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
A new species of *Anotia* Westwood from Bonaire and Curaçao (Fulgoromorpha: Fulgoroidea: Derbidae: Otiocerini)

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Abstract

A new species in the genus *Anotia* Kirby, 1821 was collected in a malaise trap during a recent collecting event on Bonaire, Dutch Antilles. A single female of the same species, collected at light on Curaçao in 1957, was found in the collection of the Naturalis Biodiversity Center. Here *Anotia posa* **sp. nov.** is described and molecular data for the barcoding region (5' half) of the cytochrome c oxidase subunit I (COI), 18S rRNA gene and D9–D10 expansion region of the 28S rRNA gene is provided. Some records of a second undescribed *Anotia* from Curaçao are included.

Key words: Dutch Antilles, Caribbean, planthoppers, *Anotia posa*

Introduction

In an endeavour to increase the knowledge of the fauna of the Dutch Antilles, an expedition to the island of Bonaire was organised during the winter of 2022–2023 to supplement collected Auchenorrhyncha in the RMNH collection (Leiden, the Netherlands). In this collection, two species belonging to the genus *Anotia* Kirby, 1821 (Derbidae: Otiocerinae: Otiocerini) were found, both collected on Curaçao. One of these species was also found during the expedition to Bonaire and determined to be new.

The genus *Anotia* comprises 21 species, distributed through eastern, central and southern North America, Central America, Cuba and Trinidad (Bourgoin, 2024; excluding *Anotia septentrionalis* (Anufriev, 1968) from far eastern Russia). Species in this genus are delicate forms, often pale with distinctive markings on the body and wings, wings often held diverging above the body (lobe on humeral region low and rounded or absent, vs. triangular in *Sayiana* Ball, 1928), head conically angled upward, antennae lacking appendages and second segment distinctly enlarged.

Here we describe the new species of *Anotia* from Bonaire and Curaçao and publish records of a second undescribed species of *Anotia* from Curaçao.

Materials and methods

Specimen collection and deposition. Specimens were collected with the use of a Malaise trap; material was later sorted and sent to the first author. All *Anotia* specimens from the Dutch Antilles, deposited in the RMNH collection, were studied. Studied specimens are deposited in the following collections:

RMNH: Naturalis Biodiversity Center, Leiden, Netherlands;

FLREC: University of Florida—Fort Lauderdale Research and Education Center, Davie, FL, U.S.A.

Label data of studied specimens is quoted with “/” indicating a new line within a label, “//” indicating a new label, and comments in square brackets.



FIGURE 1. Type-locations of *Anotia posa* **sp. nov.** on Bonaire; inset photo = Malaise trap at Put Bronswinkel in which part of the type-series was collected.

Morphological study. Specimens of the novel taxon were studied under a Leica MZ7.5 stereomicroscope. For male terminalia, the abdomen with the genital segment was removed using tweezers. The abdomen was then heated in water at 80°C for 20 minutes, after which the pygofer was separated from the abdomen and photographed. The aedeagus and parameres were subsequently disarticulated and photographed. Terminalia were photographed with a mirrorless camera (Sony A7 III) and a 20× microscope objective (Mitutoyo M Plan APO 20x) mounted on a motorized vertical focus stacking setup (MJKZZ ultra rail set) controlled by MJKZZ Focus stacking Studio software, and lit by four LED panels (Neewer ZC - 10S). Whole specimens were photographed in the same way using a macro lens Laowa 25 mm f/2.8 2.5–5×. After examination, specimens were stored in separate Eppendorf's with 70% ethanol.

Dissections and DNA Extraction. A single leg (right side, middle leg) was removed and placed directly into a solution of tissue lysis buffer (buffer ATL) and proteinase K (180 µl ATL and 20 µl proteinase K) from the DNeasy® Blood and Tissue Kit (Qiagen). The leg was left to lyse for 24 hours at 56°C. Following lysis, the eluate was transferred to a new 1.5 ml microcentrifuge tube and DNA extraction proceeded as per the manufacturer's instructions.

PCR Parameters, Sequence Data, and Analysis. To obtain COI, 18S and 28S sequence data, previously published primers were used in all PCR reactions (Table 1). PCR reactions contained 5× GoTaq Flexi Buffer, 25 mM MgCl₂, 10 mM dNTP's, 10 mM of each primer, 10% PVP-40, and 2.5U GoTaq Flexi DNA Polymerase, 2 µl DNA template, and sterile dH₂O to a final volume of 25 µL. Thermal cycling conditions for all loci involved were as follows: 2 min initial denaturation at 95°C, followed by 35 cycles of 30-sec denaturations at 95°C, 30-sec annealing, and extension at 72°C. Specific annealing temperatures and extension times for respective loci are presented in Table 1. Products were visualized on a 1.5% agarose gel stained with GelRed (Biotium). PCR products of the appropriate size were purified using the ExoSAP-IT™ Express PCR Product Cleanup Reagent per the manufacturer's protocol.

(ThermoFisher Scientific, Waltham, Massachusetts, USA). The purified PCR product was quantified using a NanoDrop Lite Spectrophotometer (ThermoFisher Scientific, Waltham, Massachusetts, USA) and sequenced using the SeqStudio Genetic Analyzer (Applied Biosystems). Contiguous files were assembled using DNA Baser (Version 4.36) (Heracle BioSoft SRL, Pitesti, Romania), and aligned using ClustalW as part of the package MEGA7 (Kumar *et al.* 2016). Maximum Likelihood trees were generated using the Bootstrap method at 1,000 replicates based on the Tamura-Nei model for both the COI, 18S, and 28S loci as well as the consensus tree with concatenated data for COI, 18S and 28S data.

TABLE 1. Primers used to amplify corresponding gene regions that were used to assess the placement of novel taxon and PCR parameters for each locus.

| Locus | Primer | Direction | Sequence (5' → 3') | Annealing | Extension | Reference |
|-------|---------|-----------|--------------------------|-----------|----------------|---------------------------|
| COI | LCO1490 | Forward | GGTCAACAAATCATAAAGATATTG | 40°C | 1 min. 30 sec. | Folmer <i>et al.</i> 1994 |
| | HCO2198 | Reverse | TCAGGGTGACCAAAAAAATCA | | | |
| 18S | 18SF | Forward | ACTGTCGATGGTAGGTTCTG | 50°C | 2 min. | Bahder <i>et al.</i> 2019 |
| | 18SR | Reverse | GTCCGAAGACCTCACTAAA | | | |
| 28S | V | Forward | GTAGCCAAATGCCTCGTCA | 55°C | 1 min. 30 sec. | Cryan <i>et al.</i> 2000 |
| | X | Reverse | CACAATGATAGGAAGAGCC | | | |

Taxon sampling. In-group taxa (*Anotia* spp.) and out-group taxa (non-*Anotia* otiocerines, including Otiocerini, Patarini and Sikaianini) were used to generate the molecular phylogeny (Table 2). *Omolicna joi* Wilson, Halbert & Bextrine, 2014 (Derbinae, Cenchreini) was included to help root the tree. Authorities of included taxa are provided in Table 2 and are not repeated in the Results or Discussion.

Terminology. Morphological terms in general follow Bartlett *et al.* (2014), nomenclature of male genitalia follows Bourgoin (1988) and Bourgoin & Huang (1990). Forewing venation follows Bourgoin *et al.* (2015).

TABLE 2. Molecular taxon sampling and GenBank accession numbers.

| Species | Locus | | |
|---|----------|----------|----------|
| | COI | 18S | 28S |
| <i>Anotia cerebro</i> Bahder & Bartlett | OR418164 | OR419691 | OR050637 |
| <i>Anotia firebugia</i> Bahder & Bartlett | MT084365 | MT945942 | ORO50636 |
| <i>Anotia posa</i> sp. nov. | PQ279977 | PQ282499 | PQ282300 |
| <i>Cobacella palmensis</i> Bahder & Bartlett | ORO44883 | ORO41765 | ORO50628 |
| <i>Mula resonans</i> Ball | OQ473376 | OQ519977 | ORO50635 |
| <i>Omolicna joi</i> Wilson, Halbert & Bextine | KF472312 | MN472753 | PP379272 |
| <i>Patara euryfrons</i> Bahder & Bartlett | PP379474 | PP379270 | PP379271 |
| <i>Patara cooki</i> Bahder & Bartlett | MW332651 | MW333024 | ORO50634 |
| <i>Patara vanduzei</i> Ball | OQ473377 | OQ519977 | ORO50633 |
| <i>Sayiana sayi</i> (Ball) | ORO44884 | ORO41766 | ORO50632 |
| <i>Shellenius ballii</i> (McAtee) | OQ473378 | OQ519976 | ORO50631 |
| <i>Shellenius schellenbergii</i> (Kirby) | OQ473379 | OQ519975 | ORO50630 |
| <i>Shellenius serratus</i> Bahder & Bartlett | OQ473380 | OQ519974 | ORO50629 |
| <i>Sikaiana harti</i> (Metcalf) | OR418165 | OR419690 | OR419689 |

Systematics

Family Derbidae Spinola, 1839

Subfamily Otiocerinae Muir, 1917

Tribe Otiocerini Muir, 1917

Genus *Anotia* Kirby, 1821

= *Amalopota* Van Duzee, 1889 (type species *Amalopota uhleri* Van Duzee 1889 by monotypy); syn. by implication Fennah (1952: 152).

Type species: *Anotia bonnetii* Kirby, 1821

Diagnosis. A diagnosis of *Anotia* is given by Bahder *et al.* (2023). The genus can be identified using the key to New World Otiocerini genera by Bartlett & Hoch (2023). The most similar genus to *Anotia* is *Sayiana* Ball which is most easily differentiated by the latter genus possessing a large triangular lobe on the humeral margin of the forewing (e.g., Bartlett *et al.* 2014, fig. 64J), which is small and rounded (or absent) in *Anotia* (e.g., Fig. 4).

Anotia posa sp. nov.

(Figs 2–7)

Material examined. Types. Holotype: “Dutch Caribbean, Bonaire / Washington Slagbaai NP / Put Bronswinkel / 12.280, -68.398, 28.XI–5.XII.2022 / Malaisetrapp / Leg. J. van der Beek & J. Devalez // Holotype / *Anotia posa* sp. nov. ♂.” In coll. RMNH.

Paratypes: “Dutch Caribbean, Bonaire / Washington Slagbaai NP / Put Bronswinkel / 12.280, -68.398, 21–28.XI.2022 / Malaisetrapp / Leg. R. Kleukers *et al.* // Paratype / *Anotia posa* sp. nov.” 2♂ in coll. RMNH; “Dutch Caribbean, Bonaire / Washington Slagbaai NP / Put Bronswinkel / 12.280, -68.398, 28.XI–5.XII.2022 / Malaisetrapp / Leg. J. van der Beek & J. Devalez // Paratype / *Anotia posa* sp. nov.” 1♂ in coll. RMNH; “Dutch Caribbean, Bonaire / Washington Slagbaai NP / Put Bronswinkel / 12.280, -68.398, 5–12.XII.2022 / Malaisetrapp / Leg. J. van der Beek & J. Devalez // Paratype / *Anotia posa* sp. nov.” 2♂ in coll. FLREC; “Dutch Caribbean, Bonaire / Washington Slagbaai NP / Pos Mangel / 12.295, -68.392, 7–13.I.2023 / Malaisetrapp / Leg. J.-J. Mekkes & M. Boeken // Paratype / *Anotia posa* sp. nov.” 2♂ in coll. RMNH.

Additional material: “CURAÇAO N.A. [Netherlands Antilles] / lampvangst [on light] / 1957 / leg. R.H. Cobben // RMNH Leiden / ex collectie / WAU, 2010 // *Anotia posa* ♀”. In coll. RMNH.

Diagnosis. Medium-sized, light-coloured species with three red stripes on lateral side of head. Forewings with extensive brown and red coloration, leaving two larger areas translucent. Pygofer in lateral view with a dorsocaudal rounded lobe and ventral view with a rounded, medioventral process. Gonostyli in lateral view (just past midlength) bearing a short, laterally hooked tooth and larger obliquely oriented, rounded lobe. Aedeagus simple, shaft upcurved, endosoma simple, bilobed and sinistrally arched. Anal tube in dorsal view with two short apical protrusions, in lateral view with ventral margin nearly straight, dorsal margin elevated.

Description. *Measurements* (n=6) ♂ length body + wings: 4.85–5.45 (average 5.17) mm; length body: 2.75–3.30 (average 3.08) mm; length forewing: 4.20–4.55 (average 4.36) mm.

Colouration. Base colour of body pale to brownish yellow (Fig. 2). Head white, in lateral view (Fig. 3B) with three slender red stripes from compound eye to margin of head; one from anterodorsal part of eye to anterodorsal margin of head and two stripes from anteroventral part of eye to anteroventral margin of head. Last segment of rostrum black contrasting with white proximal segments. Antennae with scape and pedicel brown (along with adjacent genae (Fig. 3A), pedicel medially suffused with reddish tinge (especially near sensory plaques); dorsal margin of frontoclypeal suture brown-shaded; clypeus white, washed with brown along ventral margin. Pronotum whitish (Fig. 3C), medially white, laterally with two reddish horizontal stripes, in lateral view with a small red spot behind compound eye. Mesonotum brownish yellow, medially lighter (in living specimens probably concolourous), carinae slightly lighter, apex nearly white. Legs yellowish white, forefemora with irregularly distributed red spots.

Forewings translucent, with extensive brown patterning, and red colouration along veins in stigma and apical regions, (Fig. 4A); veins washed with red, especially along ScP, RP and MP, otherwise white. Hindwings with apex broadly brown. Abdominal tergites pinkish with red spots, sternites light brown.



FIGURE 2. Habitus of *Anotia posa* **sp. nov.**, male holotype, A) dorsal view, B) lateral view.

Structure. Head (incl. eyes) 0.68 times the width of the pronotum. Vertex in dorsal view (Fig. 3C) narrowly triangular, 2 times as long as basal width, projecting in front of eye for about half of its length, medially deeply depressed (median carina absent), lateral margins postulate; anterior margin of vertex with small, rounded, concavity, posterior margin broadly rounded concave; in lateral view (Fig. 3B), head distinctly projected upward (bluntly conical in shape) above and in front of compound eye, with greatest length anterodorsad from eye, anterior margin of head convex, more strongly rounded ventrad forming an inflection at frontoclypeal suture (forming an angular inflection between plane of frons and clypeus); in frontal view (Fig. 3A) vertex distinctly raised above eyes. Frons strongly compressed, lateral margins in contact for entire length. Antennae with scape short and ringlike, pedicle in full-view broad, flattened and elongate, dorsal margin straight, ventral margin slightly rounded, apex dorsally emarginated; flagellum setaceous with bulbous base. Eye in lateral view round with small ventral emargination at antennae, ocelli absent. Rostrum barely attaining hind-coxae, with apical segment short.



FIGURE 3. Head of *Anotia posa* **sp. nov.**, male holotype, A) frontal view, B) left lateral view, C) dorsal view.

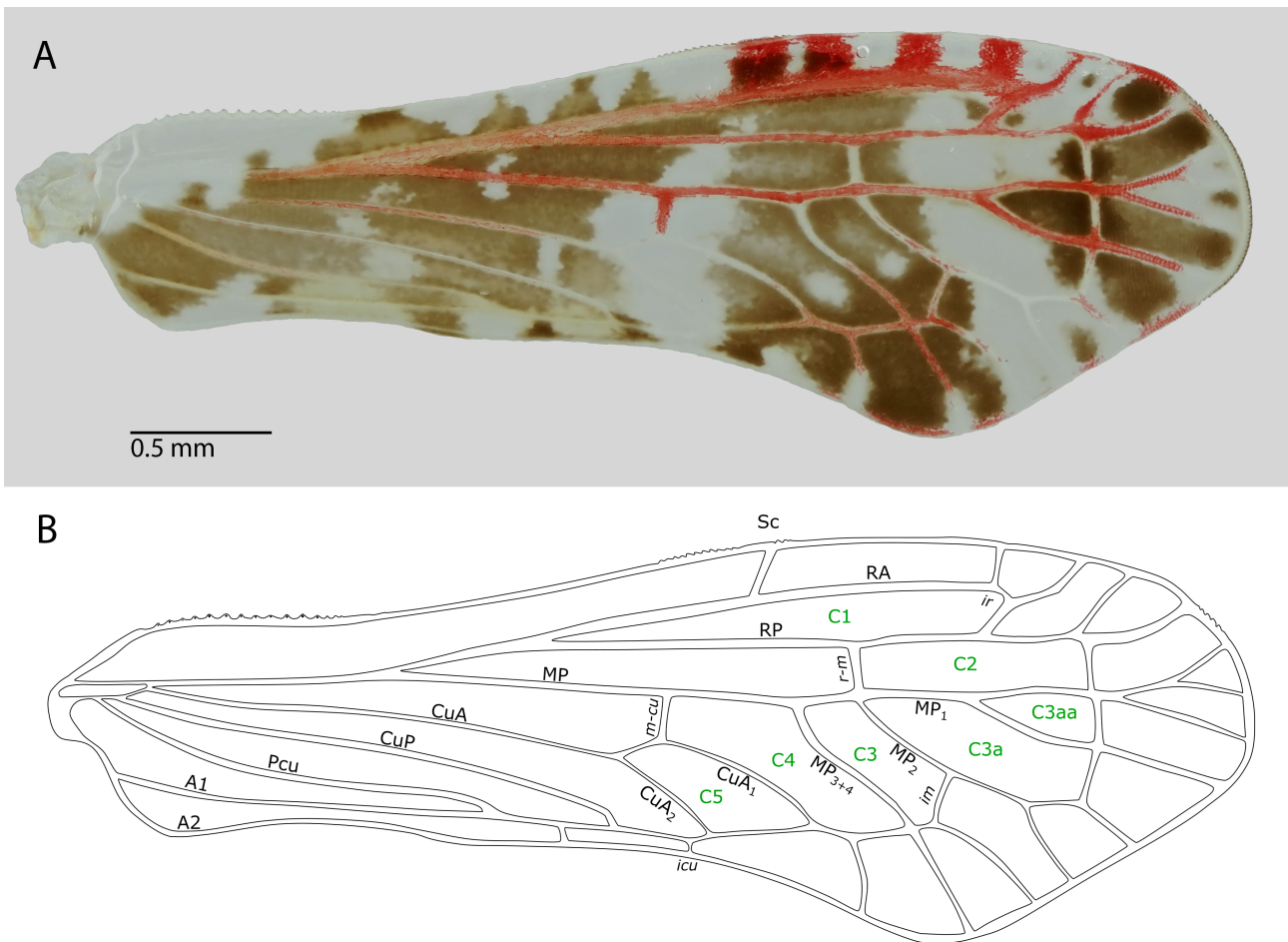


FIGURE 4. Forewing of *Anotia posa* **sp. nov.**, paratype, A) right forewing, B) line-drawing and interpretation of venation of forewing (veins in black text, crossveins in italics, cells in green text).

Pronotum in dorsal view (Fig. 3C) narrow and inversely V-shaped, slightly wider laterally, median carina present, lateral carinae serpentine, directed obliquely on disc; in lateral view (Fig. 3B) with carina between eye and tegulae (forming lateral margin of pronotum from dorsal view); paradiscal region reaching antennae. Mesonotum $1.04\times$ longer than broad (Fig. 3C), much exceeding (about $1.8\times$) combined length of vertex and pronotum at midline, weakly tricarinate, median carina reaching apex, lateral carinae parallel, fading before reaching caudal margin; in lateral view (Fig. 3B), mesonotum convexly raised with a subapical depression at proximal margin of scutellum. Spinulation of hind leg: 5-5-4 (hind tibiae lacking lateral spines).

Forewing spatulate (Fig. 4) with low elongate humeral lobe bearing marginal pustules, remaining costal margin straight, apex broadly rounded and hind margin widely triangular, wing broadest at level of cell C4'; composite vein Pcu_A1 reaching CuP before margin (i.e., clavus open); v MP basally fused with ScP+R forming elongate composite stem from basal cell; CuA anastomosing to form relatively large closed C5 cell (i.e., procubital cell of Emeljanov 1996). Branching pattern: RA 1-branched, RP 3-branched, MP 8-branched, CuA 2-branched.

Male terminalia. Pygofer in lateral view narrow (Fig. 5A), irregular in shape, narrow medially and at dorsal margin, widest ventrally; anterior margin concave, dorsocaudal margin bearing prominent rounded lobe; in ventral view (Fig. 5B) medioventral lobe rounded, just wider (at base) than tall. Gonostyli in lateral view (Fig. 6A) elongated and relatively slender, weakly upcurved, with ventral margin convex (slightly sinuate), dorsal margin bearing several projections, a small basal denticle, a laterally hooked projection near midlength near a more distal largobliquely oriented lobe, apex narrowing to a dorsally directed point; in ventral view (Fig. 6C) with lateral margins sinuate, weakly broadening toward blunt broad apex (apical margin slightly concave); inner ventral margin with a rectangulate plate (visible in ventral or dorsal view; Figs 5C, D), apical inner corner of plate with a short, medially directed, spinose process. Aedeagus (Figs 7A, B) simple, shaft upcurved and tubular, lacking processes except bearing a small subapical dentate flange on right lateral margin; endosoma simple, extending subapically (slightly laterad to right side), relatively simple, broadly bilobed distally and sinistrally arched bearing hooked and pointed apex. Anal tube (Figs 5A, C) attached dorsally near anterior margin of pygofer (thus covering the dorsal pygofer); in lateral view (Fig. 5A) broad and raised baso-medially, dorsal margin upsloped to highest point just before centre, then downsloped to apex; ventral margin nearly straight, apex narrow, acuminate, caudally directed; in dorsal view (Fig. 5C), sub-rectangular, lateral margins slightly converging; apex with lateral corners bearing blunt, short protrusions. Epiproct short, in dorsal view rectangular with apical margin straight, paraproct longer, conical.

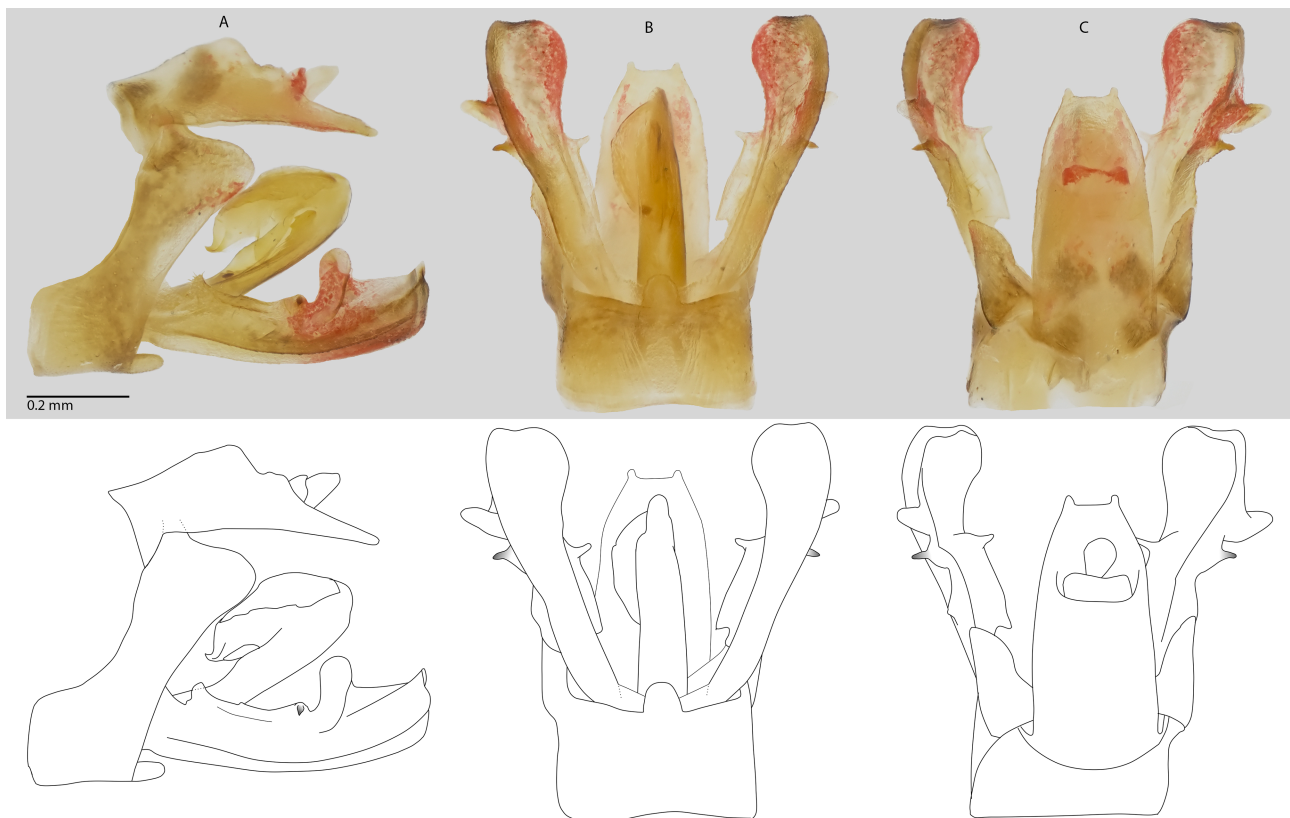


FIGURE 5. Male terminalia of *Anotia posa* **sp. nov.**, A) left lateral view, B) ventral view, C) dorsal view.

Remarks. A single, decapitated, female specimen of the novel taxon from Curaçao is not included in the type-series, due to the poor state of the specimen. The wing pattern completely agrees with specimens from Bonaire and the specimen undoubtedly belongs to this species.

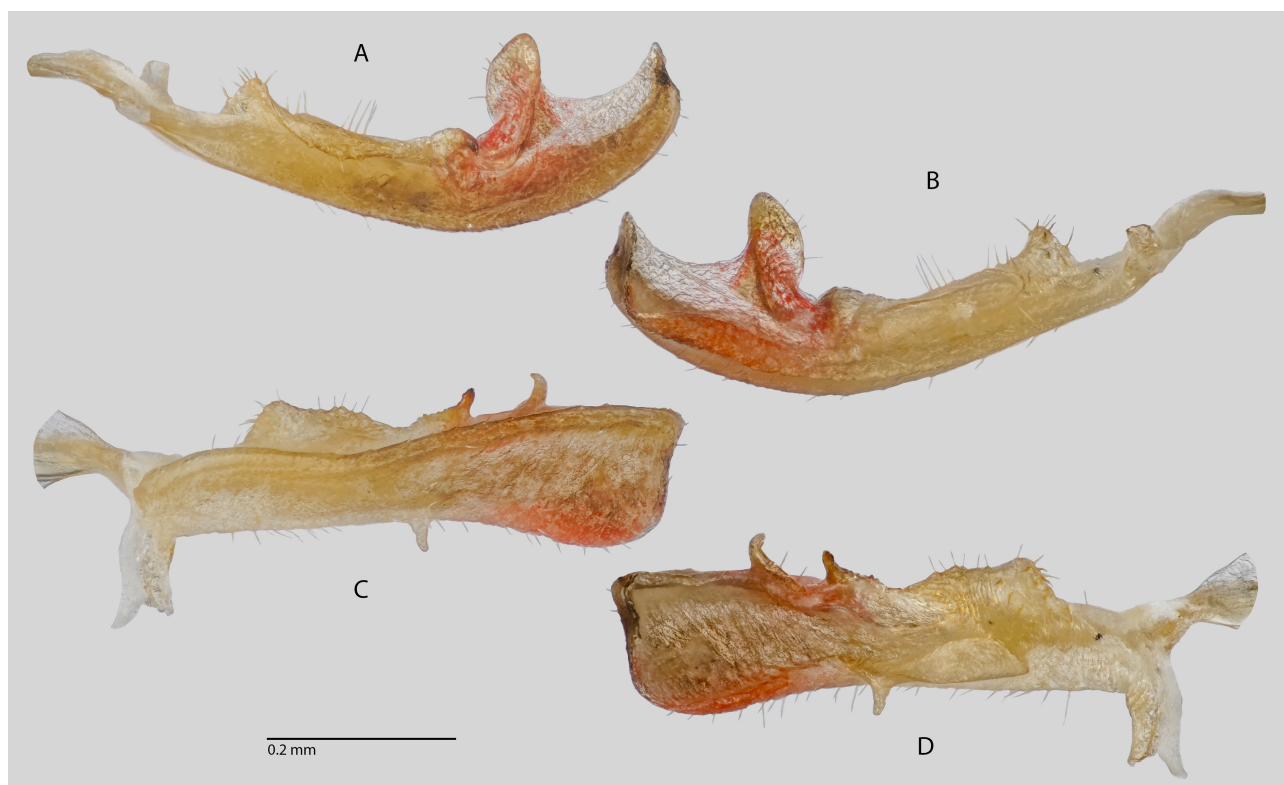


FIGURE 6. Left gonostylus of *Anotia posa* **sp. nov.**, A) left (outer face) lateral view, B) right (inner face) lateral view, C) ventral view, D) dorsal view.

A specimen that fits in external characters with *Anotia posa* **sp. nov.** was photographed on the Island of Mustique in the Grenadines by Mark de Silva. It very likely belongs to the same species, indicating that this species is probably much more widely distributed in the Caribbean.

Anotia posa **sp. nov.** appears superficially most similar to *A. sanguinea* Fennah and *A. fitchi trinitatis* Fennah, both from Trinidad (Fennah 1952). Fennah (1952) illustrates the forewing and male terminalia of both species. If the forewing pattern is rendered accurately, *A. posa* **sp. nov.** differs in details from both species; however, there are some clear differences in male terminalia. In particular *A. posa* **sp. nov.** bears a rounded lobe on the dorsocaudal margin of the pygofer, whereas in *A. sanguinea* a similar lobe is triangular and pointed, and in *A. fitchi trinitatis* it is pointed and located closer to the midpoint of the lateral margin. For both *A. fitchi trinitatis* and *A. sanguinea* the anal tube differs in shape from lateral view from *A. posa* **sp. nov.** (in *A. fitchi trinitatis* it is more elongated and distally downcurved, in *A. sanguinea* the ventral margin is dentate rather than linear).

Anotia fitchi trinitatis is a subspecies of *A. fitchi* (Van Duzee) from the eastern United States (doubtfully reported from Mexico, iNaturalist observation 98861818, and Honduras, 86006338), but based on our review of the male terminalia of specimens from the United States, it is unlikely to be conspecific.

Distribution. Bonaire (Fig. 1), Curaçao. Possibly on Mustique (Grenadines).

Biology. All specimens have been collected with traps and no plant associations are available. All type specimens have been collected in relatively green, moist areas of the Washington Slagbaai National Park on Bonaire.

Etymology. The specific epithet ‘posa’ refers to the Papiamentu word ‘pos’, which translates to ‘well’. The type-series of the novel taxon have been collected around two wells (pos), highlighting the importance of the scarce fresh surface water for the fauna on these dry islands. The moister environments of these wells are probably important for the growth of fungi on which the nymphs of Derbidae feed.

Sequence data. For the COI gene, a 569 bp product was generated for the barcoding region (5’ half), for the 18S rRNA gene, a 1,326 bp product was generated, and a 776 bp product was generated for the D9–D10 expansion region of the 28S rRNA gene. GenBank accession numbers are presented in Table 2.

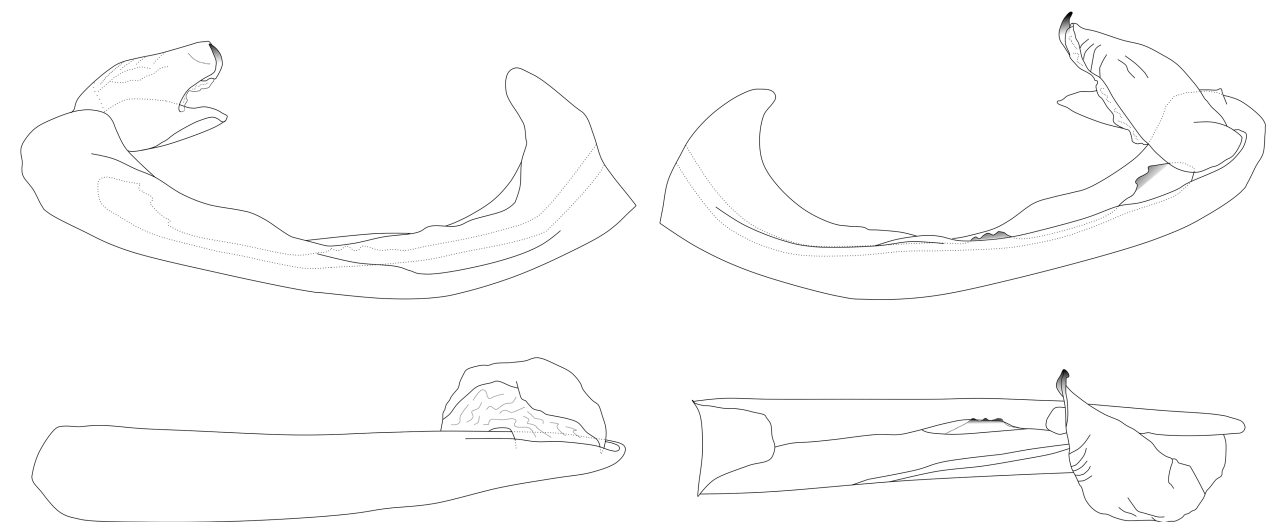
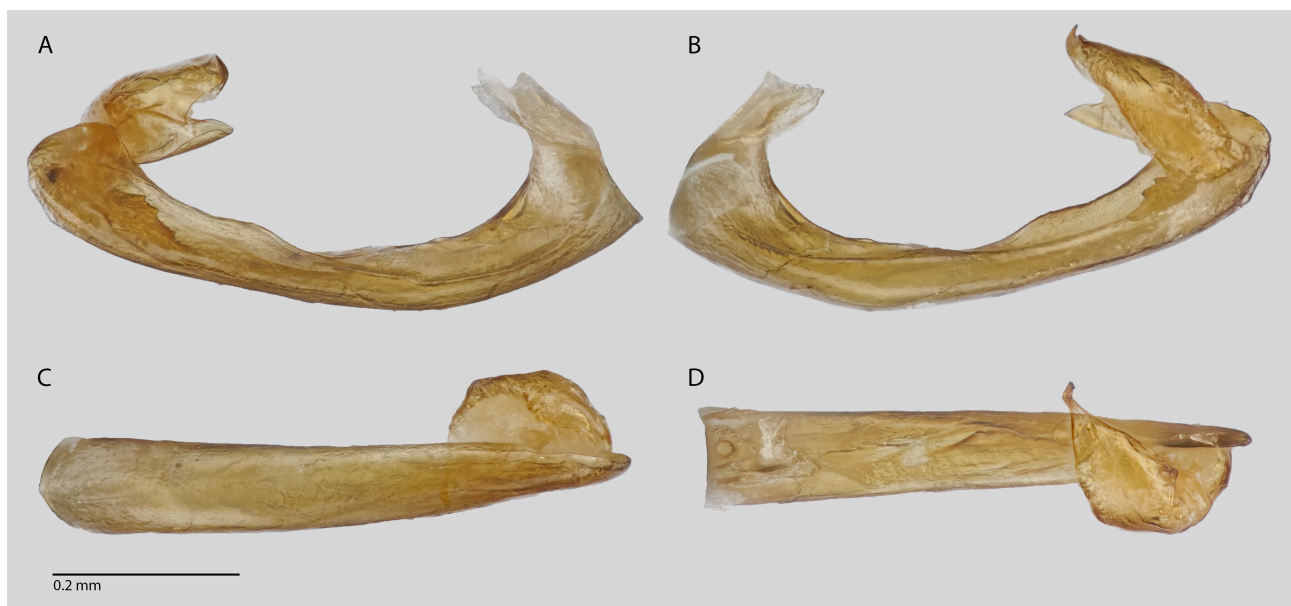


FIGURE 7. Aedeagus of *Anotia posa* sp. nov., A) right lateral view, B) left lateral view, C) ventral view, D) dorsal view.

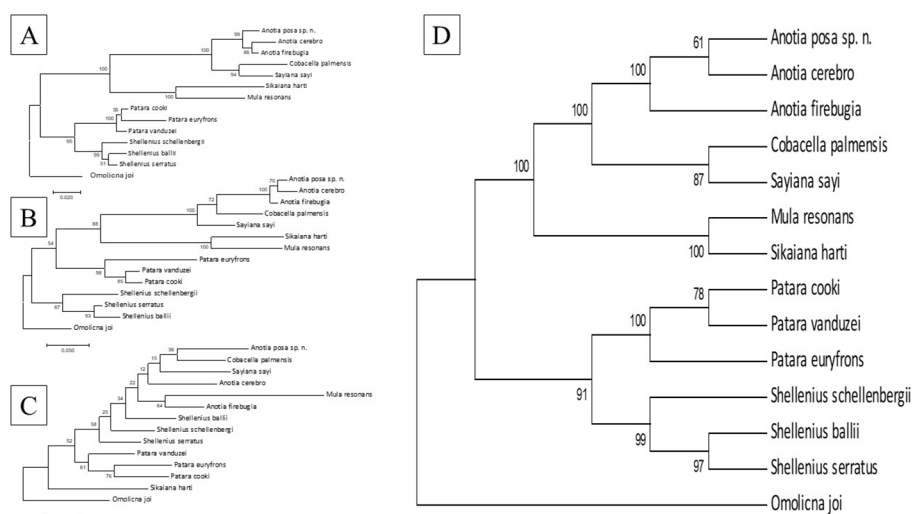


FIGURE 8. Maximum likelihood trees (1,000 replicates) exhibiting the relationship of *Anotia posa* sp. nov. to available *Anotia* (in-group) and other otiocerines (out-group taxa); (A) 18S rRNA gene, (B) 28S D9–D10 expansion region, (C) 5' half for the COI gene and (D) consensus tree based on concatenated 18S, 28S and COI data; scale bar = percent nucleotide difference.

The molecular phylogenies generated for both 18S and 28S demonstrated strong bootstrap support (99 and 100 respectively) for the monophyly of *Anotia* based on available taxa (Fig. 8). For both loci, *Anotia posa* **sp. nov.** Resolved within the genus *Anotia*, adjacent to both *A. cerebro* and *A. firebugia* based on 18S and adjacent to *A. cerebro* based on 28S (Fig. 8). All branches based on COI demonstrated weak bootstrap support (<80) (Fig. 8). The consensus tree based on concatenated data for all three loci also demonstrated strong bootstrap support (100) for the monophyly of *Anotia* with *A. posa* **sp. nov.** resolving within the clade (Fig. 8).



FIGURE 9. *Anotia* sp. from Curaçao, A) female, dorsal view, B) female, lateral view of head, C) male, lateral view of terminalia.

Additional studied specimens

Anotia sp.
(Fig. 9)

Material examined. “leg. R.H. Cobben / hofje groot Piscadera / 5-11-1956 / Curaçao // RMNH Leiden / ex collectie

/ WAU, 2010 // *Anotia* sp. ♀ / Fitch, 1856 / det. M.C. de Haas, 2024” in coll. RMNH; “Rio Camario / golf terrein [golf course] / 17-11-56 [17-11-1956] / leg. R.H. Cobben 1956 // RMNH Leiden / ex collectie / WAU, 2010 // *Anotia* sp. ♂ / Fitch, 1856 / det. M.C. de Haas, 2024” in coll. RMNH.

Remarks. In the RMNH collection, a male and female specimen of an *Anotia* species are present, both collected on Curaçao. Study of male terminalia indicate that it is an undescribed species. Due to the poor quality and low number of specimens, we feel that these specimens are inadequate to describe this species at this time.

Discussion

Despite their attractive appearance, much about *Anotia* species is still unknown. The genus is reported in the literature mainly from the eastern United States, Central America, and Trinidad (Fowler 1904, Metcalf 1945, Fennah 1952, Bartlett *et al.* 2014, Bourgoïn 2024) plus reported in Cuba (Osborn 1926), and now also on Bonaire and Curaçao. Based on iNaturalist observations, there are many putatively undescribed species of *Anotia* (or allied) in Central and South America (south to northern Argentina, observation 224787324 and southeastern Brazil (e.g., observation 107569287). From the Caribbean islands, few records are available, with only one *Anotia* recorded on iNaturalist (#98727148) from Jamaica. The described species of *Anotia*, particularly those recorded by Fowler (1904), need to be reviewed including diagnoses of male terminalia, so that undescribed species can be more readily recognized and treated.

The presence of two *Anotia* species on the Dutch Antilles which have not previously been recorded from these islands and are both undescribed show that our knowledge of the Auchenorrhyncha of the Dutch Antilles is insufficiently known. Additional study on the available collections from the Dutch Antilles and collecting efforts on these islands could reveal a higher diversity and provide more material of the herein published ‘*Anotia* sp.’.

Acknowledgements

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