



A new species of *Diaulax* Bell, 1863 (Brachyura: Dialucidae) in the Early Cretaceous of the Rosablanca Formation, Colombia

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Abstract

The oldest record of the brachyuran *Diaulax* Bell, 1863 is based on the description of *Diaulax rosablanca* n. sp. from the middle part of the Rosablanca Formation (Early Cretaceous, early Valanginian, Department of Santander, Colombia). This is also the oldest record for fossil crustaceans from Colombia. The new species is represented by numerous specimens showing ontogenic variation in size and shape, with adults becoming larger and wider at the anterior portion of carapace. Differences with the other five species of the genus are subtle but sufficient to erect a new species. The associated ammonites *Lissonia riveroi* (Lisson, 1907), *Acantholissonia gerthi* (Weaver, 1931) and *Raimondiceras* sp. confirm an age corresponding to the middle part of the early Valanginian. The paleoenvironment is interpreted as a shallow, restricted low-energy carbonate platform or lagoon within well-oxygenated warm waters. The outcrop includes other decapod remains, too incomplete to offer a preliminary identification.

Keywords: Brachyura, Dialucidae, *Diaulax*, ammonites, Valanginian, Colombia.

Resumen

El registro más antiguo del género *Diaulax* Bell, 1863 se basa en la descripción de *Diaulax rosablanca* n. sp. de la parte media de la Formación Rosablanca (Cretácico Temprano, Valanginiano temprano, Departamento de Santander, Colombia). El reporte representa también el registro más antiguo de crustáceos fósiles para Colombia. La nueva especie está representada por numerosos especímenes que muestran variación ontogénica en tamaño y forma, con adultos que presentan un caparazón más grande y ancho en la porción anterior. Las diferencias con las otras cinco especies del género son sutiles pero suficientes para proponer una nueva especie. Los ammonites asociados *Lissonia riveroi* (Lisson, 1907), *Acantholissonia gerthi* (Weaver, 1931) y *Raimondiceras* sp. confirman una edad correspondiente a la parte media del Valanginiano temprano. El paleoambiente es interpretado como una plataforma carbonatada restringida somera, de baja energía o una laguna con aguas bien oxigenadas. La localidad de estudio incluye restos de otros decápodos, muy incompletos para ofrecer una identificación preliminar.

Palabras clave: Brachyura, Dialucidae, *Diaulax*, ammonites, Valanginiano, Colombia.

1. Introduction

The collection and description of Cretaceous crustaceans from Colombia have notably increased in recent years (Vega *et al.*, 2007; Vega *et al.*, 2010; Luque *et al.*, 2013; Bermúdez *et al.*, 2013), providing valuable information about the evolution and distribution of these organisms in tropical seas. Collections made from a new fossiliferous locality in the middle part of the Rosablanca Formation (Lower Cretaceous) produced numerous specimens of a new species of *Diaulax* Bell, 1863, *Diaulax rosablanca* n. sp. (Brachyura: Dialucidae). The new discovery and subsequent description herein represents the oldest record and first report of the genus in South America.

2. Geographic and stratigraphic setting

The studied locality is located in Loma del Corral, near the Bucaramanga – Zapatoca road, Department of Santander, about 260 km northeast of Bogotá D.C., Colombia (Figure 1). In this area, the Early Cretaceous deposits represent the beginnings of a regional transgressive

event, which deposited mudstones and marine limestones of the Rosablanca Formation over the fluvial sandstones of the Los Santos Formation. Outcrop exposures are located in the middle part of the Rosablanca Formation within the Zapatoca Syncline, a part of the hanging wall of Suarez Fault (Figure 2).

The Rosablanca Formation consists of Early Cretaceous (Valanginian – Hauterivian) mudstones and marine limestones (Morales, 1958; Guzmán, 1985; Rojas-Briceño and Patarroyo, 2009). In the studied area the formation consists of interbedded mudstones, wackestones, packstones and dolomites (which predominate towards the base of unit), fossiliferous mudstones and marls (which predominate towards the middle part of unit) and by arenaceous limestones, fossiliferous sandstones and lumachellic limestones (which predominate in the upper unit) (Figure 3). The formation is highly fossiliferous with an abundant fauna of ostracods, foraminifera, mollusks and echinoderms.

Abundant *Diaulax* specimens were collected within the middle unit, although occasional specimens were collected within the lower and upper units. The associated fauna includes other crustacean remains, gastropods, ammonites and articulated bivalves. There is no evidence of

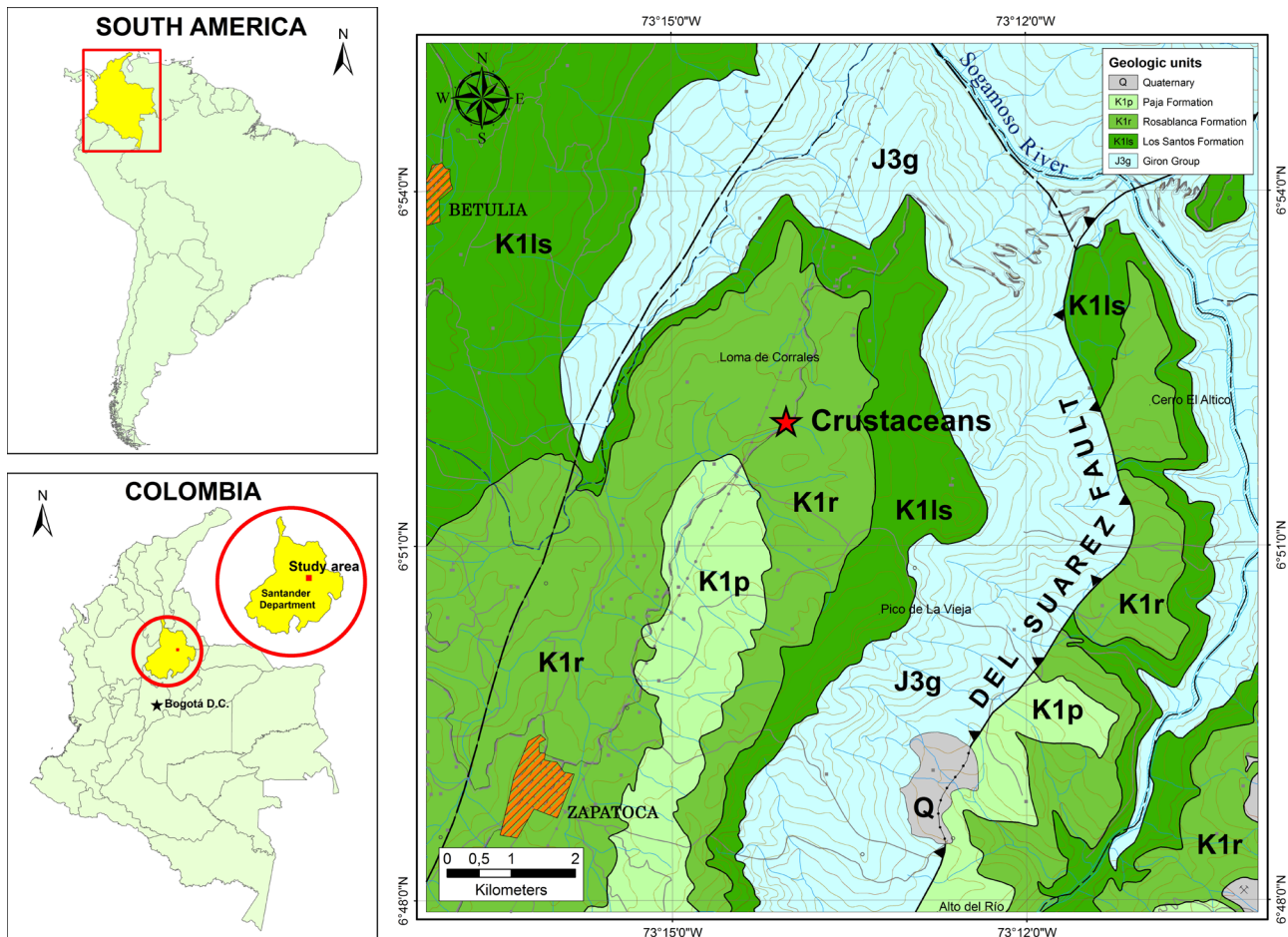


Figure 1. Geologic map with location of fossiliferous locality, north of Zapatoca, Santander Department, Colombia (Geological base from Ward *et al.*, 1973).

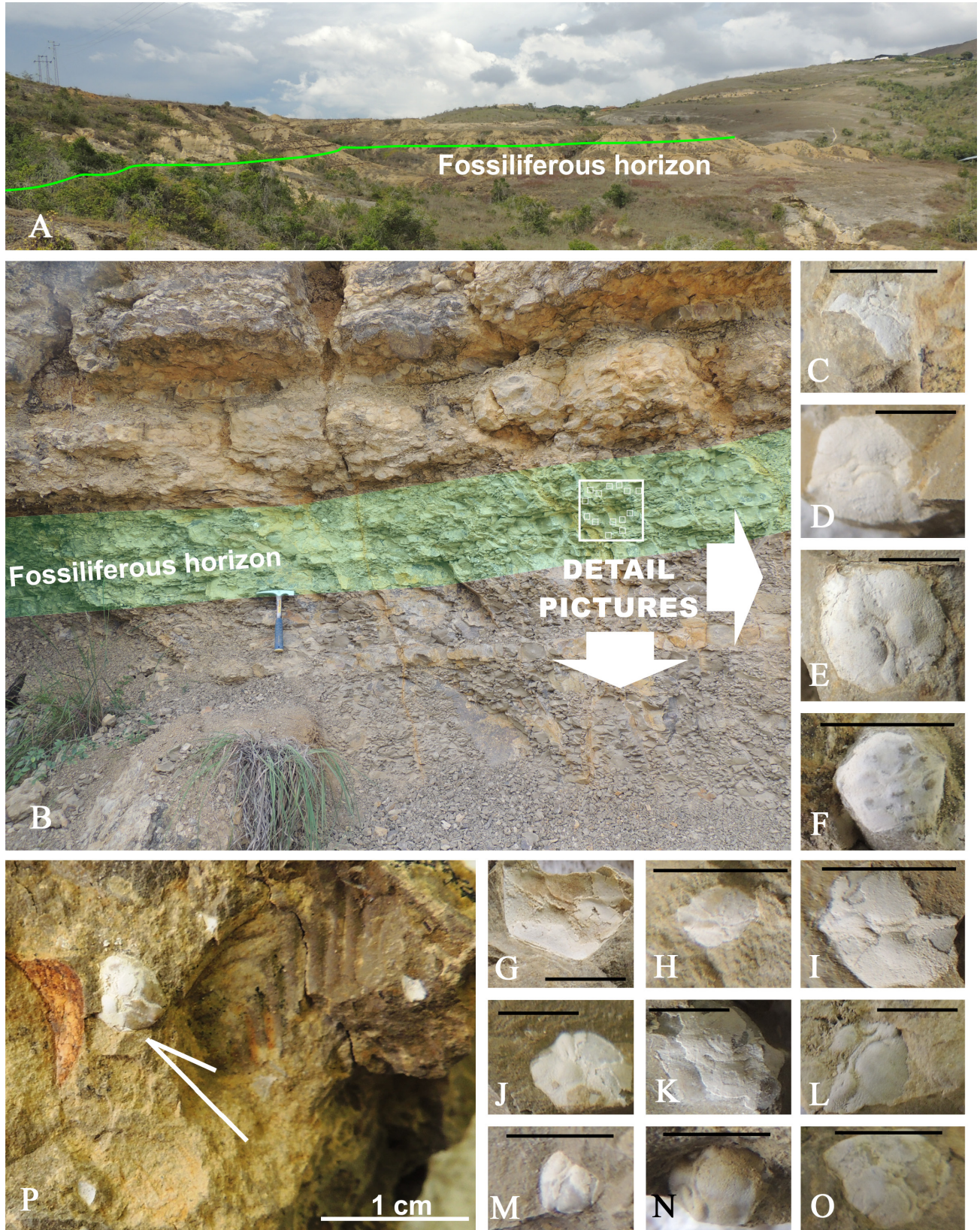


Figure 2. Composite view of the Rosablanca Formation outcrop, north of Zapatoca, with position of fossiliferous locality. A, Panoramic view of studied outcrop, with approximate position of crab-bearing fossiliferous horizon (green line). B, Close up of outcrop with fossiliferous horizon (green) and approximate position where multiple crab specimens were collected (arrows). C-P, *Dialux rosablanca* n. sp. specimens *in situ*, scale bars = 1 cm.

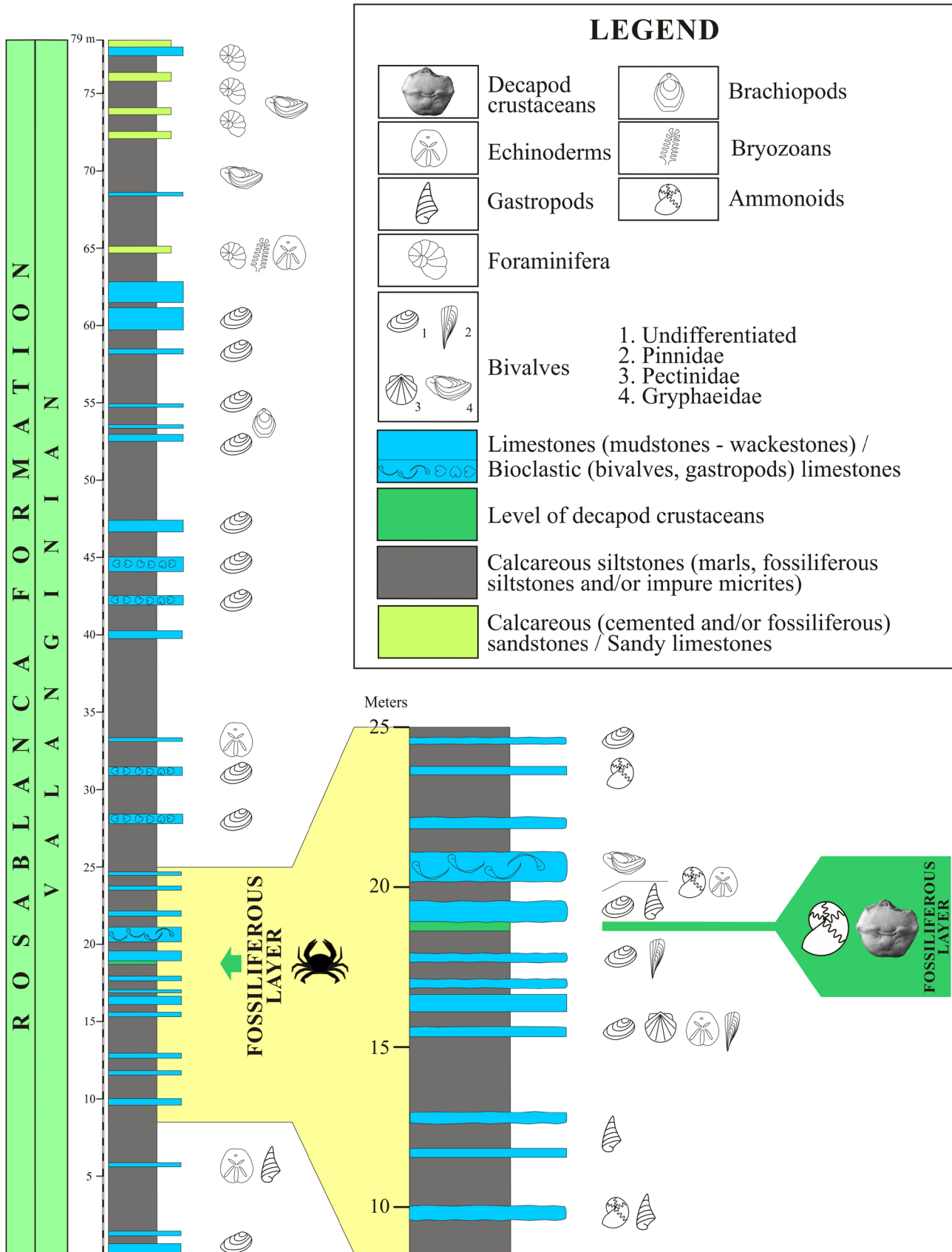


Figure 3. Stratigraphic section of the middle part of the Rosablanca Formation at study locality, with position of fossiliferous level.

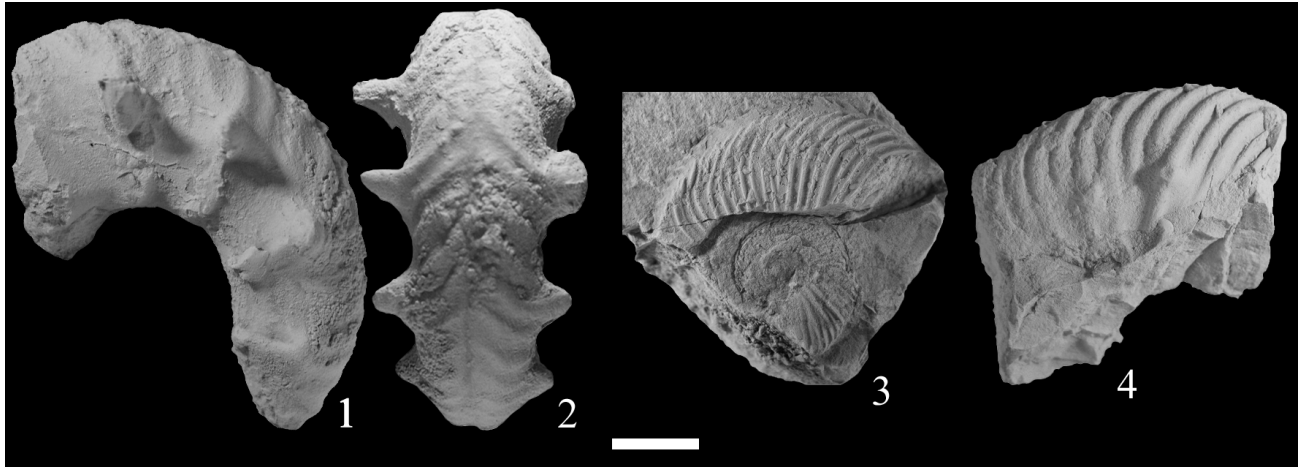


Figure 4. 1-2, *Acantholissonia gerthi* (Weaver, 1931), lateral and ventral views of specimen CAL 4141-4. 3, *Lissonia riveroi* (Lisson, 1907), lateral view of specimen CAL 4141-2. 4, *Raimondiceras* sp., lateral view of specimen CAL 4141-3. Scale bar = 1 cm.

reworking or abrasion of the fossils. The paleoenvironment is interpreted as a shallow, restricted low-energy carbonate platform or lagoon within well-oxygenated warm waters.

2.1. Ammonite biostratigraphy

Ammonites are present in the study area. They include *Lissonia riveroi* (Lisson, 1907), *Acantholissonia gerthi* (Weaver, 1931) and *Raimondiceras* sp. (Figure 4). The ammonoid assemblage composed of *L. riveroi* and *A. gerthi* has been documented in Argentina and has been assigned to the *L. riveroi* Zone (e.g. Aguirre-Urreta and Rawson, 1999; Aguirre-Urreta *et al.*, 2005, 2007; Rawson, 2007), which has been dated to the middle part of the early Valanginian. Therefore, we assign an age corresponding to the middle part of the early Valanginian to the Colombian ammonite assemblage.

Specimens are deposited at the Paleontological Collection of Caldas University, Facultad de Ciencias Exactas y Naturales, Departamento de Ciencias Geológicas, Calle 65 No. 26-10, Manizales, Colombia, under the acronym CAL.

3. Systematic palaeontology

Order Decapoda Latreille, 1802
 Infraorder Brachyura Linnaeus, 1758
 Superfamily Dromioidea de Haan, 1833
 Family Dialucidae Wright and Collins, 1972
 Genus *Diaulax* Bell, 1863

Type species. *Diaulax carteriana* Bell, 1863 [= *D. oweni* (Bell, 1850)].

Other species. *Diaulax oweni* (Bell, 1850); *D. feliceps* Wright and Collins, 1972; *D. roddai* Bishop, 1983; *D. millerae* Bishop, 1992; *D. yokoi* Collins, Kanie and

Karasawa, 1993.

Diaulax rosablanca n. sp.

Figure 5

Diagnosis. Octagonal-shaped dorsal carapace, slightly wider than long, widest part at epibranchial region. Rostrum triangular. Rimmed, large orbital sockets oval. Fronto-orbital width ~75 % of maximum width. Concavely rimmed anterolateral margin slightly convex. Posterolateral margin straight in middle part. Rimmed posterior margin straight to slightly concave, ~45 % of maximum width. Epigastric, protogastric and hepatic regions undifferentiated. Pyriform mesogastric region. Longitudinally narrow meta-/urogastric region slightly concave forward. Epibranchial with prominent node. Mesobranchial region strongly inflated. Metabranchial regions connect axially. Cardiac region hexagonal. Subhepatic region inflated. Cervical groove straight and deepest in axial portion. Postcervical groove parallels and equally strong as cervical groove. Branchiocardiac groove nearly straight. Circular granules present on gastric, cardiac, epibranchial, subhepatic, and mesobranchial regions. Female abdominal somites wide and short.

Description. Octagonal-shaped dorsal carapace usually slightly wider than long ($l/w = 0.83$, $SD = 0.08$, $n = 59$), widest part at epibranchial region, slightly-moderately convex transversely, moderately convex longitudinally, maximum measured width 12.8 mm. Rostrum downturned obliquely, triangular with blunt, rounded at tip, lateral and smooth margins flared up, with sulcus in dorsal view. Rimmed, large orbital sockets oval. In dorsal view, upper orbital margin exhibiting nick toward outer edge; lower orbital margin slightly convex, extending beyond upper orbital margin in dorsal view. Upper and lower orbital margin end in blunt, forwardly directed spine. Fronto-orbital width ~75 % of maximum width. Concavely rimmed

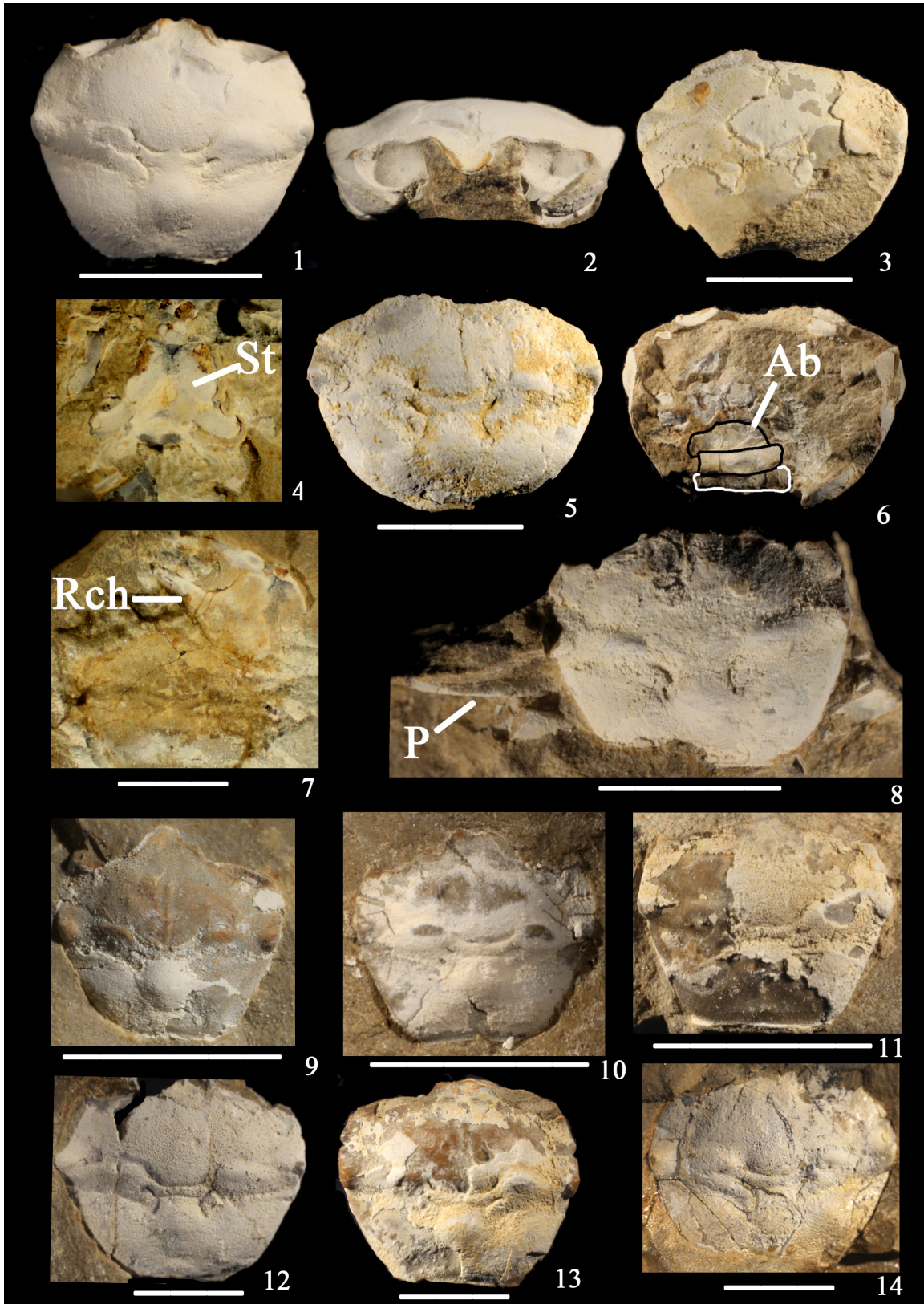


Figure 5. *Diaulax rosablanca* n. sp. 1, Dorsal view of holotype CAL 4141-8; 2, Frontal view of same specimen; 3, Dorsal view of paratype CAL 4141-9; 4, Ventral view of same specimen showing anterior portion of sternum (St); 5, Dorsal view of paratype CAL 4141-10; 6, Ventral view of same specimen, showing female abdominal somites (Ab); 7, Dorsal view of paratype CAL 4141-11, showing right chela (RCh); 8, Dorsal view of paratype CAL 4141-12, showing left middle pereiopods (P); 9, Dorsal view of paratype CAL 4141-13, juvenile specimen; 10, Dorsal view of paratype CAL 4141-14, juvenile specimen; 11, Dorsal view of paratype CAL 4141-15, juvenile specimen; 12, Dorsal view of paratype CAL 4141-16, middle-sized specimen; 13, Dorsal view of paratype CAL 4141-17, middle-sized specimen; 14, Dorsal view of paratype CAL 4141-18, large specimen. Scale bars = 0.5 cm.

anterolateral margin slightly convex, flaring upwards, with notch from intersection of cervical groove. Posterolateral margin straight in middle part, but convex near transition to anterolateral and posterior margins. Rimmed posterior margin straight to slightly concave, ~45 % of maximum width. Epigastric protogastric, and hepatic regions undifferentiated. Pyriform mesogastric region with narrow, longitudinal ridge nearly originating at cervical groove and continuing as mesogastric process. Longitudinally narrow meta-/urogastric region slightly concave forward. Epibranchial region characterized by prominent node. Mesobranchial region strongly inflated just posterior to cervical groove; less toward branchiocardiac groove. Metabranchial regions connect axially: intestinal region undifferentiated. Cardiac region hexagonal, with apex directed posteriorly, usually with three tubercles. Subhepatic region inflated. Cervical groove straight and deepest in axial portion, sinuous thereafter, intersects anterolateral margin, initially vertically oriented on lateral flank, then curves around subhepatic region below orbit. Postcervical groove parallels and equally strong as cervical groove, concave forward. Branchiocardiac groove nearly straight, shallower than axial parts postcervical and cervical grooves, intersects lateral margin just posterior to epibranchial node, then curves forward to join cervical groove. Circular granules present on gastric, cardiac, epibranchial, subhepatic, and mesobranchial regions. Granules on posterior part metabranchial region may appear elongated transversely. Female abdominal somites rectangular, narrow, short. Sternum triangular, sternite 3 narrow, subpentagonal; sternite 4 subtrapezoidal, much wider and longer than sternite 3; sternite 5 subpentagonal, episternites 5 subovate, elongated, posteriorly inclined. Right chela massive, height of palm about 85 % of maximum carapace length; fixed finger triangular, half the length of palm; movable finger triangular, slightly wider at base than fixed finger. Meri of middle pereopods long and slender.

Locality and stratigraphic position. Loma del Corral sector, near the Bucaramanga – Zapatoca road, Department of Santander, Colombia, about 260 km northeast of Bogotá D.C. middle part of the early Valanginian (Early Cretaceous).

Repository. 59 specimens, holotype CAL 4141-8, paratypes CAL 4141-9 to CAL 4141-66.

Measurements. Measurements for each specimen are given in Table 1.

Etymology. The trivial name alludes to the Rosablanca Formation, lithostratigraphic unit.

Discussion. Jagt *et al.* (2010) considered *Diaulax* to be represented by five species: *D. oweni* (Bell, 1850); *D. feliceps* Wright and Collins, 1972; *D. millerae* Bishop, 1992; *D. roddai* Bishop, 1983 and *D. yokoi* Collins, Kanie and Karasawa, 1993. *D. carteriana* Bell, 1863 is a junior subjective synonym of *D. oweni*, according to Wright and Collins, 1972.

Diaulax oweni Bell, 1850 from the Cenomanian of

Table 1. Measurements for studied specimens of *Diaulax rosablanca* n. sp.

Specimen	Length (mm)	Width (mm)
CAL 4141-8	7.6	8.7
CAL 4141-9	8.9	10
CAL 4141-10	9.3	11.7
CAL 4141-11	5.6	6.2
CAL 4141-12	7.6	9.1
CAL 4141-13	3.6	4
CAL 4141-14	5.1	5.7
CAL 4141-15	4.7	6.4
CAL 4141-16	8	8.9
CAL 4141-17	7.1	9.9
CAL 4141-18	10.2	12.1
CAL 4141-19	7.4	8.5
CAL 4141-20	9.8	10.8
CAL 4141-21	5.8	6.7
CAL 4141-22	4.6	4.5
CAL 4141-23	7.9	10.3
CAL 4141-24	9.1	10.8
CAL 4141-25	5.8	7
CAL 4141-26	11.6	14
CAL 4141-27	6.3	7.5
CAL 4141-28	10.4	11.5
CAL 4141-29	5.8	7.4
CAL 4141-30	3.8	3.3
CAL 4141-31	5.3	6.5
CAL 4141-32	6.4	8.2
CAL 4141-33	7.6	8.9
CAL 4141-34	9.2	10.8
CAL 4141-35	7.5	8.9
CAL 4141-36	6.9	9.3
CAL 4141-37	4.9	5.8
CAL 4141-38	7.3	9.3
CAL 4141-39	6.8	7.4
CAL 4141-40	3.2	3.2
CAL 4141-41	6.5	7.9
CAL 4141-42	5.9	7.3
CAL 4141-43	6	7.9
CAL 4141-44	5.8	7.8
CAL 4141-45	6	7.3
CAL 4141-46	6.9	9
CAL 4141-47	7.5	8.8
CAL 4141-48	5.6	7.2
CAL 4141-49	7.3	8.7
CAL 4141-50	5.8	6.6
CAL 4141-51	7.1	9.5
CAL 4141-52	8.6	9.3
CAL 4141-53	6.2	7.9
CAL 4141-54	5.7	8.7
CAL 4141-55	5.5	6.2
CAL 4141-56	6.6	7.3
CAL 4141-57	5.9	8.4
CAL 4141-58	5.7	6.7
CAL 4141-59	7.1	9.3
CAL 4141-60	5.2	7.5
CAL 4141-61	7.1	9
CAL 4141-62	5.9	8.5
CAL 4141-63	5	5.7
CAL 4141-64	8	9.1
CAL 4141-65	7.3	9.4
CAL 4141-66	10.5	12.8

England has a wider carapace at the anterior fourth, the anterolateral margin lacks notches, two small tubercles are found on the protogastric region and it has a stronger cervical groove; *D. feliceps* Wright and Collins, 1972 from the Albian of England has a wider anterior margin and stronger cervical groove; *D. millerae* Bishop, 1992 from the Campanian of Delaware has a more elongated carapace with stronger branchiocardiac groove and well-defined dorsal carapace regions; *D. roddai* Bishop, 1983 from the Albian of Texas has a more elongated carapace with stronger cervical groove; *D. yokoi* Collins, Kanie and Karasawa, 1993 from the Santonian of Japan has a stronger protogastric process and well-defined carapace regions.

Diaulax? italica Beschin, Busulini, De Angeli and Tessier, 2007 from the early Eocene of Italy has a narrower carapace with stronger cervical and branchiocardiac grooves, and its affinity with *Diaulax* is uncertain.

The carapace on the new species becomes relatively wider compared to the length with ontogeny (Figure 6). A similar type ontogenetic variation was suggested by Klompmaker (2013) for *Graptocarcinus texanus* Roemer, 1887 and Klompmaker, Feldmann and Schweitzer (2012) for *Distefania incerta* (Bell, 1863), *Eodromites grandis* (von Meyer, 1857), *Goniodromites laevis* (Van Straelen, 1940) and *Navarradromites pedroartali* Klompmaker, Feldmann

and Schweitzer (2012).

Occurrence of a well-represented population of *D. rosablanca* n. sp. might be the result of either a mass mortality event or an increase of population members as a result of favorable conditions. Along with the numerous specimens of the new species, incomplete remains of other crustacean taxa are found, such as disarticulated chelae, too slender to belong to *Diaulax*. Most specimens of *D. rosablanca* n. sp. are represented only by dorsal carapaces, which suggest a certain amount of transport from the place where specimens died however there is no evidence of reworking or transportation of the other fossils from this locality therefore it is possible the specimens represent molts. A relatively rapid burial of the specimens is suggested, since most carapaces do not show traces of abrasion.

Diaulax rosablanca n. sp. represents the oldest record for the genus and the first record in South America, where a center for origin of primitive Eubrachyura has been proposed (Luque et al., 2013).

Other crustacean remains (Figure 7), found along with specimens of the new species, indicate the locality has potential for future reports on other associated decapod species.

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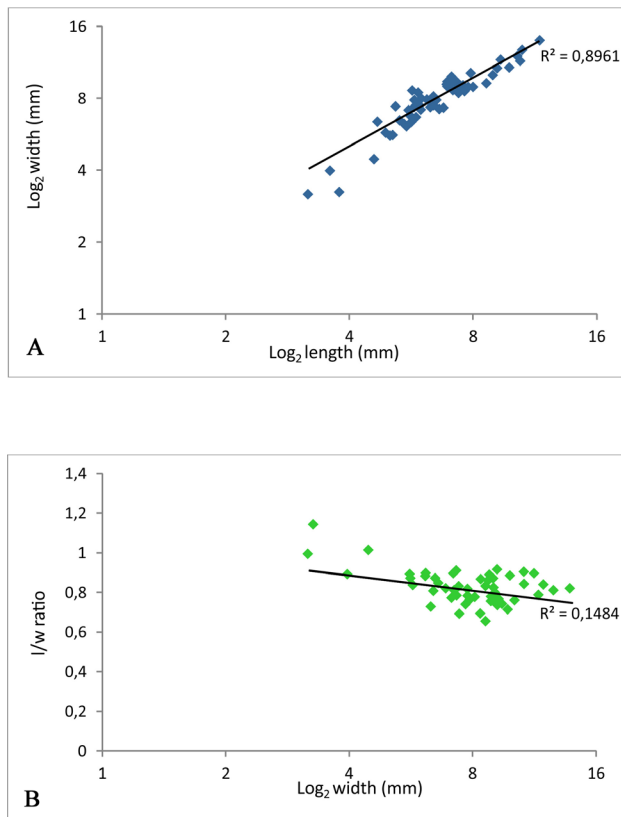


Figure 6. Morphometric analyses of the length and width of the carapace of *Diaulax rosablanca* n. sp. A, Log_2 of width plotted against length. B, Length/width ratio plotted against log_2 of the width.



Figure 7. Associated decapod remains found in the same layer where specimens of *Diaulax rosablanca* n. sp. were collected. 1, 2, Cephalothorax and uropods of a possible mecochirid specimens CAL 4141-67 and CAL 4141-68; 3, *Hoploparia* sp., left carpus and palm, specimen CAL 4141-69; 4, Right and left chelae of a possible homoloid crab, specimen CAL 4141-70. Scale bars = 0.5 cm.

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