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Caribodillo martinicensis n. gen., n. sp. habitus in life, lateral view (Photo: Baptiste Bentameur).

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Description of a new genus and species of terrestrial isopod (Oniscidea, Armadillidae) endemic to Martinique

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ABSTRACT
The terrestrial isopods of the family Armadillidae Brandt, 1833 are poorly known in tropical regions, many new species remain to be described and the classification of many already described species requires revision. The aim of this work is to improve our knowledge of the terrestrial isopods of this family in Martinique, an island in the Lesser Antilles archipelago. The species *Caribodillo martinicensis* n. gen., n. sp. is described, and a genetic barcode (CO1) is provided. Furthermore, the relationship between *Caribodillo* n. gen., and *Venezillo* Verhoeff, 1928 is discussed. The species constitutes the second Armadillidae endemic to the Lesser Antilles, the first one being *Cubaris depressa* (Dollfuss, 1896) from Saint-Vincent. In addition to increasing our knowledge on the invertebrate biodiversity of the lesser Antilles, the description of this new genus will facilitate the taxonomy of Armadillidae species in the region.

KEY WORDS
Caribbean,
Lesser Antilles,
Neotropics,
Venezillo,
woodlice,
fluorescence,
barcoding,
new species,
new genus.

RÉSUMÉ
Description d'un nouveau genre et d'une nouvelle espèce d'isopode terrestre (Oniscidea, Armadillidae) endémique de la Martinique.
Les cloportes terrestres de la famille des Armadillidae Brandt, 1833 sont mal connus dans les régions tropicales, de nombreuses nouvelles espèces restent à décrire, et la classification de nombreuses espèces déjà décrites nécessite une révision. Ce travail vise à améliorer la connaissance des isopodes terrestres de cette famille en Martinique, une île située dans l'archipel des Petites Antilles. L'espèce *Caribodillo martinicensis* n. gen., n. sp. est décrite et un code-barres génétique (CO1) est fourni. En outre, les relations de parenté entre *Caribodillo* n. gen. et *Venezillo* Verhoeff, 1928 sont discutées. L'espèce constitue la deuxième espèce d'Armadillidae endémique des Petites Antilles, la première étant *Cubaris depressa* (Dollfus, 1896) de Saint-Vincent. En plus d'élargir nos connaissances sur la biodiversité des invertébrés des Petites Antilles, la description de ce nouveau genre facilitera la taxonomie des espèces d'Armadillidae dans la région.

MOTS CLÉS
Caraïbes,
Petites Antilles,
Néotropiques,
Venezillo,
cloportes,
fluorescence,
code-barres génétique,
espèce nouvelle,
genre nouveau.

INTRODUCTION

The family Armadillidae Brandt, 1833 is a diverse family of terrestrial isopods that is widespread in tropical and subtropical regions across the globe (Taiti *et al.* 1998; Sfenthourakis & Taiti 2015). To date it comprises almost 700 species (WoRMS Editorial Board 2024). Despite their wide distribution and ecological significance, their diversity is much higher than the current taxonomy suggests. While terrestrial isopods in the Neotropics have seen significant work throughout the past years (e.g. Carpio-Díaz *et al.* 2018; Campos-Filho *et al.* 2023; López-Orozco *et al.* 2024), the Caribbean still represents a significantly understudied region. In the present study, a large species of terrestrial isopod from the family Armadillidae found on Martinique was examined and found to represent not only a new species, but also a new genus.

The species described here has been extensively distributed in the invertebrate pet trade under the hobby name "Salmon" or "Martinique Salmon" and is widely available in Europe and North America due to easy care requirements and its high reproductive rate. Specimens from the pet trade were examined and carefully compared with specimens collected at the type locality in order to confirm they are formally the same species.

MATERIAL AND METHODS

Specimens

Specimens were collected from the type locality (Fig. 1D, E), as well as the pet trade, and stored in 80% ethanol. Pet trade specimens were obtained from a German invertebrate breeder. We have gathered information from the original breeder. The founding individuals of the hobbyist cultures were originally collected at the stated type locality. Specimens from the pet trade were examined and carefully compared with specimens collected in the type locality, enabling us to establish that their morphology is identical.

Imaging

Morphological characters were obtained via examination and dissection of specimens under a BMS 74958 stereo microscope. Illustrations were made with images taken with a SWIFTCAM SC1300 microscope camera mounted on the stereo microscope, as well as images taken with a Canon EOS 600D mounted on an Olympus BH-2 microscope. Final figures were drawn with GIMP Version 2.10.38 following the methodology of Montesanto (2015, 2016). Image of the holotype (Fig. 1A) was stacked from 10 images taken with a Canon EOS 60D and a Canon EF-S 60 mm f/2.8 macro lens. Image stacking was performed in Digital Photo Professional 4. UV fluorescence was photographed (Fig. 4) as a single shot with the same camera equipment. Fluorescence was achieved with an Alonefire X901UV (365 nm) torch on living specimens from the pet trade and for imaging on freshly preserved specimens (same day), as fluorescence rapidly fades after preservation in alcohol.

DNA barcoding

DNA was extracted from three legs of one individual from the invertebrate pet trade using the method of Truett *et al.* (2000), with the volume of NaOH solution reduced to 50 ul and incubation at 95°C for 15 minutes, followed by ethanol precipitation and wash. A fragment of the mitochondrial cytochrome oxidase I (COI) gene was amplified using the forward primer CrustDF1 (5'-GGTCWACAAAYCATAAAGAYATTGG-3', Radulovici *et al.* (2009) and the reverse primer HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3, Folmer *et al.* 1994). Sanger sequencing of both strands was performed by Molecular Cloning Laboratories (South San Francisco, California, USA) with the same set of primers used for PCR.

Abbreviations

CBGP	Centre de biologie pour la gestion des populations, Continental Arthropod Collection, Montferrier-sur-Lez;
MNHN	Muséum national d'Histoire naturelle, Paris;
ZMB	Museum für Naturkunde, Berlin.

RESULTS

Order ISOPODA Latreille, 1816
Suborder ONISCIDEA Latreille, 1802
Family Armadillidae Brandt, 1833

Caribodillo n. gen.

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Type species. — *Caribodillo martinicensis* n. sp.

Diagnosis. — Animals capable of endoantennal conglobation. Body convex with flattened pereonites and pleonites epimera. Dorsal surface smooth and covered with small scale setae. Cephalon with frontal shield protruding over vertex. Pereonites 1 and 2 with ventral lobe. Ventral lobe on pereonite 1 broadly triangular. Ventral lobe on pereonite 2 slender, with anterior and posterior articulatory notch. Pereonites 3-7 epimera anteriorly thickened. Pereonites 1-7 with one line of small noduli laterales per side. Telson hourglass shaped. Mandibles with molar penicil dichotomized. Outer endite of maxillula with simple teeth. Uropod protopodite with rectangular distal portion, medial margin of protopodite weakly concave; uropod exopodite small and inserted near medial margin; uropod endopodite small. Pleopod exopods with monospiracular covered lungs.

Etymology. — The new genus name *Caribodillo* n. gen. refers to the Caribbean, where Martinique is located, combined with -dillo, a suffix commonly used for members of the family Armadillidae.

Caribodillo martinicensis n. sp.
(Figs 1A-C-4)

urn:lsid:zoobank.org:act:4E9AD3E4-6C3E-4B56-8F9F-AA4CBD0A2ED2

Material examined. — **Holotype. Martinique** • 1 ♂; Sainte Anne, Summit of Morne Manioc; 14°26'0"N, 60°51'26"W; 30.VIII.2016; Mathieu Coulis leg.; under rock, dry forest; MNHN-IU-2024-1859 **Paratypes. Martinique** • 3♂, 8♀; same data as holotype; MNHN-IU-2024-1860 • 1♂, 2♀; same data as holotype; 25.VIII.2024;

Fig. 1. — *Caribodillo martinicensis* n. gen., n. sp.: **A**, holotype MNHN-IU-2024-1859; **B**, habitus in life, lateral view; **C**, habitus in life, dorsal view; **D**, morne Manioc, the type locality of *Caribodillo martinicensis* n. gen., n. sp.; **E**, additional view of the type locality. Scale bar: 1.5 mm. Photos: A, Benedikt Kästle; B, C, Baptiste Bentameur; D, E, Mathieu Coulis.

Mathieu Coulis leg.; ZMB-33422; • 1♂, 4♀; same data as holotype; 30.V.2024; Regis Delannoye leg.; CBGP-FAUN-17361 • 5♂, 6♀; pet trade; 30.V.2024; Benedikt Kästle leg.; CBGP-FAUN-17360; • 4♂, 6♀; pet trade; 30.V.2024; Benedikt Kästle leg.; Genbank: PQ489720; ZMB-33421

Etymology. — The specific name refers to Martinique (latin.: Martinica), where the species was discovered.

Description

Male maximum body length 12 mm. Female maximum body length 15 mm. Color uniform orange to brown, frequently with gray cephalon and antennae (Fig. 1B, C). Frontal shield with anterior margin weakly convex in dorsal view (Fig. 2F). Eyes consisting of 17 ommatidia with raised lobe above each eye, continuing anteromedially as shallow elevated ridge (Fig. 2E). Antennae short and slender. Antennula with seven subapical aesthetascs (Fig. 2D). Pereonites 1-7 with posterior margin concave near epimera. Pereonite 1 epimera with rounded posterolateral corner, anterior corner acute. Pereonites 2-7 epimera rectangular (Fig. 2A). Pereonite 1 ventrally with short lobe, broadly triangular and directed backwards. Pereonite 2 ventrally with narrow, spiniform-

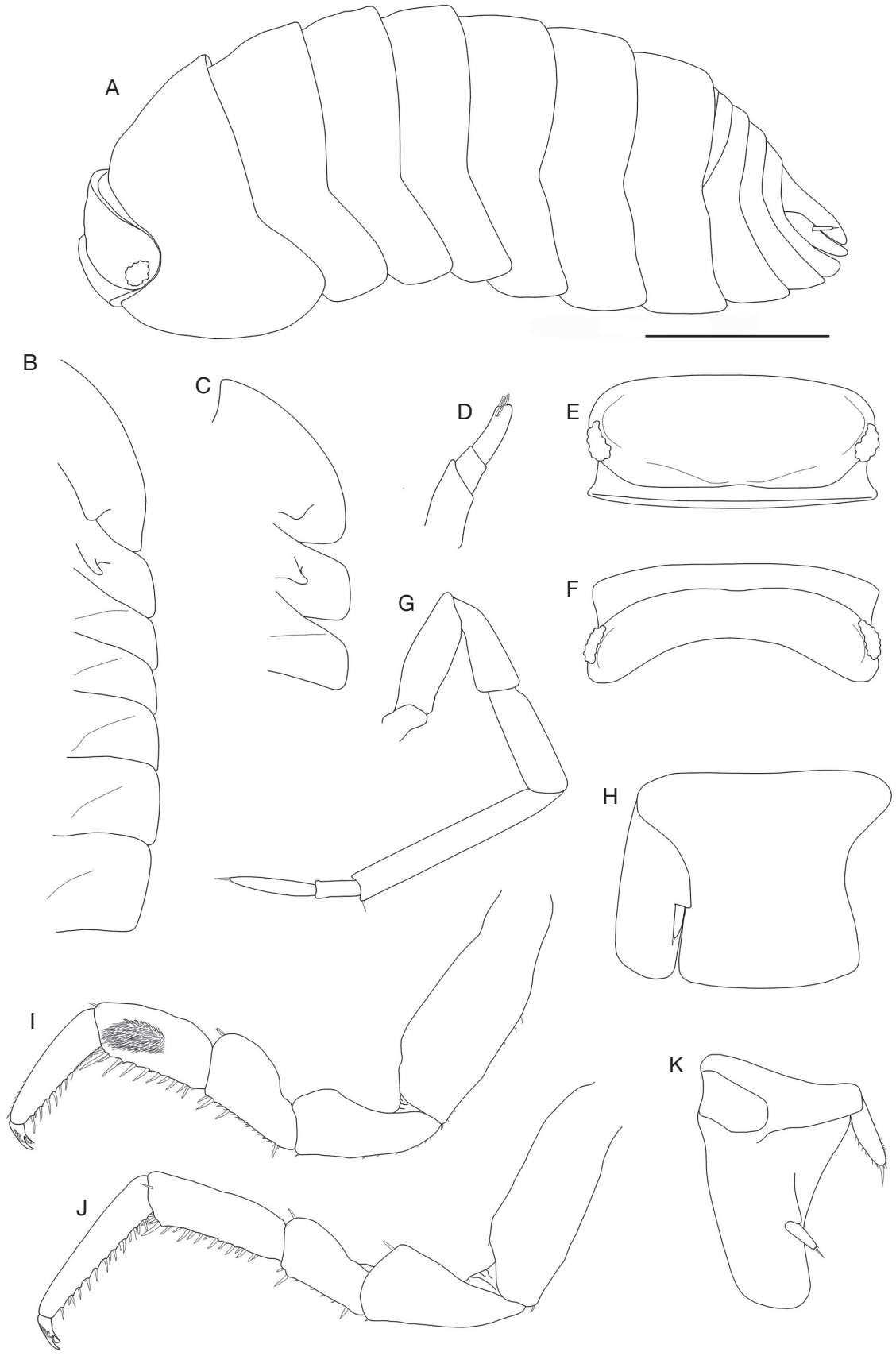

Fig. 2. — *Caribodillo martinicensis* n. gen., n. sp.: **A**, habitus; **B**, ventral lobes, ventral view; **C**, ventral lobes, oblique ventral view; **D**, antennula; **E**, cephalon, frontal view; **F**, cephalon, dorsal view; **G**, antenna; **H**, telson and left uropod; **I**, male pereopod I; **J**, male pereopod VII; **K**, uropod. Scale bars: A-C, E-K, 1 mm; D, 0.2 mm.

FIG. 3. — *Caribodillo martinicensis* n. gen., n. sp.: **A**, male pleopod I; **B**, male pleopod II; **C**, male pleopod III; **D**, male pleopod IV; **E**, male pleopod V; **F**, left mandible; **G**, right mandible; **H**, maxilliped; **I**, maxilla; **J**, maxillula, inner and outer endite. Scale bars: A-E, 0.5 mm; F-J, 0.25 mm.

like tooth, directed outwards (Fig. 2B, C). Telson longer than wide, distal portion elongate, posterior margin almost straight. (Fig. 2H). Right mandible with 1+1 penicils; left mandible with 2+1 penicils (Fig. 3F, G). Maxillula outer endite with 4+5 teeth; inner endite with two penicils, outer penicil twice as wide as inner penicil (Fig. 3J). Maxilla with outer lobe twice as wide as inner lobe; inner lobe of maxilla covered with thick setae (Fig. 3I). Maxilliped basis with outer margin convexly rounded; endite with two hook-like terminal setae, medial seta strong (Fig. 3H). Pereopods 1-7 basis and ischium bearing few setae; carpus and propodus densely covered with setae on sternal margins; carpus with longitudinal antennal grooming brush (Fig. 2I, J); dactylus with inner claw almost as long as outer claw. Uropod filling gap between pleonite 5 and telson (Fig. 2H, K); protopodite elongate, 1.6 times longer than wide, with distal portion rectangular, posterior margin slightly rounded (Fig. 2K); exopodite inserted dorsally close to the medial margin; endopodite less than one third the length of protopodite, almost twice as long as exopodite.

Male

Pereopods without sexual dimorphism. Pleopod 1 exopod triangular, slightly longer than wide, outer margin concave with deep incision at spiraculum; endopod 2.5 times longer than exopod, distal half bent outwards (Fig. 3A). Pleopod 2 exopod triangular, longer than wide, outer margin strongly concave bearing deep incision at spiraculum; endopod slender, slightly longer than exopod (Fig. 3B). Pleopod 3 and 4 exopods triangular, outer margin concave with shallow incision at spiraculum (Fig. 3C, D). Pleopod 5 exopod rhomboid, outer margin almost straight (Fig. 3E).

DNA Barcode

The obtained mitochondrial cytochrome oxidase I (CO1) sequence is available online at GenBank (https://www.ncbi.nlm.nih.gov/genbank/) under the accession number PQ489720.

```
tactttgtat tttatttttg gggtatgggc tggtgtagta ggggcttctt
tgagggtagttgttcgtatt gagttagggc aagcagggag gtttattgga
gacgaccaga tctttaatgtgatggttact gcacatgctt ttgttataat
ttttttata gtgataccta ttataattggagggtttggg aattgattaa
ccccttaat actaggggcc cctgacatag ctttcccacgtataaacaac
ctgaggttct gacttctacc tccttcttta acattattac tgac-
tagggctctagttgag agaggggtag gaacagggtg aactgtttac
cctcctttgg ctgggaacattgctcacaga ggaggggctg tggacttagg
gatttttct ttacatctag ctggagcctcttctatccta ggggctgtaa
attttattac cactatttta aatatacggg cagtaggaataaaattagat
cggatccctt tgtttgtatg atctatcttt attactgcag ttctttt-
tactcttatctttg cctgttctag ccggggctat tacaatactt ttaa-
cagacc gtaattttaatacttctttt tttgacccta gaggaggtgg
ggaccctatc ctgtatcagc atttgttttgatttttg
```

We attempted to blast the obtained sequence against the BOLD and GenBank databases, but species-level identification was not possible in either database. By extending the similarity criteria, the closest matches found were, in BOLD, *Spherillo dorsalis* (Iwamoto, 1943) (81.6%) and *Buddelundia cinerascens* (Budde-Lund, 1912) (81.3%); and, in GenBank, an unidentified species of the genus *Buddelundia* Michaelsen, 1912 (81.3%), *Eluma caelata* (Miers, 1878) (80%), and *Venezillo hasegawai* (Nunomura, 1991) (79.9%). This lack of matches with closely related taxa primarily reflects the very limited number of sequences available for Oniscidea, and particularly for Armadillidae, in the Neotropical region.

UV fluorescence

Strong fluorescence under 365 nm UV light was observed in the pleon (Fig. 4A). Different individuals showed variation in the extent of fluorescence. Variation ranged from the entirety of the pleonites fluorescing bright blue to a medial fluorescing spot restricted to pleonites 1 and 2. The extent of observed fluorescence was notably greater in males, while females exhibited only limited fluorescence. Furthermore, all setae displayed high contrast under 365 nm UV light, with the largest setae exhibiting the strongest fluorescence, particularly the setae on the pereopods and mouthparts, as well as the medial scale field of the water-conducting system (Fig. 4B, C).

DISCUSSION

Taxonomy

Caribodillo n. gen. appears to be closely related to the Neotropical genus *Venezillo*, as the two genera share many morphological similarities in the overall habitus and morphology of the uropods, telson and the ventral lobe of the second pereonite. A key distinction lies in the structure and function of pereonite 1. While *Venezillo* possesses a well-defined schisma typically with a lateral groove, *Caribodillo* n. gen. instead features a broad ventral lobe. This lobe is structurally distinct, lacking the articulatory function of a schisma with the pleonites (Gruner 1953), and articulating instead only with pereonite 2 during conglobation. Additionally, *Caribodillo* n. gen. exhibits a clinger eco-morphotype, with individuals primarily adhering to surfaces and only conglobate when detached from surface they can cling to, as observed in captive populations.

While the new genus is likely a close relative of *Venezillo* within the Neotropics, the placement of Afrotropical and Oriental species in *Venezillo*, such as *Venezillo natalensis* (Collinge, 1917) or *Venezillo hasegawai* (Nunomura, 1991), is questionable due to their great geographic distance. Although these species share morphological similarities with *Venezillo* – and thus, *Caribodillo* n. gen. – these resemblances may be the result of homoplasy rather than a close evolutionary relationship. Accordingly, the new genus can also be distinguished from these geographically distant *Venezillo* species and other morphologically similar taxa, such as *Aethiopodillo* Taiti, Paoli & Ferrara, 1998, by the absence of a schisma on the first pereonite.

Moreover, *Caribodillo* n. gen. shows superficial similarities to the polyphyletic genus *Cubaris* Brandt, 1833, but can be readily distinguished from *Cubaris sensu stricto* by the wide endolobe on pereonite 1, the flattened habitus, as well as the

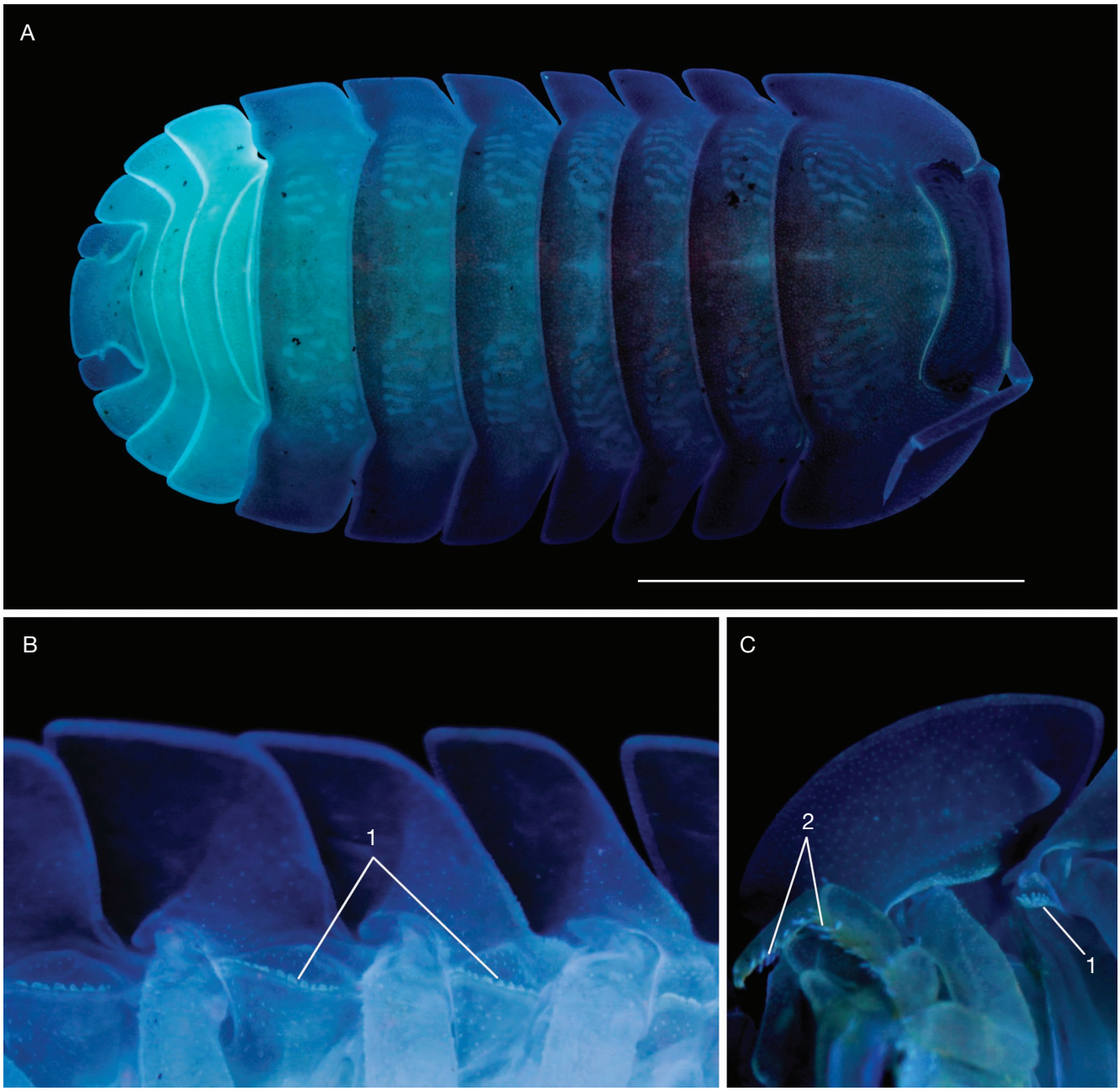

FIG. 4. — *Caribodillo martinicensis* n. gen., n. sp. under 365nm UV light: **A**, habitus in dorsal view; **B**, pereonites 3-7 in ventral view; **C**, pereonite 1 with pereopod in ventral view. **1**, medial scale field of the water conducting system; **2**, setae of the pereopods. Scale bar: A, 0.5 mm.

elongate distal portion of the telson. Most notably, *Cubaris sensu stricto* features a wedge shaped lobe without an anterior articulatory notch on pereonite 2, whereas *Caribodillo* n. gen. features a structurally different, slender ventral lobe with an anterior and posterior articulatory notch. in addition, *Cubaris sensu stricto* is assumed to be of Asiatic origin, the type species *Cubaris murina* Brandt, 1833 having probably been introduced into the Neotropics and therefore being biogeographically separate as well (Van Name 1936; Taiti & Ferrara 1991; Leistikow & Wägele 1999). Some Neotropical species previously assigned to the genus *Cubaris*, such as *Cubaris flavobrunnea* (Dollfus, 1896), may in fact belong to *Caribodillo* n. gen. However, confirmation of this hypothesis would require direct examination of specimens. The use of the molecular tool to aid taxonomy is promising, but at this stage, the lack of data, namely in the Neotropical region, prevents its effective use. The genus *Cubaris* has only 31 CO1 sequences, with the only identified species being *Cubaris murina* and the genus *Venezillo* has only 14 sequences, all belonging to the same species: *Venezillo hasegawai* from Japan. This could explain the low percentage of similarity in CO1 with species from closely related genera and supports the idea that the described species is an ancient endemic from Martinique.

Biogeography and ecology

Caribodillo martinicensis n. gen., n. sp. is the largest terrestrial isopod found in Martinique where it is found in the dry, semi-deciduous forests. It is particularly abundant on Morne Manioc (Coulis *et al.* 2017), its only currently known locality. Its preferred habitat seems to be crest areas where the soil is shallow and limestone rocks are abundant at ground surface level (Fig. 1D, E). For the moment, it is endemic to Martinique, but given the paucity of data on the adjacent islands (Dominica and St Lucia), its status could well change in the future. Coulis *et al.* (2017) mentions juveniles of this species being of a red color. Examination of specimens revealed that these individuals represent a distinct species, which is readily differentiated from *C. martinicensis* n. gen., n. sp. by its tuberculation, the presence of a schisma on pereonite 1, weak transverse ridges on the pereonites epimera, the smaller maximum size, as well as its red coloration. The discovery of *C. martinicensis* n. gen., n. sp. marks an important step in expanding our knowledge of the biodiversity of the lesser Antilles, as only one species of the family Armadillidae, *Cubaris depressa* (Dollfuss, 1896), was previously known from the region.

Significance and applications of UV fluorescence

The fluorescence observed in *Caribodillo* n. gen. represents only the third documented case of UV fluorescence in terrestrial isopods, alongside *Pseudolaureola atlantica* (Vandel, 1977) and *Mesoniscus graniger* (Frivaldsky, 1865) (Giurginca *et al.* 2015; Dutton & Pryce 2018), though this phenomenon is certainly underreported. In the critically endangered *Pseudolaureola atlantica*, fluorescence has been shown to aid in locating specimens during field surveys (Dutton & Pryce 2018). While the more limited extent of fluorescence in *Caribodillo* n. gen. – restricted to the pleonites rather than the entire body – may reduce its effectiveness for this purpose, it could still prove useful. As noted by Dutton & Pryce (2018), if fluorescence proves to be more widespread in terrestrial isopods, it may have applications in conservation efforts, particularly for cryptic or threatened taxa. Given the potential significance of this trait, we encourage scientists to examine specimens under UV light to assess the true extent of fluorescence in terrestrial isopods.

Opportunities and risks of the invertebrate pet trade

Caribodillo martinicensis n. gen., n. sp. is the second species of terrestrial isopod that was circulated in the pet trade before its formal description, the first being *Parakermania longa* Hong, Wang & Li, 2022 from China. The description of *Caribodillo martinicensis* n. gen., n. sp. highlights a complex aspect of the pet trade. While the pet trade has significant downsides, such as trafficking and over-collection that can severely damage wild populations and push species toward extinction, it can also present benefits. In this instance, the examination of specimens from the pet trade not only facilitated but initiated the description of *Caribodillo martinicensis* n. gen., n. sp. The availability of a large number of specimens, thanks to breeding in the pet trade, as well as clear knowledge of their origin, were factors that facilitated its description. The pet trade does not appear to pose an immediate threat to *Caribodillo martinicensis* n. gen., n. sp., as the specimens come from captive breeding rather than wild collection. Nevertheless, it is important to note the potential dangers of the pet trade, as the impact of the invertebrate trade on terrestrial isopods remains largely unexplored. While one study examined the impact of trade on the woodlice of Spain (Robla *et al.* 2024), no research has specifically investigated the trade of species from the Neotropics. Illegal trading often involves the capture of animals in their natural habitat, which can decimate local populations, disrupt ecosystems, and threaten the survival of already endangered species. *Caribena versicolor* (Walckenaer, 1837), a species of tarantula emblematic of Martinique, is a prime example. Due to its popularity in the invertebrate keeping hobby, *Caribena versicolor* has been heavily targeted by the pet trade. Specimens are frequently collected illegally in large numbers from their natural habitat, posing a significant threat to wild populations.

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