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***Martensopsalis*, a new genus of Neopilionidae from New Caledonia (Opiliones: Eupnoi)**

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Abstract

New Caledonia has an endemic opiliofauna with two named species of Triaenonychidae, 17 Troglosironidae and eight Zalmoxidae. The recent finding of Neopilionidae on Grande Terre was thus surprising, and required the formal description of a new genus, which we undertake here. *Martensopsalis* gen. nov. is characterized by a small unsclerotized body with a unique palp with a pointed basal apophysis on the ventral side of the femur and with a distal apophysis on the prolatateral side of the patella. The distinct external morphology, simple penis and unique phylogenetic position justify the erection of the new genus with *Martensopsalis dogny* spec. nov. as its type species. In addition to the type locality we report several other localities of putative congeneric, yet undescribed species.

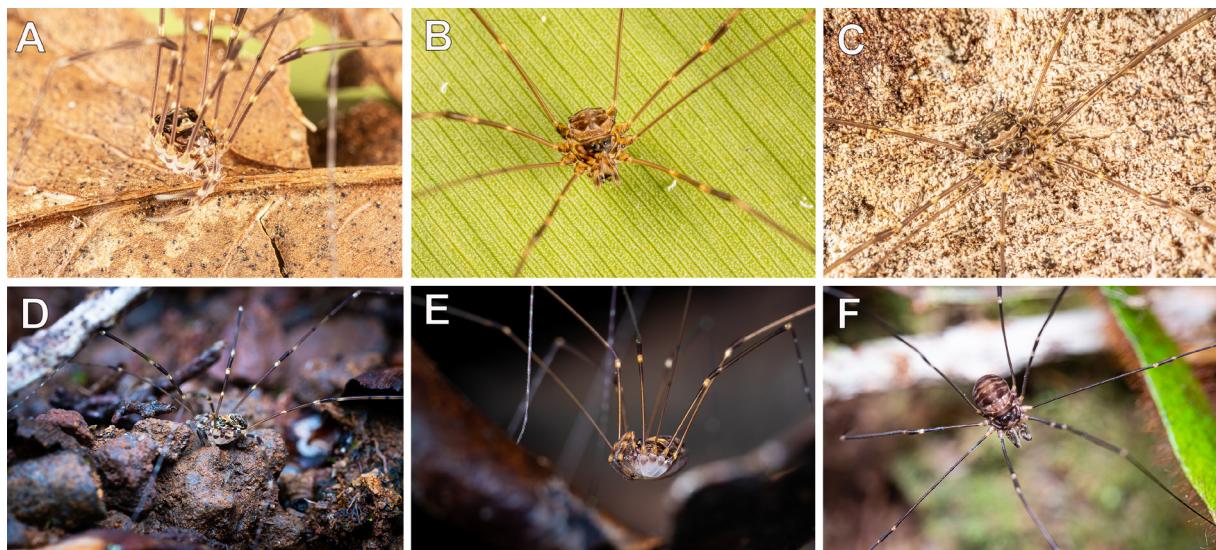
Key words: Gondwana, harvestmen, taxonomy, Zealandia

Introduction

New Caledonia is a fascinating group of islands with a biogeographical history tightly connected to the breakup of Gondwana followed by a long episode of deep oceanic submersion (Grandcolas *et al.* 2008; Etienne *et al.* 2018). Geologically New Caledonia is located at the northern margin of the largely submerged continent Zealandia (Mortimer *et al.* 2017). Because of this key geographical location and the well-documented submersion history, the origins of New Caledonian's biota have been debated (Murienne *et al.* 2005; Nattier *et al.* 2017; Giribet & Baker 2019), with harvestmen playing a key role in this debate. As a consequence, taxonomic work on New Caledonian harvestmen has surged in recent times, the focus being on its three known families: Triaenonychidae, Troglosironidae, and Zalmoxidae. Triaenonychidae is represented by two species, *Triconobunus horridus* Roewer, 1914 and *Diaenobunus armatus* Roewer, 1915, placed in two monotypic genera whose origin was just elucidated (Baker *et al.* 2020; Derkarabetian *et al.* 2021). Troglosironidae was established by Shear (1993) for the endemic genus *Troglosiro* Juberthie, 1979, now consisting of 17 described species (Giribet *et al.* 2021). Zalmoxidae includes an endemic clade which in turn is part of a South Pacific radiation (Sharma & Giribet 2012; Gainett *et al.* 2020) with eight named species to date (Sharma, 2012).

More recently, the first specimens of the family Neopilionidae were reported for New Caledonia (Giribet & Baker 2019). Neopilionidae species are known from most landmasses that once constituted Gondwana, with representatives in South America, South Africa, Australia, New Zealand (Šilhavý 1970; Giribet *et al.* in press), plus the New Caledonian species mentioned before—a similar distribution to that of the family Triaenonychidae. The neopilionid material examined consists of four specimens, one from Mé Maoya (Province Nord), collected at 1,161 m elevation on November 14th, 2018 (Fig. 1C), and three from the Plateau de Dogny, Saraméa (Province Sud), at 998 m, collected on November 15th, 2018 (Figs 1A–B). The specimens were originally thought to be juveniles due to their small size and light sclerotization, and thus were preserved in 96% EtOH and RNAlater for molecular study,

to better understand their phylogenetic and biogeographic relationship to other members of the family Neopilionidae. After careful examination under a stereomicroscope back in the laboratory they were recognized to be adults because one male had its penis everted. Subsequent to this discovery, the third author posted photos of several living neopilionids from additional localities in the Province Sud of New Caledonia. With the specimens currently hosted at the Museum of Comparative Zoology (MCZ) and the new distributional data, we here erect a new genus of New Caledonian Neopilionidae and describe the first and so far only species in the genus. Future work should focus on collecting at unsampled localities, which undoubtedly will bring to light multiple species of this family of Opiliones in New Caledonia which were overlooked by taxonomists until recently.



FIGURES 1A–F. Live habitus of *Martensopsalis* gen. nov. A–B *Martensopsalis dogny* gen. & spec. nov. from Plateau de Dogny (paratype MCZ IZ-151592). C *Martensopsalis* sp. from Mé Maoya (MCZ IZ-151588). D *Martensopsalis* sp. from Mt Do. E *Martensopsalis* sp. from Kwa We Dare. F *Martensopsalis* sp. from the Humboldt rainforest. Photos by G. Giribet (A–C) and D. Brouste (D–F).

Materials and methods

Specimens were collected in the field, photographed alive, and preserved in 96% EtOH. For specimen MCZ IZ-151588 two legs were preserved in RNAlater and later transferred to the MCZ cryogenic collection. All measurements are in millimeters.

We imaged the male holotype (with legs attached) and one female paratype (with legs removed) in dorsal, ventral and lateral views using a JVC-KY-F75U digital camera mounted on a Leica MZ 12.5 stereomicroscope (Leica Biosystems, Nußloch, Germany) with a Plan 0.5 objective. The software package Auto-Montage Pro version 5.02.0096 (Synoptics Group, Cambridge, UK) was used to produce and assemble a series of 3–5 images taken at different focal planes.

After the initial imaging with Automontage, the penis¹ was dissected out and imaged on an LSM 880 confocal microscope (Carl Zeiss Microscopy, Jena, Germany) using a 20x/0.8 NA Plan-Apochromat objective. Autofluorescence was excited with a 561 nm laser and signal was collected from 570–730 nm. An axial volume of 57 μm was obtained in 75 slices. Post-acquisition, a maximum intensity projection was performed and a gamma correction of 0.45 was applied to enable visualization of dim structures.

In addition, we used field photographs of the described species and of additional specimens from the citizen science portal iNaturalist (Heberling & Isaac 2018). These considerably extended the known range of the genus to the southern tip of the main island of New Caledonia, Grande Terre (see Table 1). All these records were used to generate a distribution map for the genus (Fig. 2).

1. We initially chose to image the penis articulated on the specimen, as it did not show any salient structures, but the editors requested higher-resolution images during a time where the authors had no access to high-end microscope with an imaging system due to COVID-19 restrictions. The prepared specimen was thus handed to the imaging facility and was lost during imaging.

The four specimens examined were sequenced for three standard Sanger-based markers, two nuclear ribosomal rRNA genes (18S and 28S) and one mitochondrial protein-encoding gene (cytochrome *c* oxidase subunit I). All sequences are available in GenBank under COI accession codes MW837101–MW837104, MW843228–MW843231 and MW849410–MW849413.

Repositories. MCZ—Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA. MNHN—Muséum national d’Histoire naturelle, Paris, France.

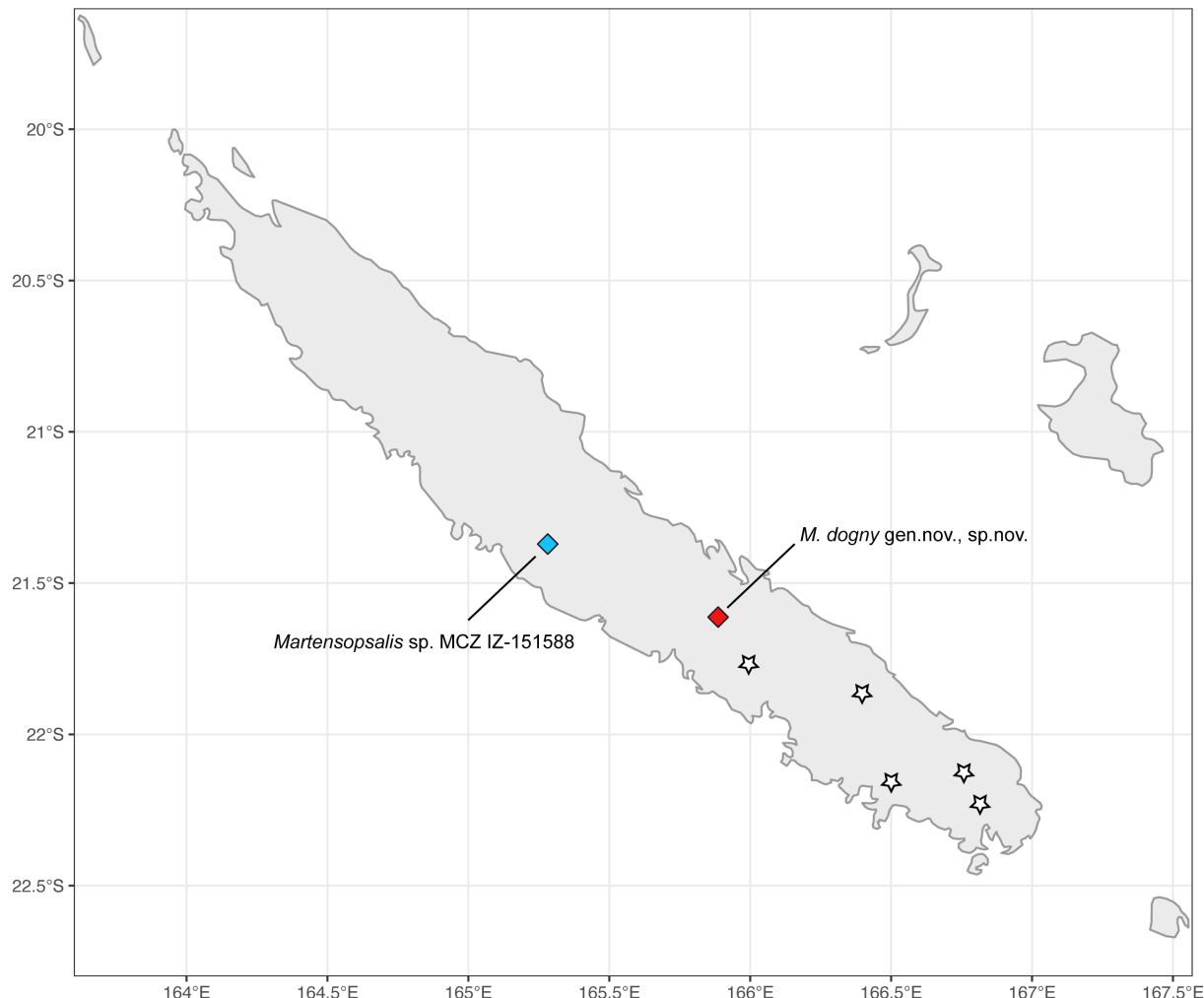


FIGURE 2. Known localities of *Martensopsalis* gen. nov. in New Caledonia. Red diamond indicates *Martensopsalis dogny* spec. nov.; blue diamond indicates a second undescribed species of *Martensopsalis* gen. nov. included in our molecular study; stars indicate iNaturalist records of additional specimens.

Taxonomy

Neopilionidae Lawrence, 1931

Martensopsalis Giribet & Baker gen. nov. (Figs 1, 3–6)

ZooBank registration: urn:lsid:zoobank.org:act:04C4AC0D-DE0C-46F0-AB6A-F5D2B3D24514

Type species. *Martensopsalis dogny* spec. nov.

Diagnosis. *Martensopsalis* can be distinguished from all other genera of Neopilionidae by the presence of a pointed basal apophysis on the ventral side of the palpal femur (Figs 3, 4C), although being more conspicuous in some individuals than others; palpal patella with a distal-prolateral apophysis (Figs 3, 4C), also with different de-

grees of development; palpal patella and tibia of similar size; palpal tarsus longer than other articles; a dense set of thick setae on all palpal articles; palpal claw well developed and smooth. Penis with long sclerotized straight shaft with a short glans, and the stylus being a coiled tube; without bristles, spines or setae.

TABLE 1. *Martensopsalis* gen. nov. records registered in iNaturalist.

observed	url	place	latitude	longitude
2019/04/30	https://www.inaturalist.org/observations/24264052	Les Koghis	-22.177409	166.508104
2019/05/25	https://www.inaturalist.org/observations/26958522	Mt Do	-21.761743	166.000186
2019/09/28	https://www.inaturalist.org/observations/33645698	Pic du Pin	-22.237172	166.833790
2019/10/08	https://www.inaturalist.org/observations/34291751	Kwa We Dare	-22.159260	166.761041
2019/10/30	https://www.inaturalist.org/observations/35130609	Les Koghis	-22.177409	166.508104
2019/11/16	https://www.inaturalist.org/observations/36817617	Humboldt rainforest	-21.880681	166.407405
2019/11/16	https://www.inaturalist.org/observations/36817618	Humboldt rainforest	-21.880804	166.407304
2019/11/16	https://www.inaturalist.org/observations/36817622	Humboldt rainforest	-21.881005	166.406111
2019/11/16	https://www.inaturalist.org/observations/36817626	Humboldt rainforest	-21.880782	166.406012
2019/11/16	https://www.inaturalist.org/observations/36817632	Humboldt rainforest	-21.880911	166.406767
2019/11/16	https://www.inaturalist.org/observations/36817634	Humboldt rainforest	-21.880639	166.407513
2019/11/16	https://www.inaturalist.org/observations/36817635	Humboldt rainforest	-21.880604	166.408060
2019/11/17	https://www.inaturalist.org/observations/36818776	Humboldt rainforest	-21.880674	166.407722
2020/01/08	https://www.inaturalist.org/observations/37480385	Les Koghis	-22.177409	166.508104

Description. Prosoma weakly sclerotized, smooth; carapace with the metapeltidium² well demarcated; opisthosoma unornamented; dorsum color of earth tones or green, with a transverse reflective pale/orange band on first opisthosomal tergite (Figs 3, 4A–B, 6A); ozophores large, raised and visible from above, located immediately behind fixed spine of coxa I. Ocularium large, smooth, positioned behind anterior margin of carapace at a distance equal to length of ocularium (Figs 4A–B, 6A, C). Chelicerae (Figs 4B, D) of normal size, without evident sexual dimorphism; second article setose, except for fixed finger; movable finger without setae. Palp (Fig. 4C) covered with stiff thick setae, giving it a spiny appearance; without plumose setae; femur with a distinct basal-proventral apophysis (Figs 3, 4C); patella with a distinct prodistal apophysis (Fig. 3); patella and tibia of similar size; tarsus longer than femur, slightly bent; tarsal claw without ventral teeth.

Coxae of legs I–III with dorsal spines; other leg articles without denticles or spines. Legs long and slender, femur I longer than carapace; pseudoarticulations of tarsi with paired ventral spines; leg II with two pseudoarticulations on femur and eight on tibia; leg IV with two or four pseudosegments on tibia only, not always the same in the corresponding right and left legs.

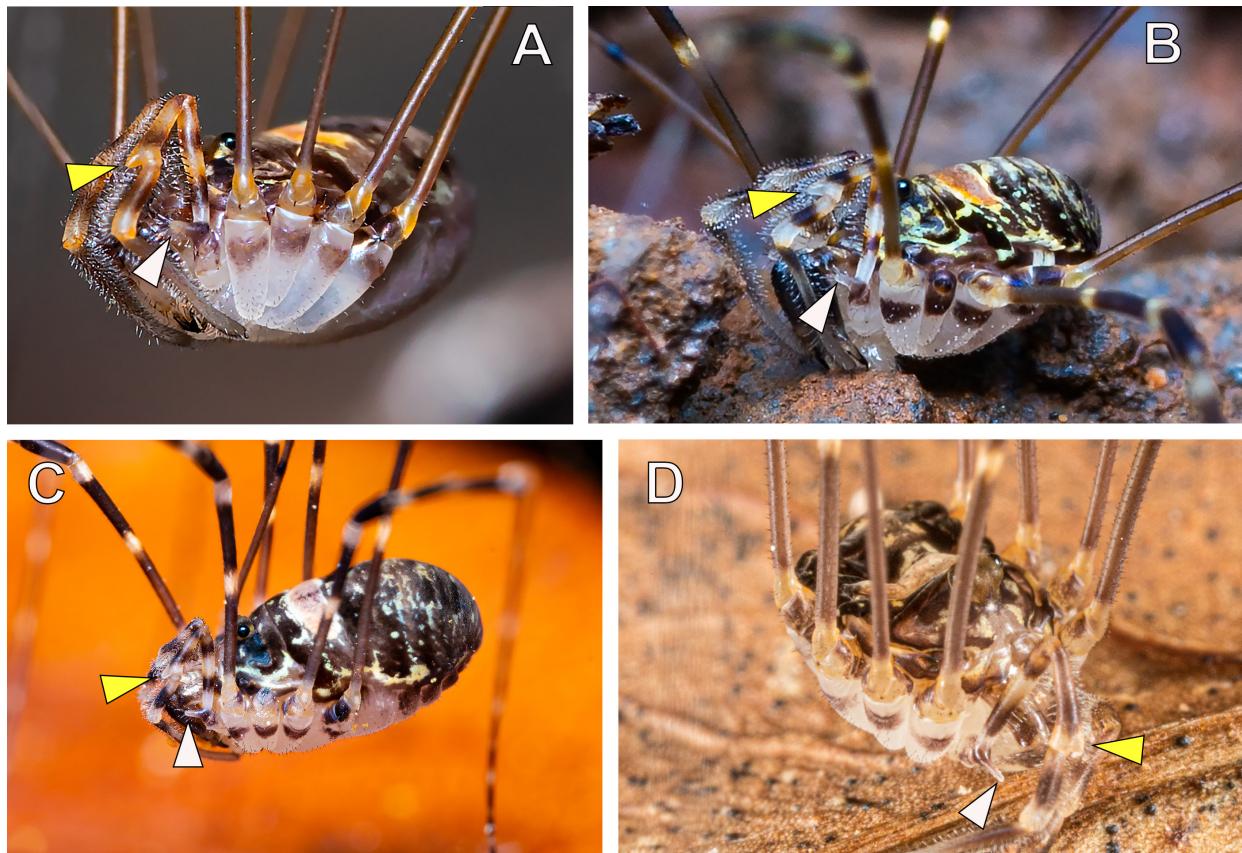
Penis (Figs 4E, 5) simple, with a straight shaft, without spines, groups of bristles or sensory setae; shaft folding towards the tip from which the short glans and the coiled stylus tube protrude.

Etymology. Named for our dear colleague Jochen Martens for his contributions and enormous influence on Opiliones systematics. The second part of the generic name is the classical Greek noun “psalis” (= scissors) which has been previously used in the names of other genera of Neopilionidae such as *Megalopsalis*, *Forsteropsalis* and *Pantopsalis*. The gender is feminine.

Distribution. Widespread in the southern half of New Caledonia’s Grande Terre.

Comments. *Martensopsalis* is so far the only genus of Neopilionidae in New Caledonia, known only from four specimens collected during our 2018 expedition and from additional records posted on iNaturalist. The simple straight penis without setae or spines and with a short glans with a long stylus distinguishes *Martensopsalis* from most other neopilionids, including all other Australasian species. The penis of *Neopilio* Lawrence, 1931 is similar in lacking supination and setae and in having the stylus developed as a tightly coiled tube, but the shaft widens basally (Hunt & Cokendolpher 1991; Lotz 2011).

2. We follow Shultz & Pinto-da-Rocha (2007) in defining the carapace as a dorsal region of the prosoma formed by the consolidation of the tergites of six appendage-bearing somites, irrespective of whether the mesopeltidium and metapeltidium are distinct or not, as they note “the carapace may be uniform or show differentiation of the posterior two somites”.



FIGURES 3A–D. Detail of the habitus showing the pointed basal apophysis on the ventral side of the palpal femur (white arrow heads) and the patellar apophysis (yellow arrow heads). A *Martensopsalis* sp. from Kwa We Dare. B *Martensopsalis* sp. from Mt. Do. C *Martensopsalis* sp. from Les Koghis. D *Martensopsalis dogny* gen. & spec. nov., spec. nov. from the Plateau de Dogny (paratype MCZ IZ-151592). Photos by D. Brouste (A–C); photo by G. Giribet (D).

***Martensopsalis dogny* Giribet & Baker spec. nov. (Figs 1A–B, 3D, 4–6)**

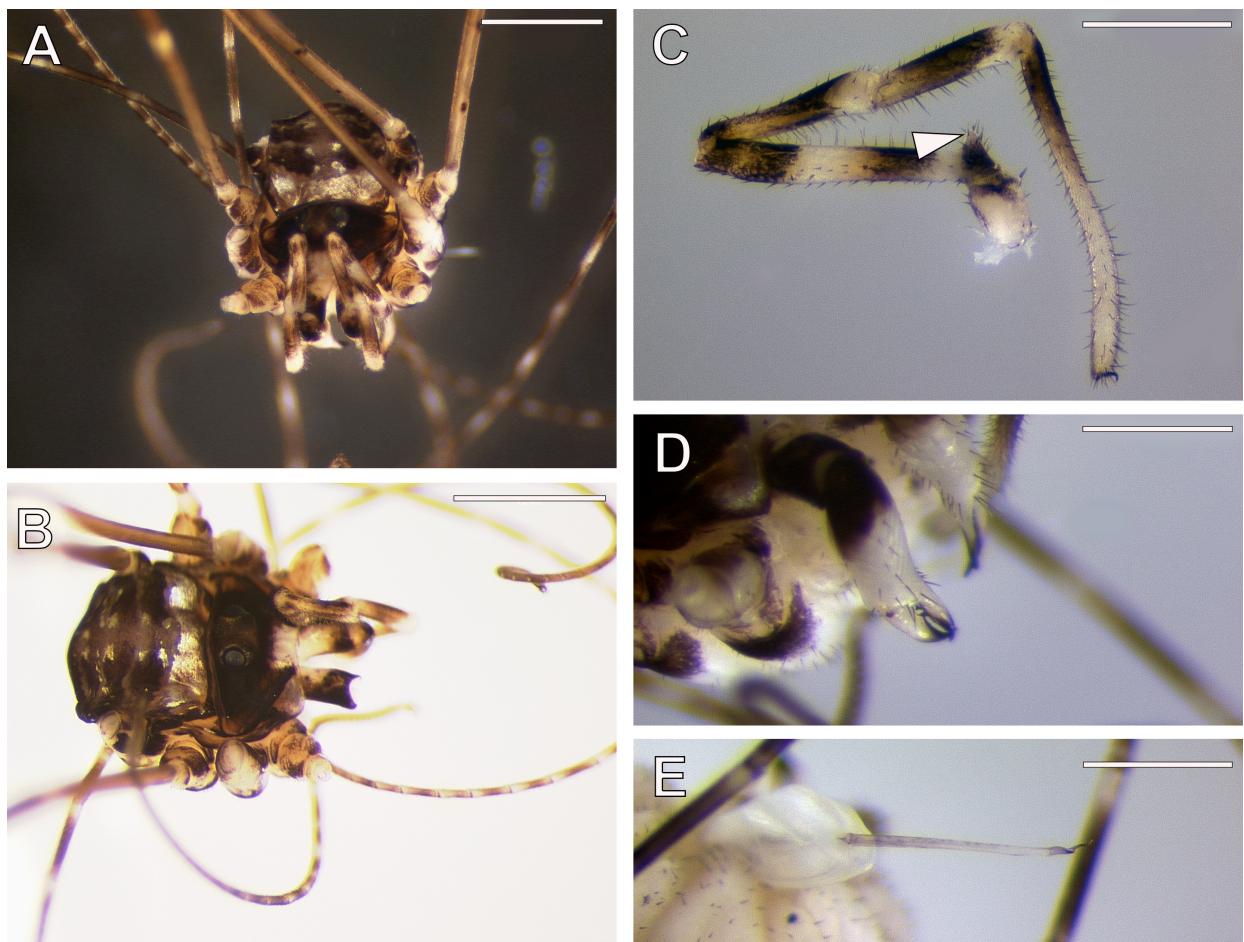
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Type material. NEW CALEDONIA: Province Sud: Holotype male (MNHN; ex. MCZ IZ-152401³; 1 leg used for DNA extraction; DNA kept in MCZ cryogenic collection; GenBank accessions MW849412 [18S rRNA], MW843230 [28S rRNA], MW837103 [COI]) from Sarrameia, Plateau de Dogny, 21°37'1.06"S, 165°53'2.15"E, 914 m elevation, C.M. Baker & G. Giribet leg. 15.11.2018, collected by sifting leaf litter. **Paratypes: 1 female** (MCZ IZ-152402; 1 leg used for DNA extraction; DNA kept in MCZ cryogenic collection; GenBank accessions MW849413 [18S rRNA], MW843231 [28S rRNA], MW837104 [COI]), **1 unsexed specimen** (MCZ IZ-151592; 1 leg used for DNA extraction; DNA kept in MCZ cryogenic collection; GenBank accessions MW849411 [18S rRNA], MW843229 [28S rRNA], MW837102 [COI]), with same collecting data as for holotype.

Etymology. The specific epithet, a noun in apposition, refers to the type locality, an emblematic mountain of New Caledonia that served as a place for exchange between the tribes from the east and the west of Grande Terre.

Diagnosis. As for genus.

3. This specimen was accessioned in the MCZ before becoming the holotype of a new species, which, for permit requirements, had to be deposited in the MNHN. Because the species was originally catalogued in MCZbase, its collecting data and images were available online before a new taxon was described, and because one leg and its DNA remain stored in the MCZ cryogenic collection, we kept this record with the MCZ accession number.



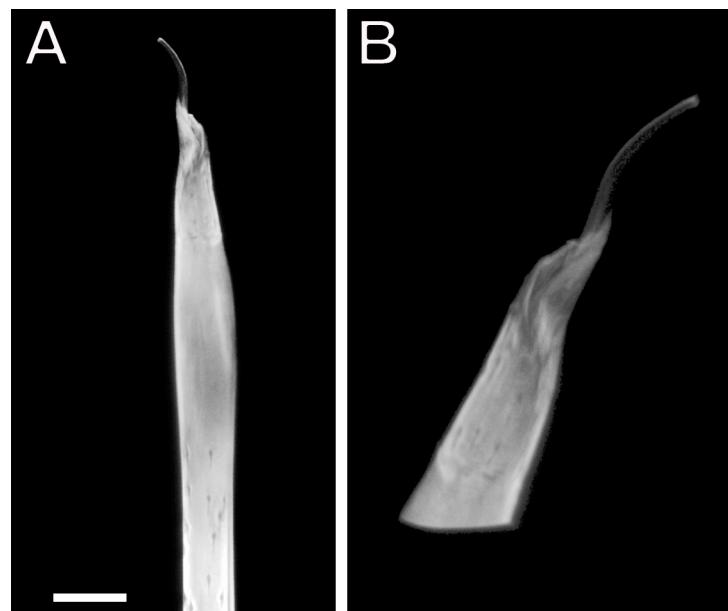
FIGURES 4A–E. *Martensopsalis dogny* gen. & spec. nov., holotype male (MNHN, MCZ IZ-152401). A Body, dorsofrontal. B Body, dorsal. C Right palp, prolateral, showing ventrobasal femoral apophysis (arrow head). D Laterofrontal view of chelicerae. E Penis. Scale bars: 1 mm (A–B), 0.5 mm (C–E).

Description. Male (holotype; Figs 4–5): As for genus. Body length 1.38, maximum width 1.14; carapace length 0.60, width 1.14; ocularium width 0.42, length 0.26, located 0.28 from anterior margin of carapace. Dorsum color a combination of earth colors (brown to orange-color) with a reflective band on first opisthosomal tergite when preserved in ethanol (Figs 4A–B). Cheliceral articles 0.52, 0.95 and 0.31 long from basal to distal. Palpal trochanter 0.27 long, femur 1.00, patella 0.65, tibia 0.55, tarsus 1.16 (Fig. 4C). Penis shaft 0.69, glans short, 0.15 long and twisted clockwise (Figs 4E, 5).

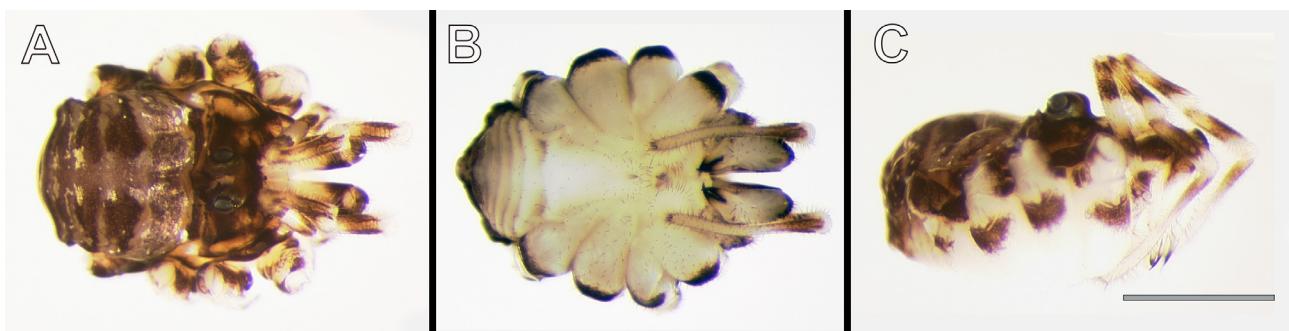
Female (paratype MCZ IZ-152402; Fig. 6): body length 1.66, maximum width 1.12, height without ocularium 1.22; carapace length 0.64, width 1.08; ocularium width 0.44, length 0.36, height 0.18, located 0.24 from anterior margin of carapace. Color as in male holotype. Ovipositor not studied.

Distribution. Only known from its type locality, the Plateau de Dogny, at an elevation above 900 m.

Comments. *Martensopsalis dogny* spec. nov. is the only species in this new genus that we were able to study in detail. Another specimen from high elevations at Mé Maoya (Province Nord; Fig. 1C) was included in a phylogenetic analysis (see Fig. 7) which showed that it is not conspecific with the species described here. Genetic and morphological studies of additional specimens from the localities reported in Table 1 will probably reveal the presence of additional species of *Martensopsalis* gen. nov.



FIGURES 5A–B. *Martensopsalis dogny* gen. & spec. nov., holotype male (MNHN, MCZ IZ-152401). A Confocal image of total penis. B Detail of penis tip. Scale bar: 50 µm.



FIGURES 6A–C. *Martensopsalis dogny* gen. & spec. nov., female paratype (MCZ IZ-152402), habitus of body (A dorsal, B ventral, C lateral). Scale bar: 0.5 mm.

Discussion

New Caledonia is known for its high levels of endemism, which is clearly shown in short-range endemic soil arthropods. Indeed, all known New Caledonian harvestman species seem to be endemic to the archipelago, and many of them are known from single locations. Not surprisingly, the first neopilionids discovered in New Caledonia are also endemic to the Grande Terre. When comparing DNA sequence data from the new species with those of a specimen from a second location, the divergence clearly suggests that the species at these two locations are genetically separated for a very long time (38.9 Ma, HPD 71.8–15.4 Ma), as estimated by Giribet *et al.* (in press) (see also Fig. 7).

Martensopsalis gen. nov. is clearly different from all known neopilionid genera and has an unclear phylogenetic position, either as sister group to most other Australian / Zealandian neopilionids (Fig. 7) or nested within an Australian clade as shown in some analyses (Giribet *et al.* in press). Most importantly, there are many obvious morphological differences between the new species and the members of the Australian clade. This paper therefore formalizes the range extension of Neopilionidae, first reported by Giribet and Baker (2019) for New Caledonia, and shows that the genus has undergone a radiation of species that remained undetected until now. Our paper will hopefully be followed by many others exploring this new genus so as to better understand the biological history of New Caledonia and adds to the recent body of work describing new lineages of Neopilionidae from East Gondwana (e.g., Hunt & Cokendolpher 1991; Taylor 2008; Taylor 2009; Taylor & Hunt 2009; Taylor 2013).

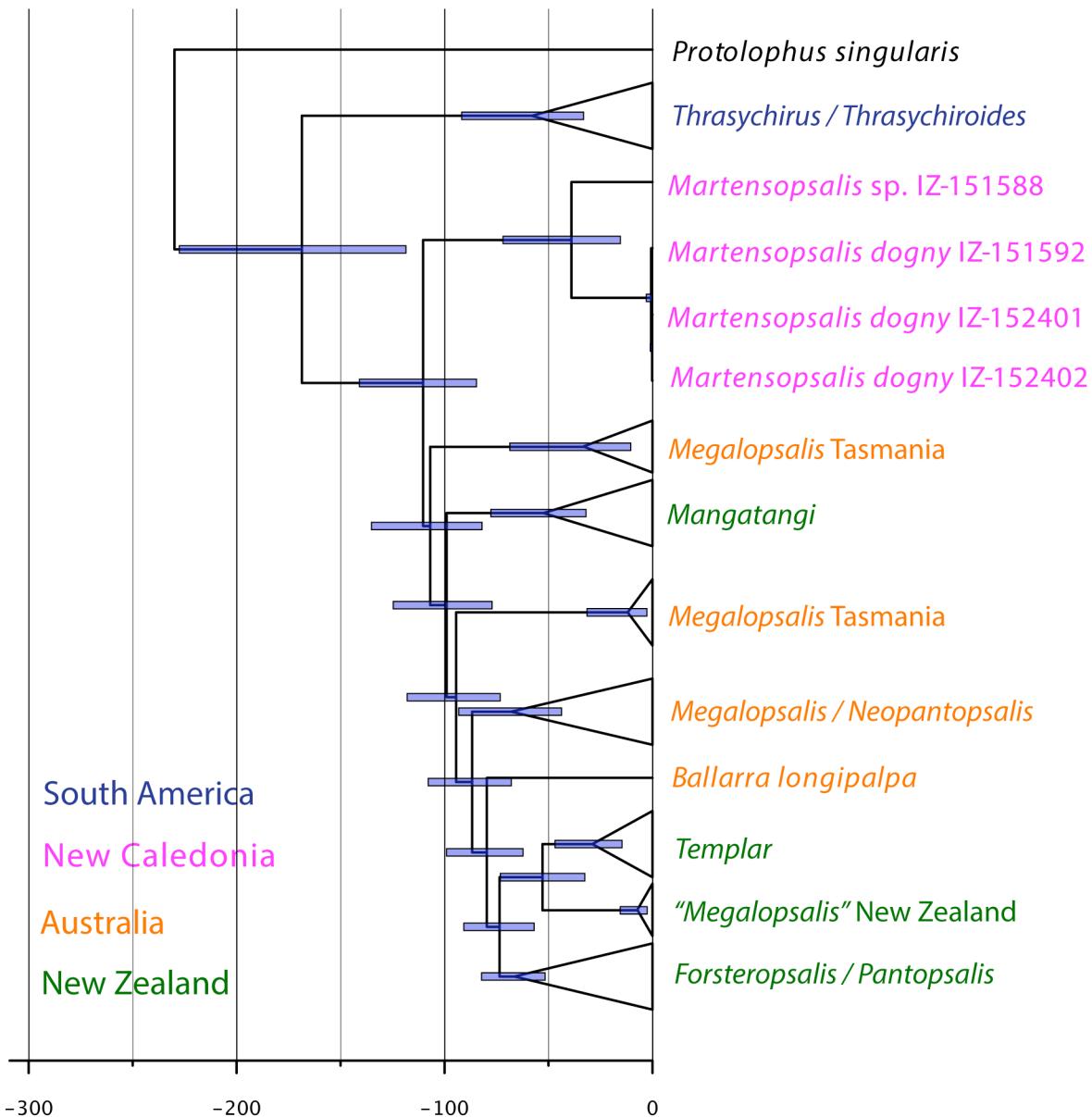


FIGURE 7. Simplified chronogram from Giribet *et al.* (in press) showing the position and divergence time estimates of *Martensopsalis* gen. nov. with respect to other clades of Australian and Zealandian neopilionids. Numbers indicate divergence times in millions of years.

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