A new subspecies of *Ovalona setulosa* (Megard, 1967) (Cladocera: Anomopoda: Chydoridae) from the Caribbean coast of Colombia

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**Abstract**

A new subspecies of *Ovalona setulosa* (Megard, 1967) (Cladocera: Anomopoda: Chydoridae) is described based on material from Laguna Navío Quebrado (La Guajira Department), Colombia. *Ovalona setulosa arangureni* ssp. nov. differs from the nominative subspecies in: (1) major head pores position on head shield; (2) posterior margin of labral keel without clusters of short setules; (3) more elongated postabdomen, with length/height ratio about 2.7-3; (4) male postabdomen with straight dorsal margin in whole distal portion. In outer morphology and morphology of postabdomen, *O. setulosa* arangureni ssp. nov. can be confused with *O. glabra* (Sars, 1901), but, like nominative subspecies, differs from it by interrupted connection between major head pores. Our data suggest that diversity of Aloninae species with limited distribution areas in South America is underestimated yet, and areas north and south of Amazon basin can have different local species.

**Key words:** Cladocera, Anomopoda, taxonomy, new subspecies, South America

**Introduction**

Species historically assembled into the genus *Alona* Baird, 1843 form the largest and most diverse assemblage within the family Chydoridae; it comprises over 80 valid species worldwide which represent about 17 % of the total species number in Cladocera (Van Damme *et al.* 2010). *Alona s. lato* is an artificial assemblage, according to Van Damme & Dumont (2008a), being *Alona s. str.*, a small group, formed by the type species of the genus *Alona quadrangularis* (O.F. Mueller, 1775) and its siblings. *Alona s. lato* is composed of several species-groups of generic status. Some of these groups already attained generic status, for example *rectangula*-group was placed into the genus *Coronatella* Dybowski & Grochowski, 1894 (Van Damme & Dumont 2008b), *verrucosa*-group—into the genus *Anthalona* Van Damme, Sinev & Dumont, 2011 (Van Damme *et al.*, 2011b), *pulchella*-group—into genus *Ovalona* Van Damme & Dumont 2008 (Sinev 2015). Several more species-groups—*affinis*, *costata*, *guttata* and *elegans* are not yet formally recognized as genera and await revision.

Twenty species of *Alona s. lato* had been reported to Neotropic (Kotov *et al.* 2013), but diversity of the group in the region is probably much higher. For example, recent studies of *Alona s. lato* from Central Mexican Plateau revealed two new species of the group (Sinev & Silva-Briano 2012), and revision of *Coronatella* from Brazil revealed three new species (Sousa *et al.* 2015b).

In Colombia, the knowledge of *Alona s. lato* still remains inadequate. Stingelin (1913) reported four species and one variety from Colombia Mountains: *A. pulchella* King, 1853, *A. affinis* (Leydig, 1860), *A. costata* Sars, 1862, *A. guttata* Sars, 1862, and *A. cuttata* var. *tuberculata*. According to modern data, *A. affinis* and *A. pulchella* (now a member of *Ovalona*) are not present in America (Sinev, 1998, 2001a, 2015), being substituted here by the sibling-species *Alona ossiani* Sinev, 1998 and *Ovalona glabra* (Sars, 1901), respectively, and Stingelin's (1913) report probably refers to these species. *Alona costata* is a Holarctic species, and it is not present in Neotropics as
well. Three other species of costata-group, A. iheringula Kotov & Sinev, 2004 (= A. iheringi Sars, 1901), A. hudeci Sinev, 1999 (= Alona rusticoides Hudec, 1990), and A. margipluma Sousa, Santos, Güntzel, de Melo Junior & Elmoor-Loureiro, 2015 are present in South America (Sinev, 1999, 2001b, Kotov & Sinev, 2004, Sousa et al., 2015c), but it is impossible to attribute Stingelin (1913) report of A. costata to any of these taxa. A. guttata s. str. is considered a Palaearctic species, but recent studies species revealed no differences in morphology of parthenogenetic female between European and Mexican populations of the species (Sinev & Silva-Briano, 2012). According to modern data, tuberculated varieties of Alona s. lato, including A. guttata var. tuberculata, cannot be treated as a separate subspecies, once sculpture of valves is subjected to intrapopulation variability (Van Damme et al., 2010).

Investigations of Colombian Alona s. lato were continued only recently. Fuentes-Reinés et al. (2012) confirmed the presence of O. glabra and found one more species, Alona dentifera, 1901 in material from Ciénaga Grande de Santa Marta, Magdalena Department (the taxonomic status of this species is unclear, Chatterjee et al. (2013) place it within the genus Coronatella). Fuentes-Reinés (2014) recorded O. glabra from La Guajira Department, however a detailed re-examination of this material led us to conclude that it belongs to a new taxon rather than O. glabra. The aim of this paper is to describe this new form and define its taxonomic status.

Material and methods

Plankton samples were taken from Laguna Navío Quebrado monthly between April and December 2012, mainly in the macrophyte zone, but also in the open water using a bucket of 25 L at both vegetation areas and shallow open water. All samples were filtered through a zooplankton net (45 µm) and preserved in 70% ethanol. In the laboratory, specimens were selected from samples under a binocular stereoscopic microscope, and studied under a compound optical microscope in a drop of a glycerol-formaldehyde mixture in toto. Images were taken using a Kodak Easy Share C140 digital camera attached to a compound Olympus CX22 microscope. The specimens were measured in lateral position, from the anterior end of the rostrum to the posterior margin of the valve. The specimens examined were deposited at the Museo de Colecciones Biológicas at the Universidad del Atlántico (UARC), Colombia.

Results

Order Anomopoda Sars, 1865

Family Chydoridae Dybowski & Grochowski, 1894 emend. Frey, 1967

Subfamily Aloninae Dybowski & Grochowski, 1894 emend. Kotov, 2000

Tribe Alonini Dybowski & Grochowski, 1894 emend. Kotov, 2000


Alona setulosa arangureni ssp. nov.
(Figs. 1–4)

Etymology. The new subspecies is named after the Colombian researcher Dr. Nelson Aranguren, for his extensive work on the zooplankton from aquatic systems of Colombia and for his legacy and leadership of new generations of planktologists.

Type locality. Laguna Navío Quebrado, La Guajira Department, Colombia (11°25’N and 73°5’W). From this locality, 30 parthenogenetic females, 3 ephippial females, and 20 adult males were collected in June and October of 2012 by J. M. Fuentes-Reinés.

Type material. Holotype: parthenogenetic female deposited at the Museo de Colecciones Biológicas de la Universidad del Atlántico, Colombia, UARC246M.
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FIGURE 1. Alona setulosa arangureni ssp. nov. from Laguna Navio Quebrado, Colombia (type locality). A–J, parthenogenetic female: A, lateral view; B, head shield; C, head pores; D, variants of main head pores morphology; E, labrum; F, postabdomen; G, postanal margin of postabdomen; H, postabdominal claw; I, inner distal lobe (IDL) of limb I; J, inner portion of limb IV. K–L, adult male: K, outline of the body; L, postabdomen.

Allotype: adult male from type locality, UARC247M.
Paratypes: 5 undissected females in alcohol, UARC248M; 1 dissected female, UARC243M-257M, 3 undissected ephippial females in alcohol, UARC249M; 3 adult males, UARC250M; 1 dissected male, UARC251M-252M.

Description. Parthenogenetic female. In lateral view, body ovoid (Fig. 1A, 2A), maximum height in middle, height/length about 0.66–0.76 in adults. Dorsal margin of valves generally uniformly curved, postero-dorsal angle smoothed, postero-ventral angle broadly rounded. Ventral margin of valves with 40–45 setae of different size in different regions of the margin. Posteroventral angle of valves with about 100 short setules of similar length, not differentiated into groups. Valves oblique, without any sculpture.

Head small, not keeled, rostrum short and blunt. Compound eye and ocellus subequal in size, distance from tip of rostrum to ocellus somewhat larger than between ocellus and eye.

Head shield elongated, length/width ratio about 1.5–1.6, rostrum short, broadly rounded, posterior portion widely rounded, with wavy margin (Fig. 1B, 2B). Three major head pores of equal size, with interrupted connection between them (Fig. 1C–D), distance from posterior pore to posterior margin of head shield (PP) about
0.4–0.5 distance between anterior and posterior pores (IP). Lateral head pores minute, located about 1.1–1.5 IP from midline, at the level of anterior major head pore.


*Labrum* (Fig. 1E, 2C): distal labral plate without setulation. Labral keel moderately wide, with height about 1.3 widths. Anterior margin convex, apex rounded or blunt, posterior margin convex, without clusters of short setules.

*Postabdomen* (Fig. 1F, 2D) with almost parallel margins, moderately wide, length/width ratio about 2.5–2.6. Ventral margin straight or weakly convex. Dorsal margin convex in preanal part, concave in anal part, straight in postanal part. Distal margin almost straight; dorso-distal angle weakly prominent, almost right, with rounded tip.
Preanal angle well-expressed, postanal angle weakly defined. Distal portion 1.5 times longer than preanal margin; anal and postanal portions subequal in length. Postanal margin provided with 7–8 marginal denticles; anal margin with 4–5 clusters of setulae (Fig. 1G). Each postanal denticle with 1–3 short spines near the base. Length of postanal denticles evenly decreases basally; length of distalmost denticle slightly less than width of postabdominal claw base. Postanal portion with 5–6 wide, closely spaced lateral fascicles of long setulae; distalmost setule in each fascicle being the longest and thickest, 1.5 times longer than neighboring marginal denticles. Postabdominal claw (Fig. 1H) regularly curved, somewhat longer than preanal portion of postabdomen, with fine setulation along ventral margin. Basal spine length about 0.33 of claw length.

Antennule (Fig. 2E) with four clusters of setules on inner face. Antennular sensory seta slender, arising at 2/3 distance from the base. Nine aesthetascs, the longest of them about 0.8 length of antennule. All aesthetascs projecting beyond anterior margin of the head shield.

Antenna of moderate size (Fig. 2F). Antennal formula: setae 0-0-3/1-1-3; spines 1-0-1/0-0-1. In both branches, length of segments decreasing distally. Seta arising from basal segment of endopodite thin, reaching to the end of endopodite. Seta arising from middle segment of endopodite of same size with apical setae. Basal and middle segments of endopodite with clusters of hard setules. Apical setae of both branches of similar thickness. Spine on basal segment of exopodite shorter than middle segment. Apical spines longer than apical segments. Mandible elongated; distal portion with sharp denticles (Fig. 3A)

Thoracic limbs: five pairs.

Limb I (Fig. 1I, 4A–D). Epipodite oval. ODL seta longer than IDL setae. IDL with three setae; seta 1 short; setae 2–3 long, of similar length, armed with thin setulae in distal portion. Endite 3 with four setae subequal in length. Endite 2 with three setae of different length, middle one (e) longer than ODL seta. Endite 1 with two 2-segmented setae (g–h), both setulated in distal part, without a flat plumose seta shifted to the limb base. Fascicles of thin setulae on inner face of limb, plus bunches of longer and more robust setulae at ventral margin of limb. Two unequal ejector hooks.

Limb II (Fig. 3E) exopodite narrow elongated lobe with slender seta of half length of exopodite. Inner portion of limb (“endopodite”) with eight scraping spines; scrapers 1–4 long, increasing progressively in length distally; scraper 5 longer than 4; scrapers 6–8 short, subequal in length. Distal armature of gnathobase with four elements. Filter plate II with seven setae, the posteriormost member considerably shorter than others.

Limb III (Fig. 3F). Epipodite oval, without projection. Exopodite with seven setae, seta 3 being longest (Fig. 6D). Distal endite with 3 setae (Fig. 6E); distalmost and middle setae of same size, slender and sharp, with denticles in distal part; basalmost seta short, geniculated, with thin setulae. Basal endite with 4 stiff, feathered in distal part setae, increasing in size in basal direction. Gnathobase filter plate of 7 setae.

Limb IV. Pre-epipodite setulated. Epipodite ovoid. Exopodite subquadrangular, with six setae; seta 1–3 long, of similar length; setae 4–6 about two times shorter; seta 5 longer than seta 6. Setae 1–4 flat, plumose; setae 5–6 thin, with short setulae in distal portion. Inner portion of limb IV with four setae and small sensillum (Fig. 1J). Scraping seta (1) slender, sharp; flaming-torch setae (2–4) with well-developed distal portion, bearing 6–7 long setulae each; first flaming-torch seta (2) wider than the two other (2–3). Gnathobase with two-segmented seta and a small hillock distally. Gnathobase filter plate of 5 setae.

Limb V. Preepipodite setulated, epipodite oval. Exopodite oval, with four plumose setae. Setae 1–3 long, subequal in length, seta 4 short, three times shorter than seta 1. Inner lobe as oval lobe. At inner face, two setae, distal seta two times longer than basal. Filter plate V absent.

Ephippial female. Habitus similar to that in parthenogenetic female, with a bit elongated body (body height/body length = 0.56–0.67), ephippium slightly additionally pigmented in brown, with a single egg.

Male. Body (Fig. 1K, 4A) low oval, with maximum height at the middle, height/length ratio about 0.65. Valve with naked setae at postero-ventral angle, followed by a submarginal row of strong spinules of similar size.

Postabdomen (Figs. 1L, 4B–C) of moderate size, slightly narrowing in anal portion, subrectangular in postanal portion. Length about 3.1 height. Postanal angle not defined, preanal angle well-defined. Postabdominal claw situated on small protrusion in ventral portion of convex distal margin. The sperm ducts open above the protrusion at distal margin of postabdomen. Dorso-distal margin of postabdomen straight; distal part of postabdomen 1.35 times longer than preanal; postanal portion equal or slightly shorter than anal portion. Clusters of short setulae in place of marginal denticles; lateral fascicles of setulae same as in female. Postabdominal claw weakly curved, shorter and more robust than in female. Basal spine about 0.3 length of claw.

**Antennule** broader than in female, with 10 long terminal aesthetascs and 2 lateral aesthetascs of similar length. Male seta subterminal, arising at 1/4 length from tip, not reaching the end of antennule.

**Thoracic limb I** (Fig. 4D) with U shaped copulatory hook with its free arm little longer than basal one. Row of 14–17 short setulae on ventral face of limb under copulatory brush. First IDL seta absent; 2nd and 3rd setae subequal in length, 2 times shorter and thinner than in female; male seta of same size as 2nd seta.

**Size.** Length of adult parthenogenetic females 0.32–0.42 mm, of ephippial females 0.32–0.38 mm, of adult males 0.28–0.29 mm.
TABLE 1. Main morphological differences between O. setulosa arangureni ssp. nov, O. setulosa setulosa (Megard, 1967) and O. glabra (Sars, 1901).

<table>
<thead>
<tr>
<th>O. setulosa arangureni ssp. nov.</th>
<th>O. setulosa setulosa</th>
<th>O. glabra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body height/body length</td>
<td>0.66–0.76</td>
<td>0.64–0.67</td>
</tr>
<tr>
<td>Ventral margin of valves</td>
<td>with 40–45 setae</td>
<td>With 35–45 setae</td>
</tr>
<tr>
<td>PP/IP ratio</td>
<td>0.4–0.5 IP</td>
<td>0.3–0.4 IP</td>
</tr>
<tr>
<td>Major head pores</td>
<td>Connection interrupted in several places</td>
<td>Connection interrupted in several places</td>
</tr>
<tr>
<td>Distance from lateral head pore to midline</td>
<td>1.1–1.5 IP</td>
<td>1.2 IP</td>
</tr>
<tr>
<td>Labral keel</td>
<td>Without clusters of setules on the posterior margin</td>
<td>With clusters of setules on the posterior margin</td>
</tr>
<tr>
<td>Length of postanal portion of postabdomen</td>
<td>About 1–1.1 of anal portion length</td>
<td>About 1 of anal portion length</td>
</tr>
<tr>
<td>Distal angle of postabdomen</td>
<td>Acute or right</td>
<td>Right</td>
</tr>
<tr>
<td>Flaming-torch setae of limb IV</td>
<td>With developed distal portion</td>
<td>With developed distal portion</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postabdomen</td>
<td>Of same height along all anal portion, anal portion of dorsal margin parallel to ventral margin</td>
<td>Height weakly increases basally in anal portion</td>
</tr>
<tr>
<td>Length/height ratio of postabdomen</td>
<td>2.8–3</td>
<td>2.5</td>
</tr>
<tr>
<td>Marginal setules of postabdomen</td>
<td>All setules in postanal groups short, of same length</td>
<td>All setules in postanal groups short, of same length</td>
</tr>
</tbody>
</table>

**Variability.** A single parthenogenetic female without connection between posterior and central main head pore was found.

**Differential diagnosis.** O. setulosa arangureni ssp. nov. differs from O. setulosa setulosa (Megard, 1967) (see Sinev, 2009) by: (1) greater IP/PP ratio in both sexes; (2) posterior margin of labrum without clusters of short setulae; (3) longer postabdomen, with length/height ratio about 2.7–3; (4) male postabdomen with straight dorsal margin in whole distal portion. O. setulosa arangureni ssp. nov. is similar to O. glabra (Sars, 1901) in general shape and morphology of postabdomen, but, like nominative subspecies, differs from it by interrupted connections between head pores. For other differences between these taxa see Table 1. Like nominative subspecies, A. setulosa
**Arangurenii spp nov.** clearly differs from other South American Ovalona species: *O. altiplana* (Kotov, Sinev & Berrios, 2010); *O. karelica* (Sousa, Elmoor-Loureiro & Santos, 2015); and *O. nigra* (Smirnov, 1996) by interrupted connection between main head pores.

**Distribution and ecology.** To the date, the subspecies is known to the date from La Guajira Department in Colombia. The type locality, the Laguna Navio Quebrado, is a small (surface area of 10.7 km²) lagoon system, with shallow water bodies (depth 0.3–0.7 m) covered by submerged and floating aquatic vegetation; temperature varies over the seasons in the range of 28 and 31 °C; during the sampling, pH was 7.8–8.3 and salinity between 0–28 PSU, being 0 in the mouth of the river and 28 near the communication to the sea.

**Discussion**

Our study revealed few differences between females and male of the North American and Colombian populations of *Ovalona setulosa* (see Sinev 2009). The morphology of appendages is the same but morphology of labrum and of male and female postabdomen is quite different. *O. setulosa* is distributed from North Canada (Chengalath 1982) to North Mexico and Central Mexican Plateau (Elías-Gutiérrez et al. 2008; Sinev & Silva-Briano 2012). However, *O. setulosa* is absent in the South regions of Mexico (Elías-Gutiérrez et al. 2008). The level of the differences between North American and Colombian populations, in our opinion, is not high enough to justify separation of the latter into separate species, but, together with geographical disjunction, fully justifies placement of Colombian population into a separate subspecies.

In general appearance and morphology of postabdomen, *O. setulosa arangurenii spp nov.* is somewhat similar to the most common Neotropical species of the genus, *O. glabra*. These species can be easily recognized by morphology of main head pores, but can be easily confused if head pores are not studied. However, there are two important characters which clearly show that *O. setulosa arangurenii spp. nov.* is not a form of *O. glabra* with aberrant morphology of head pores. Unlike *O. setulosa arangurenii* (and *O. setulosa setulosa* as well), *O. glabra* has: (1) flaming-torch setae of limb IV with reduced distal portion (see Sinev, 2001a) and (2) male postabdomen strongly widening basally in anal portion, with enlarged postanal marginal setules; length of distalmost setule in each group is about width of the base of postabdominal claw (see Sinev 2001a; Sinev & Silva-Briano 2012).

*O. setulosa arangurenii spp. nov.* is also somewhat similar to two other South American *Ovalona* species, the endemic of Andes *O. altiplana* and the recently described Brazilian *O. karelica*. However, both these species have uninterrupted connection between pores and differs from *O. setulosa arangurenii spp. nov.* in morphology of postabdomen. *O. altiplana* have shorter postabdomen with longer postanal denticles, length of five distalmost ones exceed the width of postabdominal claw base (Kotov et al. 2010). *O. karelica* have broadly rounded distal angle of postabdomen and more narrow, widely spaced postanal lateral fascicles of setulae; distance between fascicles about half or more fascicle width (Sousa et al. 2015a).

At the moment, five species of *Ovalona* are known from South America: *O. glabra* is distributed through the whole continent, including Andes; *O. nigra* and *O. altiplana* are endemics of Andes (Sinev, 2015); *O. karelica* is known from South-East Brazil (Sousa et al. 2015a); and *O. setulosa arangurenii spp. nov.* so far only known from Colombia. Populations of *Ovalona* from Venezuela described by Rey & Vásquez (1986) as A. karelica and later by Van Damme et al. (2011a) as Alona cf. karelica have questionable status, and can belong to a separate species, but presently should be treated as a form of *O. glabra* (Sinev 2015). *O. weinecki* (Studer, 1878) is known from subantarctic islands, including Falklands, but not recorded in continent.

Our results shows that Alona-like Chydoridae in Neotropic are far from fully studied and certainly deserve further investigations. In respect of cladoceran studies, the most intensively investigated region of South America is Brazil south of Amazon basin. Many local faunas of the area were recently investigated in detail (Hollwedel et al. 2003; Elmoor-Loureiro 2007; Van Damme & Dumont 2010; Debastiani-Junior et al. 2015 and others). Recent studies revealed here a number of new Chydoridae species (Sinev & Elmoor-Loureiro 2010; Elmoor-Loureiro 2014; Sousa et al., 2015ab), and even a new genus (Elmoor-Loureiro et al. 2013). In contrast, modern studies of Colombian Cladocera are just started, but already revealed three new taxa of subfamily Aloninae: *Ovalona setulosa arangurenii spp. nov.*, *Leydigi a lourdesae* Kotov & Fuentes-Reinés, 2014; and *Leberis colombiensis* Kotov & Fuentes-Reinés, 2015 (Kotov & Fuentes-Reinés 2014, 2015), all these taxa so far are not recorded in Brazil. On the other hand, a number of other Aloninae species are known from Brazil only (Sinev & Elmoor-Loureiro 2010;
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Sousa et al. 2015ab. Many species of South American Aloninae are widely distributed, inhabiting the whole Neotropic province (excluding Andes), or even penetrate into the South of Nearctic region. However, our data suggests that a number of endemics with limited areas of distribution can be present in South America as well, and areas north and south of Amazon basin can have different local species of Aloninae, and of other groups of Cladocera as well.

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References


