUSSION

**PEDICELLAR CREST:** The pedicellar crest is one of the most remarkable and enigmatic features of *Melchisedec*. At the moment it is unclear what function it could serve. One possibility is that the crest is a stridulatory organ, for it bears a row of transverse ridges (figs. 57, 60) and could thus function as a stridulatory file. It may be argued that this is unlikely given the fact that the crest is as well developed in females as in males; usually, female spiders have either no or much-reduced stridulatory organs (e.g., Jocqué, 2005; Maddison and Stratton, 1988). However, several exceptions to this “rule” are known (see, e.g., Hinton and Wilson 1970, who document a case where only the female has a stridulatory apparatus). A role for the crest as a stridulatory organ thus remains a distinct possibility. Nevertheless, other functions are conceivable and additional studies are needed to resolve this issue.

Whatever the function of the crest, a comparative survey (figs. 62–67) failed to find similar structures in other genera. The crest thus provides a valuable diagnostic character, and a putative synapomorphy, for *Melchisedec*. Interestingly, in the course of this survey, some oonopids were found to exhibit other peculiar modifications of the ventral sclerite, such as bilobed ridges (figs. 66, 67). The ventral pedicel sclerite could thus be an important source of phylogenetic characters.

**SMOOTH SETAE AND SCEPTERLIKE SETAE:** *Melchisedec* exhibits two peculiar types of leg setae: completely smooth setae (fig. 40) and scepterlike setae (fig. 43). The smooth setae occur exclusively on the anterior and posterior surface of the coxae, consist of an asymmetrical socket and a completely smooth shaft, and project into the narrow space between adjacent legs (figs. 39–41). Similar setae have been discovered in entelegyne spiders by Eckweiler et al. (1989). Presumably, entelegyne spiders use these setae to monitor the distance between the coxae during locomotion (Barth, 2001; Eckweiler et al. 1989). The smooth setae observed in *Melchisedec* may serve a similar function.

The scepterlike setae are situated on the distal metatarsi of legs I and II (figs. 42, 43). They occur either as a single seta or as a closely spaced pair of setae (fig. 43). Scepterlike setae have never been reported from other oonopids and may be unique to *Melchisedec*. Interestingly, some species of *Grymeus* have closely spaced pairs of densely barbed setae on their distal metatarsi I (Fannes, personal obs.); these paired setae may be homologous to the scepterlike setae of *Melchisedec*.

**RECEPTACULUM MORPHOLOGY:** The female genital system of *M. thevenot* corresponds closely with that of *Grymeus*, *Silhouettella* Benoit, *Myrmopopaea* Reimoser, and *Lionneta* Benoit (figs. 68–80; Burger, 2007, 2010; Burger et al., 2006; Harvey, 1987). However, the receptaculum of *M. thevenot* is much larger than that of these genera (fig. 68), and it extends far anteriorly

from the genital opening (figs. 68, 75). Also, in *M. thevenot* most of the receptaculum surface is strongly folded (figs. 69, 70) whereas in *Silhouettella*, *Myrmopopaea*, *Lionneta*, and *Grymeus* the receptaculum surface is mostly smooth (e.g., Burger et al., 2006; Burger, 2010).

The aberrant morphology of the receptaculum raises many questions. Is the large size of the receptaculum an adaptation to allow for the storage of more sperm? If so, does this mean that females of *Melchisedec* store the ejaculate of more than one male? What is the functional significance of the folds? Do they simply add mechanical strength to the voluminous receptaculum? Or do they allow the receptaculum to expand? To answer these and other questions, additional histological and ethological studies are needed.

**AFFINITIES OF MELCHISEDEC:** *Melchisedec* may be closely related to the Australian genus *Grymeus*. The two genera have many features in common, including a large globular appendix (figs. 72, 77; Burger, 2010), a sternal pouch (fig. 9; Harvey, 1987), a prominent conductor (figs. 48–50; Burger, 2010; Harvey, 1987), and a densely grooved embolus that ends in two equally long flanges (figs. 48–52; Burger, 2010; Harvey, 1987). Furthermore, both species of *Melchisedec* and at least some species of *Grymeus* have closely spaced pairs of setae on the distal metatarsi (see above). However, it must be noted that there are also many differences between the two genera. For example, in *Melchisedec* the embolus and conductor are positioned close together, especially basally (fig. 48), whereas in *Grymeus* they are relatively well separated (see, e.g., Burger, 2010, fig. 7B). Also, in *Melchisedec* the conductor splits into a dorsal and a ventral branch (figs. 50, 52) while no such bifurcation is apparent in *Grymeus* (Burger, 2010; Harvey, 1987; Fannes, personal obs.).

Other possible relatives of *Melchisedec* are *Gamasomorpha* Karsch and *Diblemma* O.P.-Cambridge. Judging from the available drawings, these genera have genitalia similar to those of *Melchisedec* (e.g., Saaristo, 2001). Unfortunately, *Gamasomorpha* and *Diblemma* have not yet been studied by SEM, precluding any detailed comparison. The genera *Silhouettella*, *Myrmopopaea*, and *Lionneta* may also be related to *Melchisedec*. As noted above, their female genital system is broadly similar to that of *M. thevenot* (Burger, 2007, 2010; Burger et al., 2006).

Members of the PBI project are currently revising the genera *Grymeus*, *Gamasomorpha*, and *Silhouettella*. The results of these studies will help to determine whether *Melchisedec* is related to these genera.

#### ACKNOWLEDGMENTS

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