Journal of South American Earth Sciences 109 (2021) 103285

Contents lists available at ScienceDirect

Journal of South American Earth Sciences

journal homepage: www.elsevier.com/locate/jsames

New species of fossil Cirolanidae (Isopoda, Cymothoida) from the Lower Cretaceous (Aptian) Sierra Madre Formation plattenkalk dolomites of El Espinal quarries, Chiapas, SE Mexico

Niel L. Bruce [a,b], María de Lourdes Serrano-Sánchez [c], Gerardo Carbot-Chanona [d], Francisco J. Vega [e,*]

[a] Biodiversity & Geosciences Program, Queensland Museum, PO Box: 3300, South Brisbane BC, Queensland, 4101, Australia
[b] Water Research Group, Unit for Environmental Sciences and Management, North-West University, Private Bag X6001, Potchefstroom, 2520, South Africa
[c] Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, CdMx, 04510, Mexico
[d] Museo de Paleontología "Eliseo Palacios Aguilera", Secretaria de Medio Ambiente e Historia Natural, Calzada de Los Hombres Ilustres S/n, Parque Madero, 29000, Tuxtla Gutiérrez, Chiapas, Mexico
[e] Instituto de Geología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, CdMx, 04510, Mexico

ARTICLE INFO

Keywords:
Isopoda
Cymothoida
Cirolana
Plakolana
Lower Cretaceous (Aptian) dolomite plattenkalk
Shallow lagoon
Chiapas
Mexico

ABSTRACT

One new species of *Plakolana* Bruce, 1993 and three new species of *Cirolana* Leach (1818), from the Lower Cretaceous (Aptian) Sierra Madre Formation dolomites at El Espinal quarries (Central-East Chiapas, SE Mexico) are reported and described and compared with other fossil species Cirolanidae from around the world. The specimens consist of the body and a few moults, with showing various degrees of decay but most of them with preserved taxonomic features, including mandibles, pereonites, pereopods, pleonites, pleotelson and uropods. This is the third report of fossil marine or estuarine isopods from the Cretaceous of Mexico and the second on the Peracarida of El Espinal quarries, as well as the first record of fossil *Cirolana* and *Plakolana* from Mexico.

1. Introduction

Fossil isopods from Mexico are mostly Cretaceous marine species, although recently, some estuarine and terrestrial species have been documented from the early Miocene amber of Chiapas (Table 1). The first fossil isopod reported from Mexico was *Sphaeroma burkartii* Bárcena (1875) from continental Neogene deposits of Jalisco (Hessler, 1969; Vega et al., 2006). The Lower Cretaceous marine sphaeromatid isopod *Archaeoniscus aranguthyorum* Feldmann et al. (1998), was reported from the upper Albian plattenkalk deposits of the Tlayúa Formation, Puebla (Vega et al., 2005, 2006). At least three species of late Aptian marine sphaeromatid and cirolanid isopods were recorded by Vega et al. (2003), García-Barrera et al. (2005) and Serrano-Sánchez et al. (2006). Vega et al. (2019) mentioned the record of marine isopods from the Lower Cretaceous of Mexico. Parasitic cryptoniscus larvae of epicarid isopods were reported from the early Miocene amber of Chiapas (Serrano-Sánchez et al., 2016). The diversity of terrestrial isopods (Serrano-Sánchez et al., 2007; Broly et al., 2018) and the first record of parental care in terrestrial isopods was documented by Broly et al. (2017) from the same early Miocene amber of Chiapas. The cirolanid *Palaega* sp. Was documented from the upper Campanian of Chiapas (Vega et al., 2018). Vega et al. (2019) reported *Natatolana poblana* Vega and Bruce, 2019, a Cirolanidae sp., and *Archaeoniscus* sp. From the Lower Cretaceous (Valanginian–Hauterivian) San Juan Raya Formation, Puebla, Central Mexico. This is the first record of fossil *Cirolana* from Mexico.

Fossil isopods assigned to *Cirolana*, Leach, 1818 (Table 2), included nine species prior to this report. *Cirolana enigma* Wieder and Feldmann (1992) was described from shallow Lower Cretaceous deposits

Abbreviations: An, antenna; Ba, basis; Cph, cephalon; Cxp, coxal plate; Dml, dermoliths; En, endopod; ex, exopod; Ftl, frontal lamina; Md, mandibles; Mx, maxiliped; P, pereopods 1–7; Pr, pereonites 1–7; Pl, pleonites 1–5; Plte, pleotelson; Ro, rostrum; Ur, uropods.

* Corresponding author.
E-mail addresses: niel.bruce@qm.qld.gov.au (N.L. Bruce), mlourdeserrano@ciencias.unam.mx (M. de Lourdes Serrano-Sánchez), carbotsaurus@yahoo.com (G. Carbot-Chanona), vegver@unam.mx, vegver@geologia.unam.mx (F.J. Vega).

https://doi.org/10.1016/j.jsames.2021.103285
Received 17 December 2020; Received in revised form 9 March 2021; Accepted 19 March 2021
Available online 4 April 2021

Table 1
Fossil isopoda from Mexico.

Species	Age	Locality	Main reference
Natatolana poblana	Valanginian-Hauterivian	San Juan Raya Formation, Puebla	Vega et al. (2019)
Archaeoniscus sp.	Valanginian-Hauterivian	San Juan Raya Formation, Puebla	Vega et al. (2019)
Plakolana chiapaneca sp. nov.	Aptian	Sierra Madre Formation, Chiapas	This report
Cirolana aptiana sp. nov.	Aptian	Sierra Madre Formation, Chiapas	This report
C. bretoni sp. nov.	Aptian	Sierra Madre Formation, Chiapas	This report
C. longirostra sp. nov.	Aptian	Sierra Madre Formation, Chiapas	This report
Sphaeromatidae	Aptian	Sierra Madre Formation, Chiapas	Vega et al. (2019)
Archaeoniscus aranguthyorum	late Albian	Tlayúa Formation, Puebla	Feldmann et al. (1998)
Sphaeromatidae	late Albian	Tlayúa Formation, Puebla	Vega et al. (2019)
Palaega sp.	Late Campanian	Ocozocoautla Formation, Chiapas	Vega et al. (2019)
Epicaridea	Early Miocene	La Quinta Formation, Chiapas	Serrano-Sánchez et al. (2016)
Palaeolibrinus spinicornis	Early Miocene	La Quinta Formation, Chiapas	Broly et al. (2018)
Armadilloniscus miocaenicus	Early Miocene	La Quinta Formation, Chiapas	Broly et al. (2018)
Crinocheta sp. 1	Early Miocene	La Quinta Formation, Chiapas	Broly et al. (2018)
Crinocheta sp. 2	Early Miocene	La Quinta Formation, Chiapas	Broly et al. (2018)
Crinocheta sp. 3	Early Miocene	La Quinta Formation, Chiapas	Broly et al. (2018)
Crinocheta sp. 4	Early Miocene	La Quinta Formation, Chiapas	Broly et al. (2018)
Crinocheta sp. 5	Early Miocene	La Quinta Formation, Chiapas	Broly et al. (2018)
Aquitanoscia chiapasensis	Early Miocene	Mazantic Shale, Chiapas	Broly et al. (2017)
A. maternus	Early Miocene	Mazantic Shale, Chiapas	Broly et al. (2017)
Palaeospherarmadillo mazanticus	Early Miocene	Mazantic Shale, Chiapas	Broly et al. (2018)
P. rotundus	Early Miocene	Mazantic Shale, Chiapas	Broly et al. (2018)
Archeostenoniscus robustus	Early Miocene	Mazantic Shale, Chiapas	Broly et al. (2018)
A. mexicanus	Early Miocene	Mazantic Shale, Chiapas	Broly et al. (2018)
Sphaeroma burkartii	Neogene	Valle de Ameca, Jalisco	Bárcena, 1875

(fluviatile to lacustrine Berriasian–Valanginian, according to Joyce et al., 2020) of the Lakota Formation of South Dakota. *Cirolana fabianii* De Angeli and Rossi (2006) was described from the lower Oligocene of Italy. *C. makihiki* Feldmann et al. (2008) was reported from the Pliocene of New Zealand. *Cirolana garassinoi* Feldmann (2009) and *C. cottreaui* (Roger, 1946) are known from Santonian of Lebanon (Feldmann and Charbonnier, 2011). Hyžný et al. (2013) described *Cirolana feldmanni* Hyžný et al. (2013) from the Lower Miocene deposits of the Vienna Basin in Slovakia. *Cirolana acuticaudata* (Secretan, 1975) is known from the Eocene Pesciara di Bolca, Italy (Vonk et al., 2015). *Cirolana forticrura* was described from the Pleistocene of Tuscany, Italy (Baldanza et al., 2017). *Cirolana centinelensis* Maguire et al., 2018 was reported from the Miocene of Patagonia, Argentina (Maguire et al., 2018). The oldest species remains *C. enigma.*

The El Espinal quarries in East–Central Chiapas (SE Mexico) are a series of shallow excavations made by local people to obtain tiles as ornamental flooring for domestic housing. Laminar dolomites of the Lower Cretaceous (Aptian) Sierra Madre Formation are worked as slabs containing plant remains, a few foraminifera, mollusks (imprints of gastropods and bivalves), crustaceans (mainly Peracarida) and fishes (González-Rodríguez et al., 2002; Ovalles-Damian et al., 2002, 2006; Vega et al., 2006; Alvarado-Ortega et al., 2009; González-Ramírez et al., 2013; Heard et al., 2020). The El Espinal quarries are located approximately 45 km west of Tuxtla Gutierrez, Chiapas, at Lat 16°41′1″ N and Long 93°26′97″ W (Fig. 1). See Heard et al. (2020) for details on stratigraphy, lithology and paleoenvironment.

2. Materials and methods

Photographs were taken using an Olympus SZH 7.5–64X Zoom microscope with adapted Canon Eos 5D, Mark II camera and a Zeiss Axiozoom V.16. Figures were prepared with Adobe Photoshop Elements 2.0. Type material is deposited in the Museo de Paleontología "Eliseo Palacios Aguilera", Secretaria de Medio Ambiente e Historia Natural (IHNFG), Tuxtla Gutierrez, Chiapas under acronym IHNFG.

3. Systematic palaeontology

Class Malacostraca Latreille, 1802
Order Isopoda Latreille, 1817 Suborder Cymothoida Wägele, 1989 Family Cirolanidae Dana, 1852 Genus *Plakolana* Bruce, 1993.
Plakolana Bruce, 1993: 9.— Keable (1999): 764. —Bruce et al., 2002: 155.
Type species: *Plakolana accola* Bruce (1993); by original designation.

Table 2
Fossil species of extant genera of Cirolanidae.

Species	Age	Locality	Main reference
Cirolana enigma	Berriasian-Valanginian	Lakota Formation, South Dakota	Wieder and Feldmann (1992)
Cirolana centinelensis	Miocene	Argentina	Maguire et al. (2018)
Plakoolana chiapaneca n. Sp.	Aptian	Sierra Madre Formation, Chiapas	This report
C. aptiana n. Sp.	Aptian	Sierra Madre Formation, Chiapas	This report
C. bretoni n. Sp.	Aptian	Sierra Madre Formation, Chiapas	This report
C. macrorrostra n. Sp.	Aptian	Sierra Madre Formation, Chiapas	This report
C. garassinoi	late Santonian	Lebanon	Feldmann (2009)
C. titanophila	Eocene	Italy	Robin et al. (2019)
C, acuticauda	Early Eocene	Verona, Pesciara di Bolca, Italy	Vonk et al. (2015)
C. fabianii	Early Oligocene	Vicenza, Italy	De Angeli and Rossi (2006)
C. centinelensis	Early Miocene	Centinela Formation, Argentina	Maguire et al. (2018)
C. feldmanni	Early Miocene	Cerová-Lieskové, Slovakia	Hyžný et al. (2013)
C. makihiki	Early Pliocene	Kowai Formation, New Zealand	Feldmann et al. (2008)
C. forticrura	Early Pleistocene	Poggi Gialli, Tuscany, Italy	Baldanza et al. (2017)

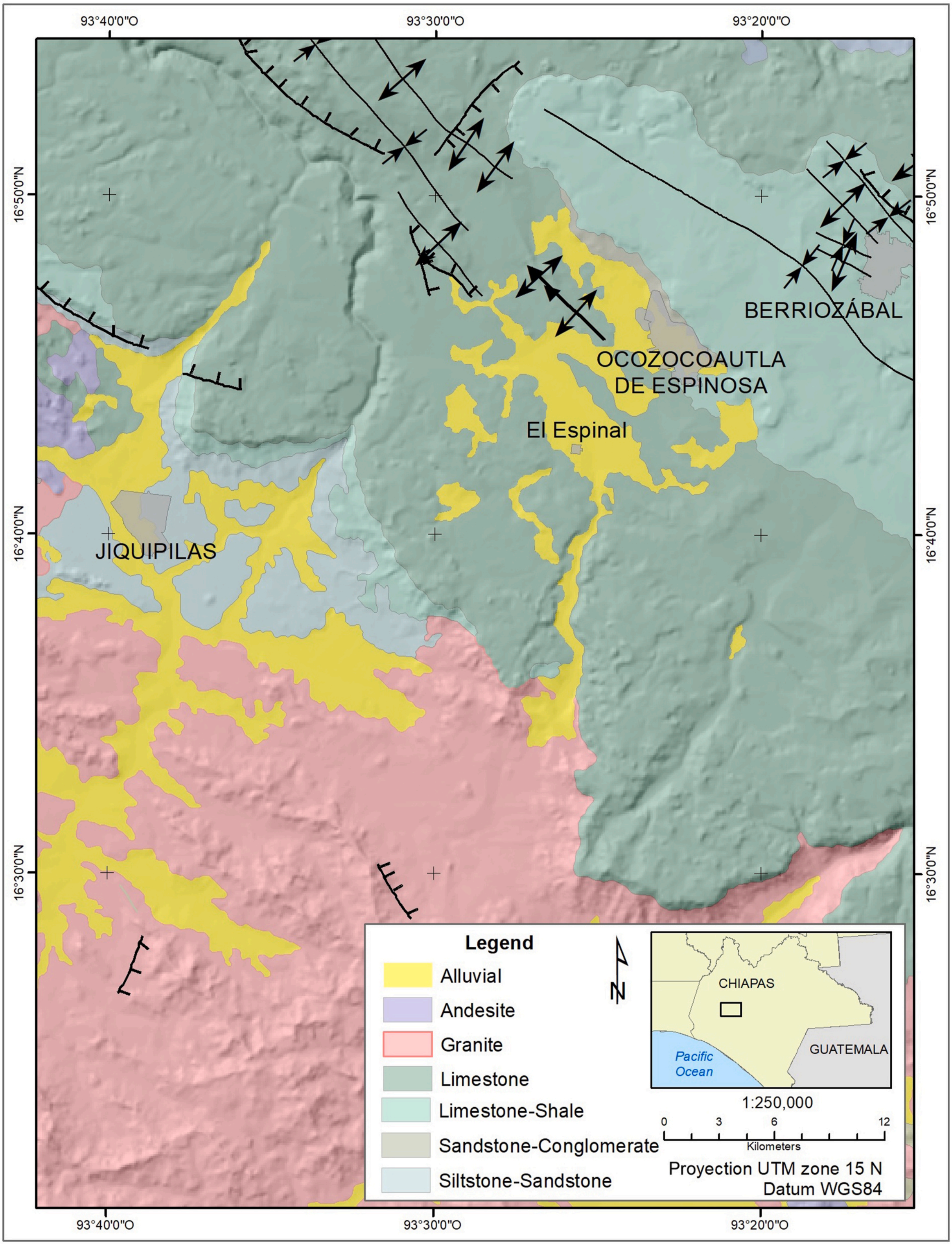

Fig. 1. Location map of El Espinal quarries, Chiapas, SE Mexico.

Remarks. *Plakolana* is a small genus of six extant species with a distribution from Papua New Guinea (Bruce, 1993) and Australia, from the Kimberly coast of tropical Western Australia (Hosie et al., 2015), Darwin in the Northern Territory, and the Queensland coast to New South Wales and Tasmania (Bruce et al., 2002). The occurrence of a fossil species of the genus in Mexico may at first seem to be remarkable, but most of the larger cirolanid genera do have world-wide distributions, and several of the smaller genera with a primarily Indo-Pacific Ocean distribution such as *Booralana* Bruce, 1986 (Camp and Heard, 1988) and *Dolicholana* Bruce, 1986 (Paiva and Souza-Filho, 2015) are represented in the tropical Atlantic species, presumable evoking a former Tethyan distribution.

Cirolanid genera are typically characterized by characters that include pleon and head characters, but in most cases also antennulae, antennae, pereopods, penial processes and shape of, in particular, pleopods 1 and 2. Many, indeed most, fossils lack appendages and equally may only be represented by part of the animal. This characteristic of fossil cirolanid taxonomy has been discussed in some detail by Gasparic et al. (2015), Hyžný et al. (2013) and Maguire et al. (2018). In some instances, as is the case here for the new species, cirolanids may show good preservation of not only uropods but the pereopods, though more rarely other appendages. This permits some fossil species to be more clearly related to extant taxa and identified as genera thereby allowing for a greater understanding of fossil cirolanid diversity at both species and genus levels.

Plakolana is characterized by a number of somatic and appendage characters (Bruce, 1993). Two of these characters are clearly shown by the specimens of *Plakolana chiapaneca* sp. nov., namely the expanded lateral margins of pleonite 3, evident in dorsal view, and the notably short quadrate merus about as long as wide (compared to 1.2–1.7 times as long as wide in *Cirolana*) of pereopods 5–7; several other cirolanid genera (e.g. *Dolicholana* and *Aatolana* Bruce, 1993) have prominently expanded pleonite 3, but in those genera the merus of pereopods 5–7 is wider distally and more elongate. Species of the *Cirolana* "*parva*-group" (see Bruce, 2004; Rodcharoen et al., 2016; Sidabalok and Bruce, 2017) have pleonite 3 posteriorly produced to or beyond pleonite 5, but it is not expanded or enlarged as in *Plakolana*.

Pleovideolana Gasparic, Fraaije, van Bakel, Jagt and Skupien, 2015, from the Middle Jurassic period in France, is similar to *Plakolana* as noted by those authors, notably in the large posteriorly directed lateral margins of pleonites 3 and 4. The genus differs from *Plakolana* in having a largely exposed pleonite (vs pleonite 1 largely or wholly concealed in *Plakolana*) and also large eyes that are conspicuous in dorsal view.

Plakolana chiapaneca sp. nov.

Figs. 2 and 3

Material. Eleven specimens, holotype IHNFG-5934, paratypes IHNFG-5935 to IHNFG-5944.

Measurements (in mm). Holotype IHNFG-5934, length = 13.2 mm; width = 4.4.

Paratypes: IHNFG-5935, length = 6.5; width = 2.9; paratype IHNFG-5936, length = 13.5; width = 5.8; paratype IHNFG-5937, length = 14.1; width = 5.3; paratype IHNFG-5938, length = 7.9; width = 3.8; paratype IHNFG-5939, length = 9.7; width = 3.2; paratype IHNFG-5940, length = 11.1; width = 4.5; paratype IHNFG-5941, length = 10.5; width = 6.0; paratype IHNFG-5942, length = 7.5; width = 3.7; paratype IHNFG-5943, length = 4.8; width = 1.8; paratype IHNFG-5944, length = 18.9; width = 9.1.

Description. *Body* 2.3 times as long as greatest width, widest at pereonite 5, dorsal surfaces smooth, lateral margins weakly ovate. *Cephalon* with small median rostral point. *Pereonite 1* and *coxae* 2–3 each with posteroventral angle rounded; posterior margins of pereonites 5–7 smooth. *Pleon* with pleonite 1 largely concealed by pereonite 7; pleonites 3–5 posterior margin smooth; pleonite 2 not posteriorly produced; pleonite 3 with posterolateral margins posteriorly produced, extending clearly beyond posterior margin of pleonite 5, expanded; posterolateral margin of pleonite 4 acute, clearly extending beyond posterior margin of pleonite 5; pleonite 5 with posterolateral angles overlapped by lateral margins of pleonite 4. *Pleotelson* 0.9 times as long as anterior width, dorsal surface without longitudinal carina; lateral margins convex, smooth, posterior margin converging to caudomedial point.

Pereopod 6 basis 2.4 times as long as greatest width, superior margin convex, inferior margin weakly convex; ischium 0.6 as long as basis, 1.9 times as long as wide; merus 0.5 as long as ischium, 1.3 times as long as wide; carpus 0.9 as long as ischium, 2.8 times as long as wide; propodus 0.97 as long as ischium, 5.8 times as long as wide.

Uropod peduncle posterior lobe about one-third as long as endopod; rami extending beyond pleotelson, exopod and endopod subequal in length, apices narrowly rounded. *Endopod* 4.5 times as long as wide, apically not bifid; lateral margin weakly concave, without prominent excision; mesial margin weakly convex. *Exopod* extending to end of endopod, 6.3 times as long as wide, apically not bifid, 6.0 times as long as greatest width; lateral margin weakly convex; mesial margin weakly convex.

Remarks. *Plakolana chiapaneca* sp. nov. differs from all other fossil Cirolanidae and indeed most other Cirolanidae—fossil or extant—by the elongate uropodal rami (4.8–6.6 times as long as wide) extending well beyond the posterior margin of the pleotelson. The species may be further identified and distinguished from fossil *Cirolana* by the large and posteriorly produced posterolateral margins ("epimera") of pleonite 3 and the quadrate shape of the merus of pereopods 6 and 7 both of these being generic characters for *Plakolana* Bruce, 1993. The presence of a small rostral point does not accord with the extant species of *Plakolana*, and though presence or absence of a rostral point is generally a conservative character, in *Natatolana* the rostral point is both present and absent depending on species group (see Keable, 2006). As such we consider that *Plakolana* is the most appropriate genus for this species as other fossil genera such as *Cirolana*, *Natatolana* and *Palaega* can be specifically excluded.

Having a temporal distance of more than 55 Ma from the Paleogene species of the genus, it seems highly improbable that the species lasted that long, not to mention the obvious morphological differences with the Cenozoic species from Europe and the Southern Hemisphere.

Etymology. Species name is dedicated to the fossiliferous state of Chiapas, SE Mexico.

Genus *Cirolana* Leach, 1818.

Restricted synonymy:

Cirolana.— Bruce (1986): 139.— Brusca et al. (1995): 17.— Hyžný et al., 2013: 621.

Obtusotelson Schädel, van Eldijk, Vinkelhorst, Reumer and Haug, 2020: 150; type species *Obtusotelson summesbergeri* Schädel et al., 2020; by monotypy. **New synonymy.**

Type species. *Cirolana cranchii* Leach and Cuvier, 1818, by monotypy (see Bruce and Ellis, 1983).

Remarks. There are in effect two types of functional diagnoses and descriptions for *Cirolana*, those that represent the extant genus and those that more briefly diagnose the fossil representatives. The species described herein do not necessitate further emendations to these diagnoses. It is recommended that for fossil taxa both forms of diagnosis are used as far as possible when appendages are available to further confirm genus identity by reference to diagnoses and descriptions of extant genera.

As discussed below in relation to the synonymy of *Obtusotelson*, the Cirolanidae has been split into three defined subfamilies by Kensley and Schotte (1989), namely the Eurydicinae Stebbing, 1905, Cirolaninae Hansen, 1890 and Conilerinae Kensley and Schotte, 1989. Genera of the Eurydicinae have all pleonites unfused with free (not overlapped) lateral margins, in particular the lateral margins of pleonite 5 are not enclosed. The Conilerinae are differ on a number of characters (e.g. see Bruce, 1981, 1986; Brusca et al., 1995; Keable, 2006) the most readily seen being the anterior pereopods with a strongly produced anterolateral angle on the ischium and merus. The present species lacking these characters, and also showing characteristic broad uropodal endopods, thus belong in those genera of the Cirolaninae.

Fossil cirolanids often lack appendages, but in many cases the uropods are relatively well preserved. Uropods, both the peduncle but particularly the rami, present a number of species differentiating characters that are very useful in separating species; these include the relative length of the peduncle mesial lobe, the intrinsic length to width proportions of each ramus, the relative size of the exopod in relation to

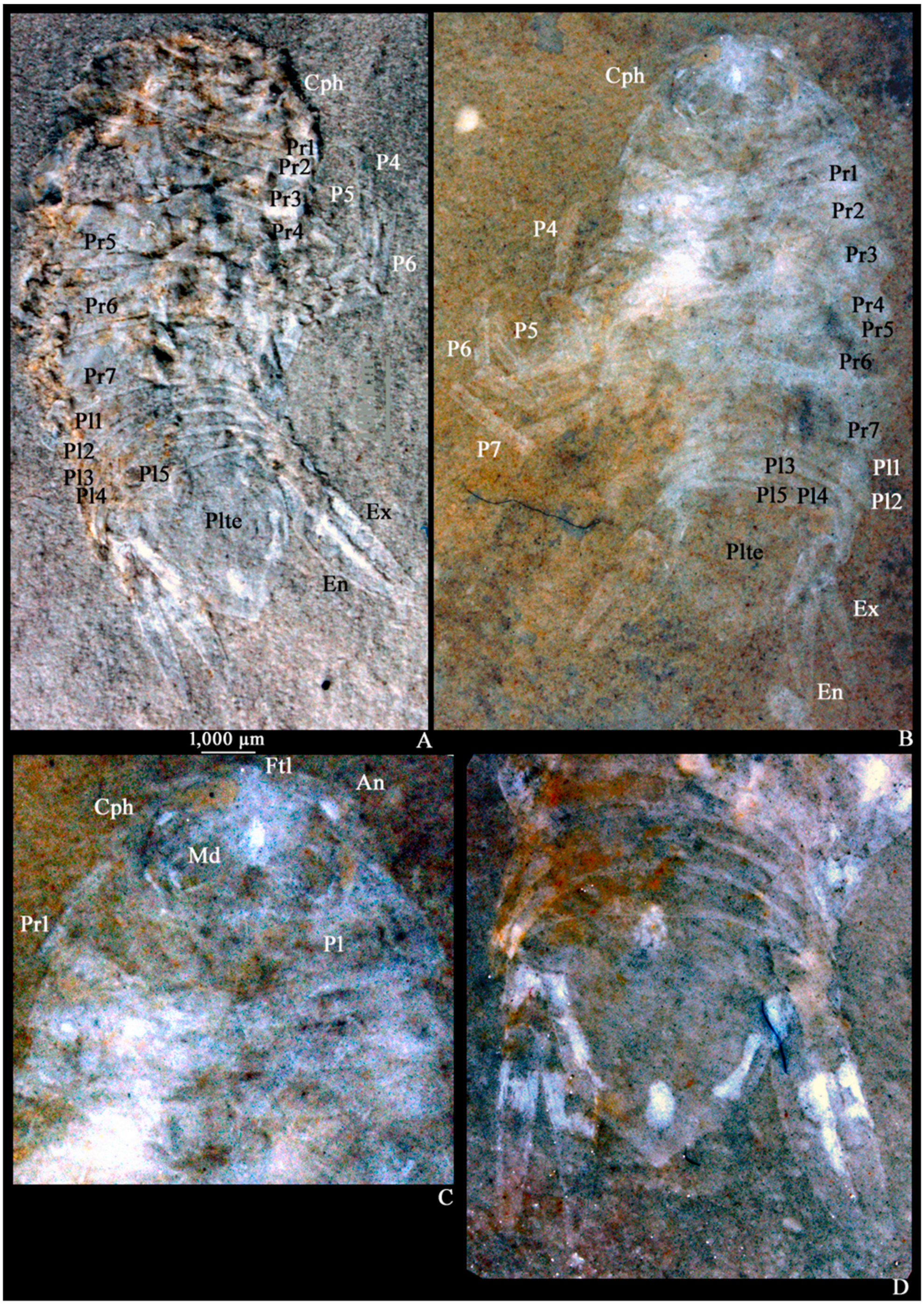

Fig. 2. *Plakolana chiapaneca*, sp. nov. A–D, holotype IHNFG-5934, positive, counterpart and close ups of anterior and posterior portions of carapace.

the endopod, the extent to which the rami extend beyond the pleotelson (or not), the apical angle of the endopod, and the shape of all the margins of each ramus.

Synonymy of *Obtusotelson*. Schädel et al. (2020) described the new monotypic genus *Obtusotelson* without offering any defining characters and not classifying the genus below the level of Scutocoxifera Dreyer and Wägele, 2002. In establishing this genus Schädel et al. (2020) commented that the genus cannot be diagnosed because it is monotypic, and "*Obtusotelson* does not represent a monophyletic group of organisms, since only a single species is included (monotypic). Yet, *Obtusotelson* may serve as a 'group name in advance …". The type species and holotype of *Obtusotelson summesbergeri* Schädel et al., 2020 is a well-preserved specimen in two parts but no hypothesis of genus identity (i.e. genus description based on the type species) was given. The description of the type species consists almost entirely of higher-taxon characters from family to class level (i.e. uninformative at genus and species level) and appears to be a description of the fossil rather than of the species.

The Scutocoxifera represents a useful division of taxa within the Isopoda; the included orders being Oniscidea, Valvifera, Sphaeromatidea, Anthuridea and Cymothoida [Dreyer and Wägele, 2002; see Brandt and Poore (2003) for more detailed classification (Table 2) and diagnoses]. *Obtusotelson* clearly shows a pleon of five free (i.e. unfused) pleonites, together with lamellar uropods that articulate with the

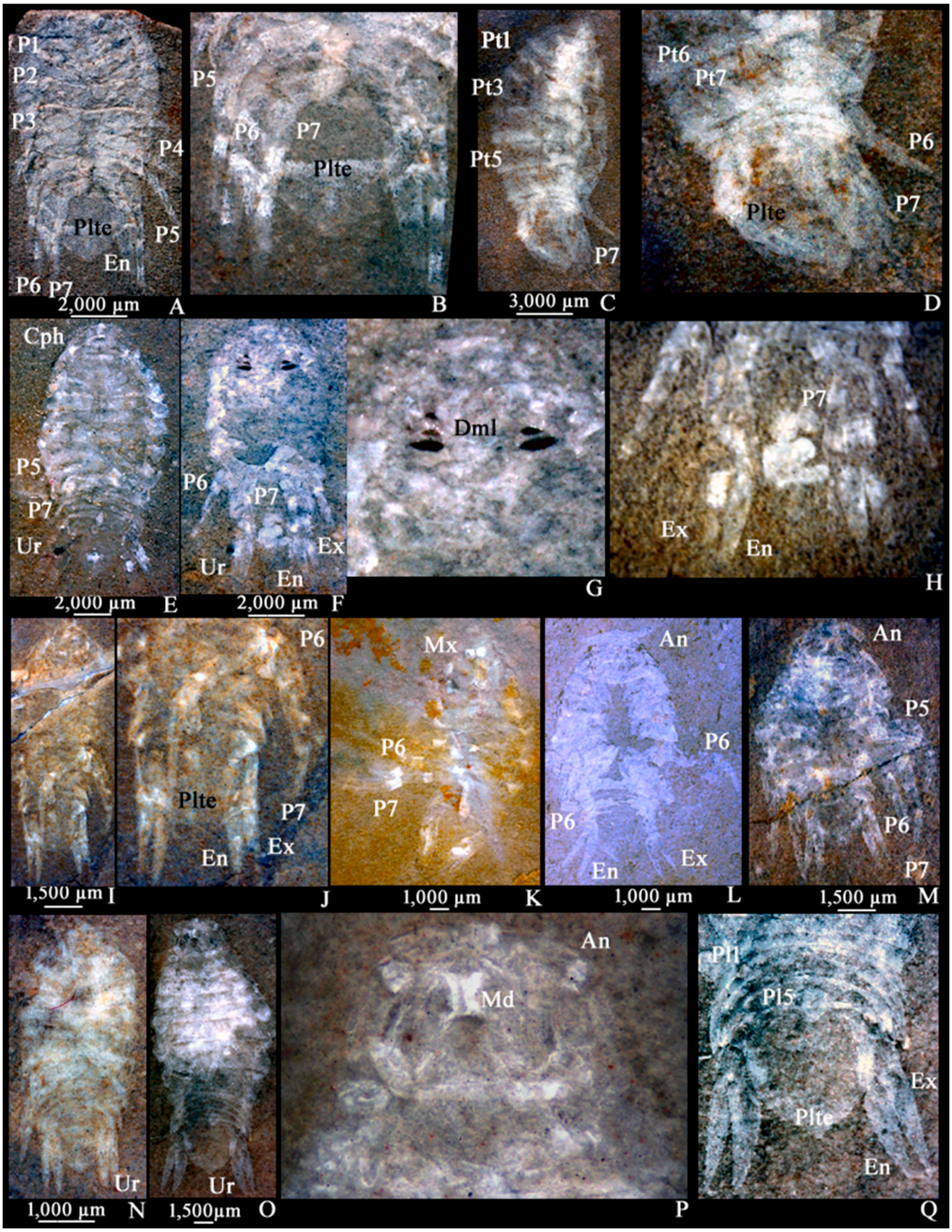

Fig. 3. *Plakolana chiapaneca* Bruce, sp. nov. A, B, paratype IHNFG-5935, ventral view and close up to posterior portion of carapace. C, D, paratype IHNFG-5936, right lateral view and close up of posterior portion of carapace. E, paratype IHNFG-5937, dorsal view. F–H, paratype IHNFG-5938, ventral view and close-ups of anterior and posterior portions of carapace. I, J, paratype IHNFG-5939, ventral and close up of posterior portion of carapace. K, paratype IHNFG-5940, ventral view of carapace. L, paratype IHNFG-5941, ventral view of carapace. M, paratype IHNFG-5942, ventral view of carapace. N, paratype IHNFG-5943, ventral view of carapace. O-Q, paratype IHNFG-5944, ventral view and close-ups of anterior and posterior portions of carapace.

pleotelson (pleonite 6+telson) in a ventrolateral position, the latter a defining apomorphy for the Cymothoida (see Brandt and Poore, 2003). These two character states exclude *Obtusotelson* from all suborders except the Cymothoida Wägele, 1989. Within the Cymothoida the Anthuroidea Leach, 1814 are excluded by multiple characters, but most readily on elongate body form, pleonites all or most fused and the uropods being lateral or dorsolateral in position, while the Bopyroidea Rafinesque, 1815 and Cryptoniscidea Kossmann, 1880 are excluded on the basis of being fully obligate parasites of other crustaceans with a highly modified morphology as well as having prehensile pereopods (among other characters). The remaining superfamilies are then Cymothooidea Leach, 1814 and Cirolanoidea Dana, 1852. *Obtusotelson* has unequivocally ambulatory pereopods, with a short dactylus (half the length of the propodus or less) that is not strongly recurved (i.e. not "hooked"). Ambulatory pereopods excludes *Obtusotelson* from the Aegidae White, 1850 and Cymothoidae Leach, 1814 (e.g. see Bruce, 2009; Hadfield et al., 2014; Martin et al., 2016), while the Anuropidae Stebbing, 1893 (undifferentiated uropods), Protognathiidae Wägele and Brandt, 1988 (pereopod 7 absent) and Gnathiidae Leach, 1814 (only five functional pereopods) are all excluded on the basis of diverse and different characters. The remaining families for consideration are the Cirolanidae Leach, 1814, Corallanidae Hansen, 1890 and Tridentellidae Bruce, 1984. The latter two families are primarily fish symbionts and the key defining characters are to be found in the mouthparts, and as such potentially impossible to separate from each other and from the Cirolanidae as recognized by Hyžný et al. (2013) and Maguire et al. (2018). Species of Tridentellidae are primally continental shelf and slope in habitat (shallow to 1840 m; four species occurring at less than 200 m), have large eyes, are often strongly ornamented dorsally; the anterior pereopods are ambulatory, the uropods usually rounded distally (rather than the margins forming an acute angle (see Bruce, 2008; Bruce and Svavarsson, 2018 and reference therein), and have a similar pleon morphology to *Cirolana*. The Corallanidae have narrow mandibles, and consequently a relatively narrow head in comparison to cirolanids, and are often dorsally strongly setose; the pleon is generally similar to that of cirolanids, though the epimera of pleonite 4 are usually subtruncate or bluntly rounded rather than acute, and the posterolateral margins of pleonite 3 are never posteriorly produced to reach the anterior of the pleotelson; the pereopods while ambulatory do have a more curved dactylus (see Delaney, 1989). Given the improbability of *Obtusotelson* belonging to the Corallanidae or Tridentellidae on grounds of parasitic habitat, general morphology and pleon morphology the only plausible family for this genus is the Cirolanidae.

Within the Cirolanidae there are three recognized, though not widely used, groups of genera, treated as the subfamilies Eurydicinae, Cirolaninae and Conilerinae by Kensley and Schotte (1989). Genera of the Euydicinae have all pleonites with lateral margins free (not overlapped by the preceding pleonite) and most particularly pleonite 5 is not overlapped by pleonite 4 (among other characters). The genera of the Conilerinae have the superodistal angle of the ischium and merus of pereopods 1–3 strongly produced. *Obtusotelson* lacks these character states, and belongs with the genera of the Cirolaninae. The Cirolaninae does contain a number of similar genera, often distinguished by characters relating to the frontal lamina mouthparts. There are no preserved mouthparts for *Obtusotelson*, and the head is unfortunately crushed, but the pereon, pleon, pleotelson and uropods all agree well with those of *Cirolana* and furthermore the species readily arrives at *Cirolana* using the key given by Hyžný et al. (2013). We conclude that as there are no characters distinguishing *Obtusotelson* from *Cirolana* the name should be placed into junior synonymy, with the type species now forming the new combination *Cirolana summesbergeri* (Schädel et al., 2020) **comb. nov.**

Cirolana aptiana

Fig. 4

Material. Two specimens, holotype IHNFG-5945, paratype IHNFG-5946.

Measurements (in mm). Holotype IHNFG-5945, length = 11.2; width = 6.3; paratype IHNFG-5946, length = 19.1; width = 11.3.

Description. *Body* 3.3 times as long as greatest width, widest at pereonite 5, dorsal surfaces smooth, lateral margins weakly ovate. *Pereonite 1* and *coxae* 2–3 each with posteroventral angle rounded; posterior margins of pereonites 5–7 smooth. *Pleon* with pleonite 1 largely concealed by pereonite 7 (pleon 0.7 as wide as pereon); pleonites 3–5 posterior margin smooth; not posteriorly produced; pleonite 3 with posterolateral margins not extending to posterior margin of pleonite 5, narrowly rounded; posterolateral margin of pleonite 4 narrowly rounded, not extending beyond posterior margin of pleonite 5; pleonite 5 with posterolateral angles overlapped by lateral margins of pleonite 4. *Pleotelson* 1.1 times as long as anterior width, dorsal surface without longitudinal carina; lateral margins convex, margins smooth, posterior margin narrowly rounded, without median point.

Uropod peduncle posterior lobe about three-quarters as long as endopod; rami extending just beyond pleotelson, exopod 0.7 as long as endopod; apices acute. *Endopod* 2.3 times as long as wide; lateral margin weakly convex, without prominent excision; mesial margin strongly convex; lateral and mesial margins forming an angle of 52°. *Exopod* not extending to end of endopod, 2.7 times as long as greatest width (inferred—apices all broken); lateral margin weakly convex; mesial margin straight, distally convex.

Etymology. Refers to the Aptian (Early Cretaceous) age for the species.

Remarks. *Cirolana aptiana* sp. nov. differs from *Cirolana enigma*, *C. garassinoi* and *C. cotreaui* in having short uropods that only extend slightly beyond the posterior of the pleotelson and a slender, comparatively narrow pleon; these characters also make it different from the other two *Cirolana* species herein described.

Cirolana bretoni sp. nov

Fig. 5 and 6

Material. Nine specimens, holotype IHNFG-5947, paratypes IHNFG-5948 to IHNFG-5955.

Measurements (in mm). Holotype IHNFG-5947, length = 14.4; width = 6.4; paratype IHNFG-5948, length = 7.2; width = 2.4; paratype IHNFG-5949, length = 12.5; width = 6.2; paratype IHNFG-5950, length = 6.5; width = 2.3; paratype IHNFG-5951, length = 16.8; width = 5.8; paratype IHNFG-5952, length = 6.7; width = 2.5; paratype IHNFG-5953, length = 15.1; width = 4.5; paratype IHNFG-5954, length = 13.5; width = 4.8; paratype IHNFG-5955, length = 15.5; width = 4.2.

Description. *Body* 2.8 times as long as greatest width, widest at pereonite 5, dorsal surfaces smooth, lateral margins subparallel. *Pereonite 1* and *coxae* 2–3 each with posteroventral angle rounded; posterior margins of pereonites 5–7 smooth. *Pleon* with pleonite 1 largely concealed by pereonite 7; pleonites 3–5 posterior margin smooth; posterolateral angles of pleonite 2 rounded, not posteriorly produced; pleonite 3 with posterolateral margins not extending to posterior margin of pleonite 5, narrowly rounded; posterolateral margin of pleonite 4 narrowly rounded, not extending beyond posterior margin of pleonite 5; pleonite 5 with posterolateral angles overlapped by lateral margins of pleonite 4. *Pleotelson* 0.9 times as long as anterior width, dorsal surface without longitudinal carina; lateral margins convex, margins smooth, posterior margin converging to caudomedial point, without median point.

Frontal lamina pentagonal, ventral surface entirely flat, 2.0 as long as maximum width, 4.0 as long as posterior width, lateral margins straight, diverging slightly towards anterior, then angling medially forming median point.

Pereopod 6 basis 2.7 times as long as greatest width, superior margin weakly convex; ischium 0.7 as long as basis; merus 1.0 as long as ischium, 1.7 times as long as wide; carpus 0.9 as long as ischium, 2.0 times as long as wide; propodus 1.4 as long as ischium, 4.3 times as long as wide.

Uropod peduncle posterior lobe about one-half (0.4) as long as endopod; rami extending well beyond pleotelson; exopod 0.76 as long as endopod; apices acute. *Endopod* apically not bifid, 2.5 times as long as greatest width; lateral margin weakly convex, without prominent excision; mesial margin proximally convex, distally straight; lateral and mesial margins forming an angle of 48°. *Exopod* lanceolate, not extending to end of endopod, apically not bifid, 4.4 times as long as greatest width; lateral margin weakly convex; mesial margin weakly convex.

Etymology. In honour of Gérard Breton, a great French palaeontologist.

Remarks. *Cirolana bretoni* sp. nov. is best identified by the relatively

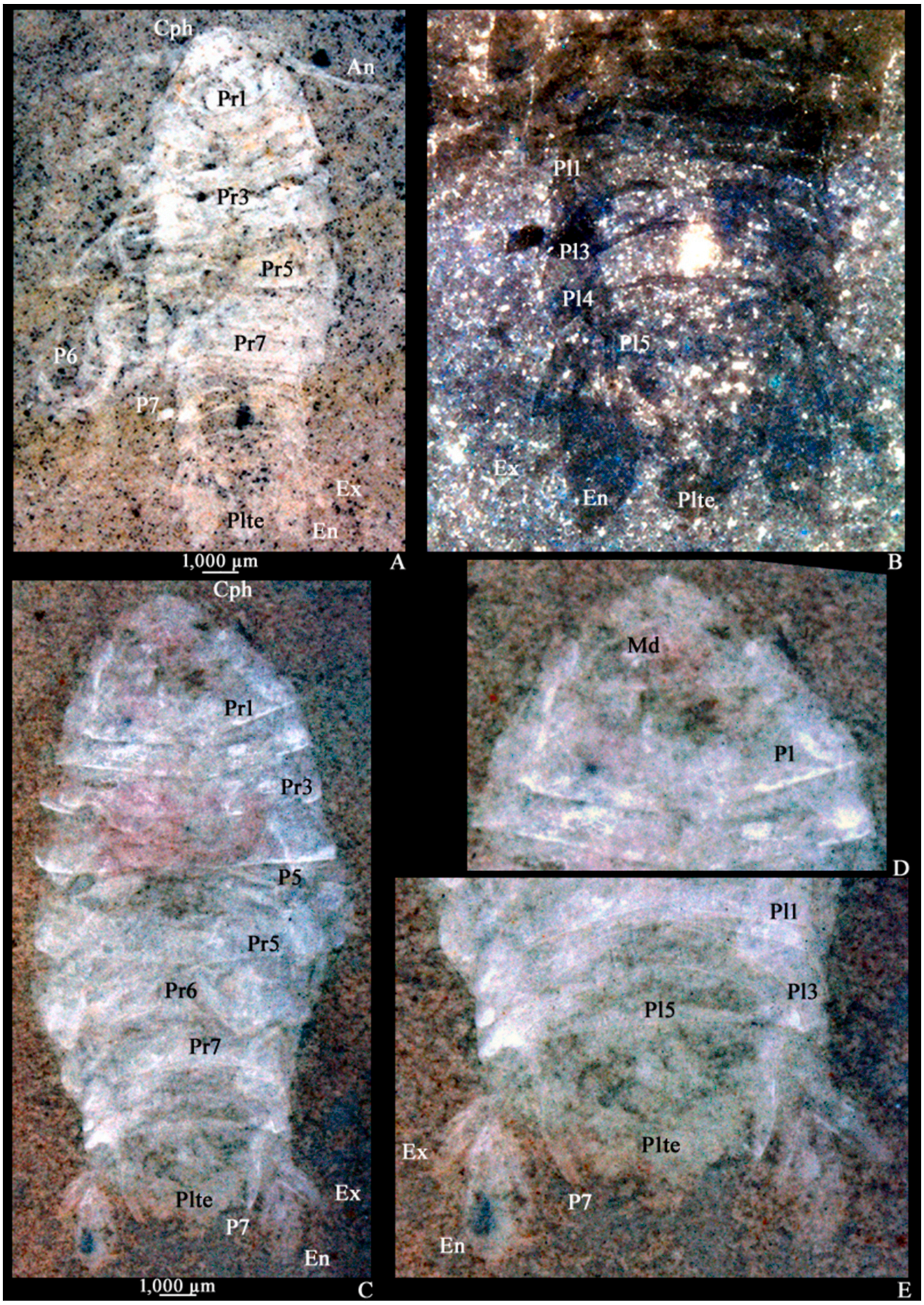

Fig. 4. *Cirolana aptiana*, sp. nov. A, B, holotype IHNFG-5945, dorsal view and close-up of posterior portion of carapace. C-E, paratype IHNFG-5946, dorsal view and close ups of anterior and posterior portions of carapace.

short mesial lobe on the uropodal peduncle, relatively slender uropodal and apically acute uropodal rami, with the exopod not extending to the posterior of the endopod and the rami extending well beyond the posterior of the pleotelson; and the lateral margins of both pleonite 3 and pleonite 4 not quite reaching the posterior margin of pleonite 5. *Cirolana bretoni* differs from *Cirolana aptiana* sp. nov., by the more acute uropodal rami extending well beyond the posterior of the pleotelson, and by, by the wider pleon and pleonites 3 and 4 being less strongly produced than in the latter species. *Cirolana bretoni* sp. nov. differs from *C. enigma* and *C. garassinoi* in having a long, endopod and a short, acute lanceolate exopod; it bears certain similarity to *C. cotreaui* but the pleotelson of the species from Libano is broader and its pleon slightly narrower.

Cirolana longirostra sp. nov.

Fig. 7

Material. Four specimens, holotype IHNFG-5956, paratypes IHNFG-5957 to IHNFG-5959.

Measurements (in mm). Holotype IHNFG-5956 length = 15.4; width = 6.2; paratype IHNFG-5957 length = 15.2; width = 5.1; paratype IHNFG-5958 length = 7.5; width = 3.7; paratype IHNFG-5959 length = 11.6; width = 5.1.

Description. *Body* 2.1 times as long as greatest width, widest at pereonite 5, dorsal surfaces smooth, lateral margins weakly ovate.

Rostral point present, projecting anteriorly, not ventrally folded, 3.3 as long as proximal width, 1.4 times as long as head. *Pereonite* 1 with two anteriorly-directed flat processes, of similar size to rostrum. *Pleon* with pleonite 1 largely concealed by pereonite 7; pleonites 3–5 posterior margin smooth; not posteriorly produced; pleonite 3 with posterolateral margins acute, weakly posteriorly produced, not extending to posterior margin of pleonite 5; posterolateral margin of pleonite 4 acute, not extending beyond posterior margin of pleonite 5; pleonite 5 with posterolateral angles overlapped by lateral margins of pleonite 4. *Pleotelson* 1.0 as long as anterior width, dorsal surface without longitudinal carina; lateral margins convex, smooth, posterior margin narrowly rounded, without median point.

Pereopod 1 obscure, propodus 2 times as long as wide, apparently swollen, with haptorial dactylus about as long as propodus. Remaining pereopods indistinct, but ambulatory.

Uropod peduncle posterior lobe about one-third as long as endopod; rami not extending beyond pleotelson, exopod 0.8 as long endopod, apices acute. *Endopod* apically not bifid, apical point; lateral margin distally straight, without prominent excision; mesial margin strongly convex; endopod 2.2 as long as wide; lateral and distomesial margins forming an angle of 88°. *Exopod* not extending to end of endopod, apically not bifid, 3.2 times as long as greatest width; mesial margin straight, distally weakly convex.

Etymology. Refers to the projected rostra of specimens of this species.

Remarks. *Cirolana longirostra* sp. nov. is a abundantly distinct species of quite remarkable appearance, and indeed unlike any known cirolanid, fossil or extant. The head has a large, conspicuous rostrum, flanked on either side by similarly shaped process arising from the anterior margin of pereonite 1. The pereopods are poorly preserved, but pereopod 1 appears to be haptorial (see Bruce and Humphreys, 1993, p. 876 for definition of that term), and not dissimilar to that shown by the

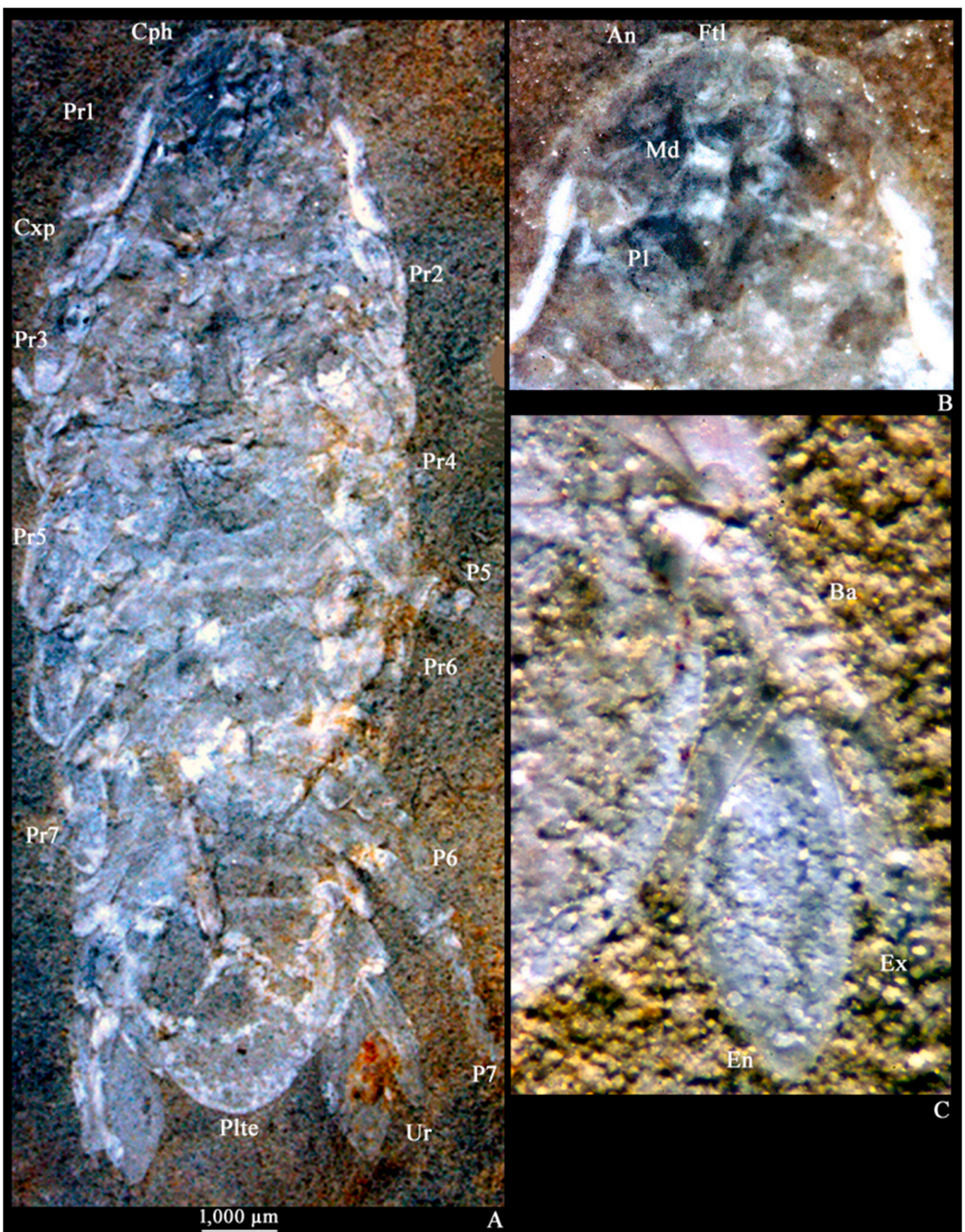

Fig. 5. *Cirolana bretoni*, sp. nov. A-C, holotype IHNFG-5947, ventral view and close-ups of anterior portion of carapace and left uropod.

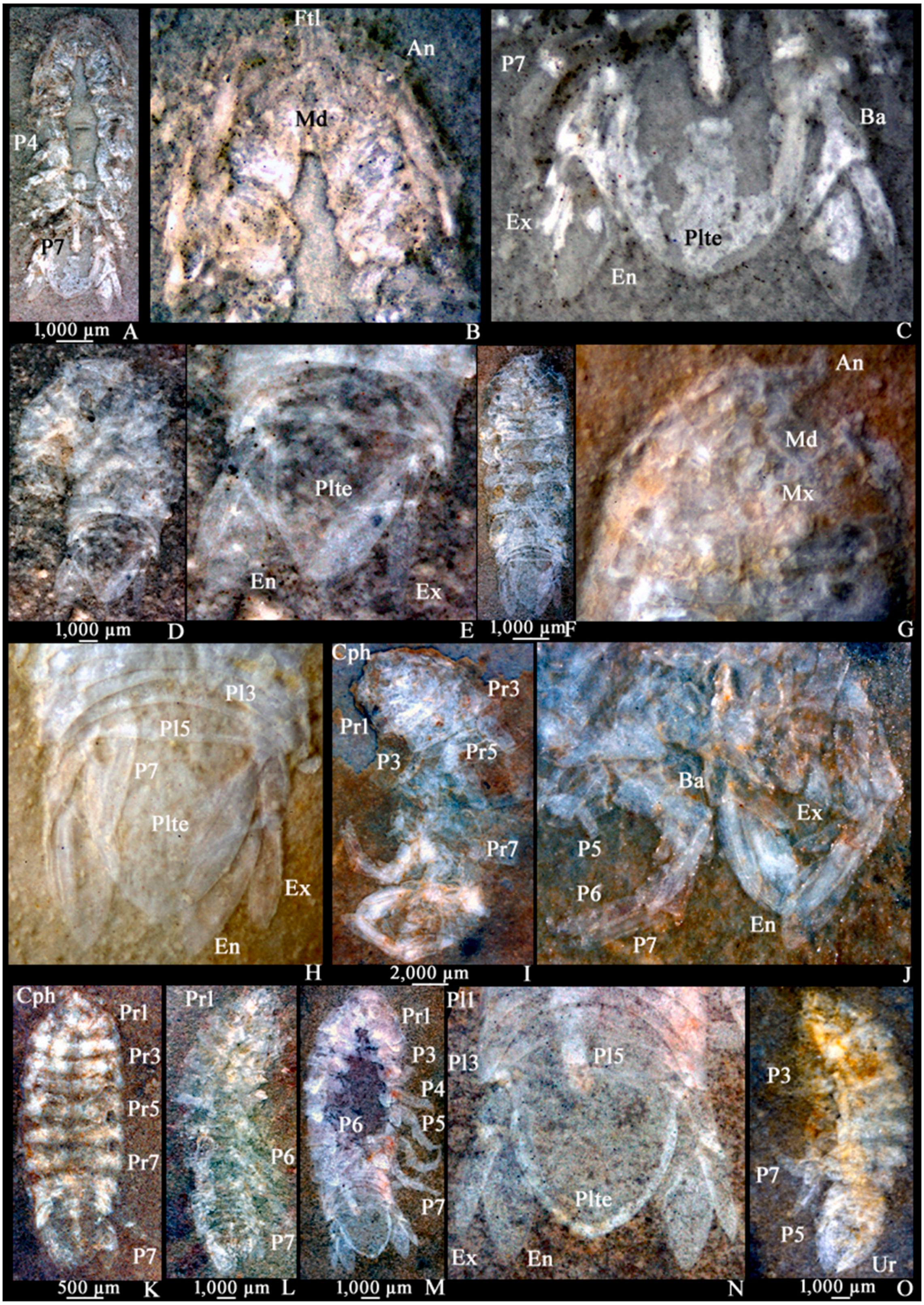

Fig. 6. *Cirolana bretoni*, sp. nov. A-C, paratype IHNFG-5948, ventral view and close ups of anterior and posterior portions of carapace. D, E, paratype IHNFG-5949, dorsal view and close up to posterior portion of carapace. F–H, paratype IHNFG-5950, dorsal view and close ups of anterior and posterior portions of carapace. I, J, paratype IHNFG-5951, left lateral view and close-up of posterior portion of carapace. K, paratype IHNFG-5952, dorsal view of carapace. L, paratype IHNFG-5953, right lateral view of carapace. M, N, paratype IHNFG-5954, dorsal view and close up of posterior portion of carapace. O, paratype IHNFG-5955, left lateral view of carapace.

deep-water cirolanid *Sintorolana* Bruce, 1996. Adult males of Aegiochus vigilans (Haswell, 1881) have a similar tri-horned appearance (Bruce, 1983, 2009), but the rostral process is usually anteriorly bifurcate, while the processes on pereonite 1 are submedian rather than sublateral, and most other characters differ markedly between the two species, notably in pleotelson and uropodal shape.

Dorsal ornamentation, whether in the Aegidae, Cirolanidae or Sphaeromatidae has repeatedly been shown not to be of generic value. Dorsal "horns" are scarce in the Cirolanidae, but are present in one species of *Metacirolana* Kussakin, 1979, an otherwise unornamented genus. Similarly, *Aegiochus weberi* (Nierstrasz, 1931) has large spatulate processes arising on the dorsal surface on the head, together with *Aegiochus vigilans*, the only species in an otherwise unornamented genus.

Cirolana longirostra sp. nov. Further differs from all species described herein, and also all other fossil cirolanids in the uropodal endopod lateral margin forming a near right angle (88°) with the distomesial margin.

4. Conclusions

The Peracarida fossil crustaceans from the Aptian dolomite plattenkalk deposits of the lower Sierra Madre Formation in Chiapas bear an abundant and diverse fauna of isopods and tanaidaceans. The preservation of many of the specimens is exceptional and shows most of the carapace morphology, including antennae, frontal lamina, mouthparts, coxal plates, pereonites, pleonites, pereopods, pleotelson and uropods. In comparison with other described species of fossil *Cirolana* species, the species from Chiapas are more abundant and well-preserved in dolomite plattenkalk deposits that suffered a diagenetic process that caused among invertebrates, that only those with chitinous carapaces could be

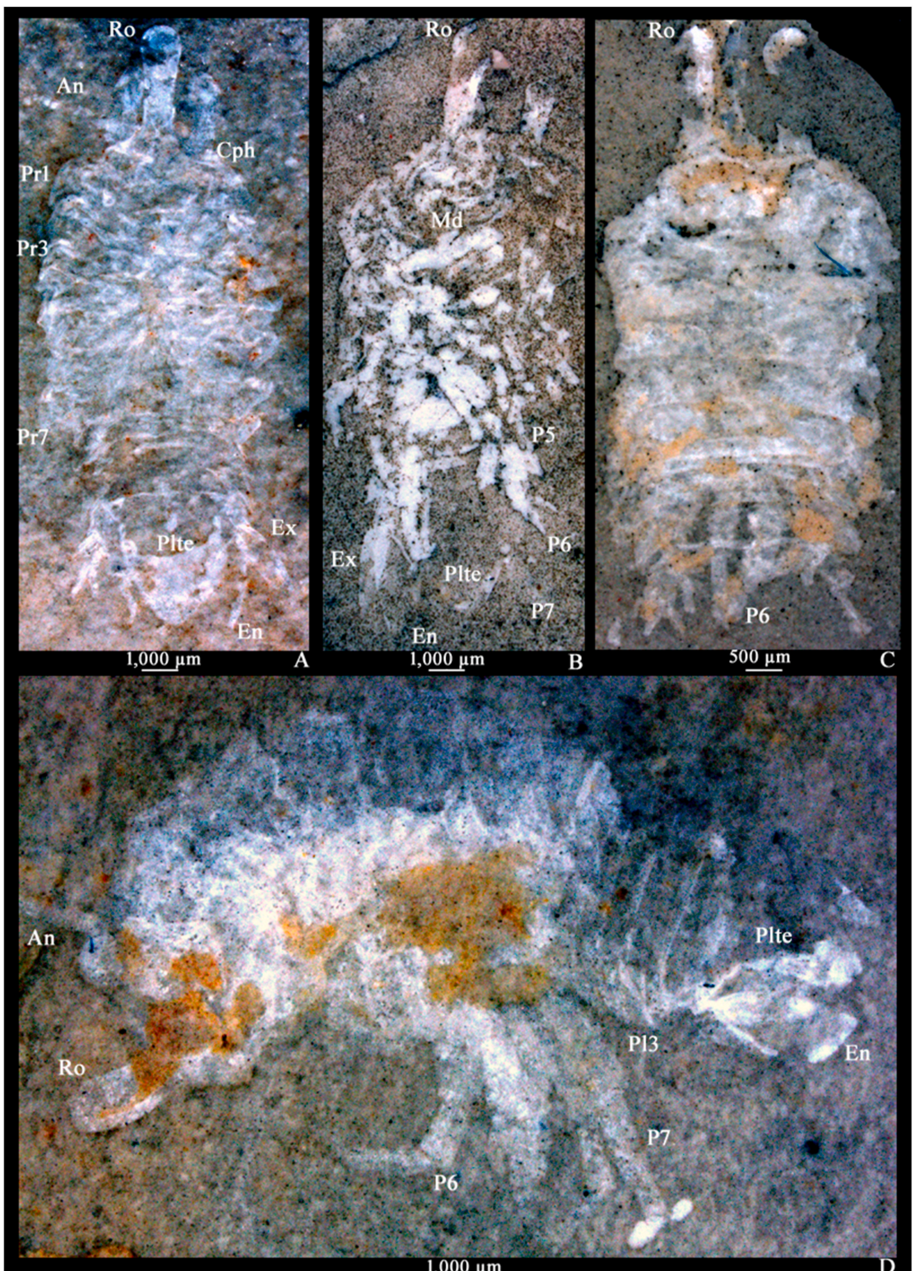

Fig. 7. *Cirolana longirostra*, sp. nov. A, holotype IHNFG-5956, ventral view of carapace. B, paratype IHNFG-5957, ventral view of carapace. C, paratype IHNFG-5958, dorsal view of carapace. D, paratype IHNFG-5959, left lateral view of carapace.

preserved (crustaceans and aquatic insects). Along with the already described associated tanaidaceans (Heard et al., 2020), this is one of the best represented Cretaceous Peracarida shallow-water marine associations and still have some unidentified sphaeromatid isopods and other lower Crustacea to be described. A contribution on the sphaeromatid isopods associated to these Peracarida is now in progress. The new species herein described rise the number of Cretaceous isopods identified as *Cirolana* to six, and the number of fossil isopods reported from Mexico to 25, from the Early Cretaceous to the Neogene.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Our sincere gratitude to Biól. Marco A. Coutiño and the Museo de Paleontologia "Eliseo Palacios Aguilera", Secretaria de Medio Ambiente e Historia Natural, for support during multiple fieldworks and collection of specimens. Also, our sincere gratitude to Drs. Margarita Reyes-Salas and Teresa Pi Puig, for their support with the microprobe and a few SEM images. This is contribution number 490 from the NWU-Water Research Group, South Africa.

References

Alvarado-Ortega, J., Ovalles-Damian, E., Blanco-Pinon, A., 2009. The fossil fishes from the Sierra Madre Formation, ocozocoautla, Chiapas, southern Mexico. Palaeontol. Electron. 12 (2), 22. 4A.

Baldanza, A., Bizzarri, R., De Angeli, A., Famiani, F., Garassino, A., Pasini, G., Pizzolato, F., 2017. A distinctive shallow marine crustacean fauna from the early Pleistocene of Poggi Gialli (Tuscany, central Italy): taxonomic inferences and palaeoenvironmental reconstruction. Neues Jahrbuch Geol. Palaontol. Abhand. 286 (1), 35–74.

Bárcena, M., 1875. Descripción de un Crustáceo fósil del género *Sphaeroma (S. burkartii)* y reseña geológica del Valle de Ameca, Jalisco. La Naturaleza 3, 355–361.

Brandt, A., Poore, G.C.B., 2003. Higher classification of the flabelliferan and related Isopoda based on a reappraisal of relationships. Invertebr. Systemat. 17, 893–923.

Broly, P., Serrano-Sánchez, M.L., Rodríguez-García, S., Vega, F.J., 2017. Fossil evidence of extended brood care in new Miocene Peracarida (Crustacea) from Mexico. J. Syst. Palaeontol. 15, 1037–1049.

Broly, P., Serrano-Sánchez, M.L., Vega, F.J., 2018. Diversity of the crinocheta (Crustacea, Isopoda, Oniscidea) from early Miocene Chiapas amber, Mexico. Rev. Mex. Ciencias Geol. 35, 204–216.

Bruce, N.L., 1981. Cirolanidae (Crustacea: Isopoda) of Australia: diagnoses of *Cirolana* Leach, *Metacirolana* nierstrasz, *neocirolana* hale, *anopsilana* paulian & debouteville, and three new genera – *Natatolana, politolana* and *cartetolana*. Aust. J. Mar. Freshw. Res. 32, 945–966.

Bruce, N.L., 1983. Aegidae (Isopoda: Crustacea) from Australia with descriptions of three new species. J. Nat. Hist. 17 (5), 757–788.

Bruce, N.L., 1984. A new family for the isopod crustacean genus *Tridentella* Richardson, 1905, with description of a new species from Fiji. Zool. J. Linn. Soc. 80, 447–455.

Bruce, N.L., 1986. Cirolanidae (Crustacea: Isopoda) of Australia. Record Aust. Mus. 6, 1–239. Supplement.

Bruce, N.L., 1993. Two new genera of marine isopod crustaceans (Cirolanidae) from Madang, Papua New Guinea. Memoir. Queensl. Mus. 33, 1–15.

Bruce, N.L., 1996. Crustacea Isopoda: some Cirolanidae from the MUSORSTOM Cruises off New Caledonia. Résultats des Campagnes MUSORSTOM, Volume 15. Mém. Mus. Nat. Hist. Nat. Paris 168, 147–166.

Bruce, N.L., 2004. New species of the *Cirolana* 'parva-group' (Crustacea: Isopoda: Cirolanidae) from coastal habitats around New Zealand. Species Divers. 9, 47–66.

Bruce, N.L., 2008. New species of *tridentella* richardson, 1905 (Isopoda: Cymothoida: Tridentellidae), tropical marine isopod crustaceans from the banda sea, Indonesia. Zootaxa 1734, 43–58.

Bruce, N.L., 2009. The marine fauna of New Zealand: Isopoda, Aegidae (Crustacea). NIWA Biodivers. Mem. 122, 1–252.

Bruce, N.L., Ellis, J., 1983. *Cirolana cranchi* Leach, 1818 (Crustacea: Isopoda: Cirolanidae) redescribed, with notes on its distribution. Bullet. Brit. Mus. Nat. Hist. (Zool.) 44, 75–84.

Bruce, N.L., Humphreys, W.F., 1993. *Haptolana pholeta*, sp. nov., the first subterranean flabelliferan isopod crustacean (Cirolanidae) from Australia. Invertebr. Taxon. 7, 875–884.

Bruce, N.L., Lew Ton, H.M., Poore, G.C.B., 2002. Cirolanidae Dana, 1852. In: Poore, G.C. B. (Ed.), Crustacea: Malacostraca: Syncarida and Peracarida: Isopoda, Tanaidacea, Mictacea, Thermosbaenacea, Spelaeogriphacea, vol. 19. CSIRO Publishing, Melbourne, pp. 138–157.

Bruce, N.L., Svavarsson, J., 2018. Three new species species of *tridentella* richardson, 1905 (Isopoda: Cymothoida: Tridentellidae) from New Caledonia. Zootaxa 4399, 101–118.

Brusca, R.C., Wetzer, R., France, S.C., 1995. Cirolanidae (Crustacea: Isopoda: flabellifera) of the tropical eastern pacific. Proc. San Diego Soc. Nat. Hist. 30, 1–96.

Camp, D.K., Heard, R.W., 1988. *Booralana tricarinata*, a new species of isopod from the western atlantic ocean (Crustacea: Isopoda: Cirolanidae). Proc. Biol. Soc. Wash. 101, 603–613.

Dana, J.D., 1852. On the classification of the Crustacea choristopoda or tetradecapoda. Am. J. Sci. Arts 14, 297–316. Second Series.

De Angeli, A., Rossi, A., 2006. Crostacei Oligocenici di Perarolo (Vicenza – italia settentrionale), con la descrizione di una nuova specie di Mysida e di Isopoda. Lavori, Soc. Veneziana di Sci. Nat. 31, 85–93.

Delaney, P.M., 1989. Phylogeny and biogeography of the marine isopod family Corallanidae (Crustacea, Isopoda, Flabellifera). Contribut. Sci. Nat. Hist. Mus. Los Angeles County 409, 1–75.

Dreyer, H., Wägele, J.-W., 2002. The Scutocoxifera tax. nov. and the information content of nuclear ssu rDNA sequences for reconstruction of isopod phylogeny (Peracarida: Isopoda). J. Crustac Biol. 22, 217–234.

Feldmann, R.M., 2009. A new cirolanid isopod (Crustacea) from the Cretaceous of Lebanon: dermoliths document the premolt condition. J. Crustac Biol. 29, 373–378.

Feldmann, R.M., Charbonnier, S., 2011. *Ibacus cottreaui* roger, 1946, reassigned to the isopod genus *Cirolana* (Cymothoida: Cirolanidae). J. Crustac Biol. 31 (2), 317–319.

Feldmann, R.M., Vega, F.J., Applegate, S.P., Bishop, G.A., 1998. Early cretaceous arthropods from the Tlayúa Formation at tepexi de Rodríguez, Puebla, Mexico. J. Paleontol. 72, 79–90.

Feldmann, R.M., Schweitzer, C.E., Maxwell, P.A., Kelley, B.M., 2008. Fossil isopod and decapod crustaceans from the kowai formation (Pliocene) near makikihi, South canterbury, New Zealand. N. Z. J. Geol. Geophys. 51, 43–58.

García-Barrera, P., Vega, F.J., Carbot-Chanona, G., Coutiño, M.A., 2005. El registro fósil en Chiapas: 250 millones de años de biodiversidad. In: Álvarez-Noguera, F. (Ed.), Chiapas: Estudios sobre su riqueza biológica. Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City, pp. 35–53.

Gašparic, R., Fraaije, H.B., van Bakel, B.W.M., Jagt, J.W.M., Skupien, P., 2015. Mezozoic–Cenozoic crustaceans preserved with echinoid and bivalve shells. Bull. Geosci. 90, 601–611.

González-Ramírez, I., Calvillo-Canadell, L., Cevallos-Ferriz, Sergio, R.S., 2013. Coníferas cupresáceas fósiles de "El Chango", Chiapas (Aptiano). Palaontol. Mexic. 63, 24–31.

González-Rodríguez, K.A., García-Barrera, P., Avendaño, J., 2002. Un Nuevo registro de la Familia Macrosemiidae (Neopterygii: halecostomi) en Chiapas, Sureste de Mexico. In: XVI Convención Geológica Nacional and III Reunión de Ciencias de la Tierra. Sociedad Geológica Mexicana, Abstract book, p. 303.

Hadfield, K.A., Bruce, N.L., Smit, N.J., 2014. Review of the fish parasitic genus *Ceratothoa* Dana, 1852 (Crustacea, Isopoda, Cymothoidae) from South Africa, including the description of two new species. ZooKeys 400, 1–42.

Hansen, H.J., 1890. Cirolanidae et familiae nonnulae propinquae Musei Hauniensis. Det Kongelige Danske Videnskabernes Selskab Skrifter. Naturvidenskab. Math. 6, 237–426.

Haswell, W.A., 1881. On some new Australian marine Isopoda. Part I. Proc. Linn. Soc. N. S. W. 5 (4), 470–481 pls 16–19.

Heard, R.W., Morales-Núñez, A.G., Serrano-Sánchez, M.L., Coutiño, M.A., Barragán, R., Vega, F.J., 2020. A new family, genus and species of Tanaidacea (Crustacea; Apseudomorpha) from the Lower Cretaceous (Aptian) of Chiapas, Mexico: systematic revisions, including designation of two new Paleozoic families, and paleoenvironmental observations. J. S. Am. Earth Sci. 102, 102609, 29 pp.

Hessler, R.R., 1969. Peracarida Isopoda. In: Moore, R.C. (Ed.), Treatise on Invertebrate Palaeontology. Geological Society America, New York, pp. R371–R384.

Hosie, A.M., Sampey, A., Davie, P.J.F., Jones, D.S., 2015. Kimberley marine biota. Historical data: crustaceans. Record West Aust. Mus. 84, 247–285 supplement.

Hyžný, M., Bruce, N.L., Schlögle, J., 2013. Appraisal of the fossil record for the Cirolanidae (Malacostraca: Peracarida: Isopoda: Cymothoida), with a description of a new cirolanid isopod crustacean from the early Miocene of the Vienna Basin (western carpathians). Paleontology 56, 615–630.

Joyce, W.G., Rollot, Y., Cifelli, R.L., 2020. A new species of baenid turtle from the Early Cretaceous Lakota Formation of South Dakota. Fossil Record 23, 1–13.

Keable, S.J., 1999. New species and records of *Plakolana* Bruce (Crustacea: Isopoda: Cirolanidae) from Australia. Memoir. Queensl. Mus. 43, 763–775.

Keable, S.J., 2006. Taxonomic revision of *Natatolana* (Crustacea: Isopoda: Cirolanidae). Record Aust. Mus. 58, 133–244.

Kensley, B., Schotte, M., 1989. Guide to the Marine Isopod Crustaceans of the Caribbean. Smithsonian Institution Press, Washington, D.C. & London, p. 308.

Kossmann, R., 1880. Malacostraca (2. Theil: anomura, macrura, schizopoda, stomatopoda, Isopoda, laemodipoda, Amphipoda). In: Zoologische Ergebnisse einer in Auftrage der Königlichen Academie der Wissenschaften zu Berlin ausgeführten Reise in die Küstengebiete des Rothen Meeres, vol. 2, pp. 67–140. Plates 144–114.

Kussakin, O.G., 1979. Marine and brackishwater likefooted Crustacea (Isopoda) from the cold and temperate waters of the Northern Hemisphere. Suborder Flabellifera. In: Opredeliteli Po Faune SSSR, Izdavaemye Zoologicheskim Institutom Akademii Nauk SSSR, vol. 1. Izdatel'stvo Nauka, Leningrad, pp. 1–472 [In Russian]).

Latreille, P.A., 1802. Histoire naturelle, générale et particulière des crustacés et des insectes. Dufart, Paris, p. 468.

Latreille, P.A., 1817. Les crustacés, les arachnides et les insectes. In: Cuvier, G. (Ed.), Le règne animal distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée, first ed., vol. 3. Deterville, Paris, p. 653.

Leach, W.E., 1814. Crustaceology. In: Brewster, D. (Ed.), The Edinburgh Encyclopaedia, vol. 7. Baldwin, London, pp. 383–437 pl. 221.

Leach, W.E., Cuvier, F., 1818. Cymothoadées, cymothoadæ. (Crustacea). In: Dictionnaire des Sciences Naturelles, dans lequel on traite méthodiquement des différents êtres de la Nature, considérés soit en eux-mêmes, d'après l'état actuel de nos connaissances, soit relativement a l'utilité qu'en peuvent retirer la Médecine, l'Agriculture, le Commerce et les Arts. Suivi d'une biographie des plus Célèbres Naturalistes. Ouvrage destiné aux médecins, aux agriculteurs, aux commerçons, aux artistes, aux manufacturiers, et à tous ceux qui ont intérêt à connaître les productions de la nature, leurs caractères génériques et spécifiques, leur lieu natal, leurs propriétés et leurs usages, vol. 12. F.G. Levrault et Le Normant, Strasbourg et Paris, p. 564, 338–354.

Maguire, E.P., Feldmann, R.M., Jones, W.T., Schweitzer, C.E., Casadío, S., 2018. The first fossil isopod from Argentina: a new species of Cirolanidae (Crustacea: Peracarida) from the Miocene of Patagonia. J. Crustac Biol. 38 (1), 34–44.

Martin, M.B., Bruce, N.L., Nowak, B.F., 2016. Review of the fish-parasitic genus *cymothoa* fabricius, 1793 (Crustacea: Isopoda: Cymothoidae) from Australia. Zootaxa 4119, 1–72.

Nierstrasz, H.F., 1931. Isopoda genuina. II. Flabellifera. Pp. 123–233, pls 10–11. In: Weber, M., De Beaufort, L.F. (Eds.), Die Isopoden der Siboga-Expedition. E.J. Brill, Leiden.

Ovalles-Damián, E., Alvarado-Ortega, J., 2002. Los paraclupeidos de la Cantera El espinal, ocozocoautla de Espinosa, Chiapas. In: VIII Congreso Nacional de Paleontología, Ponencias. Sociedad Mexicana de Paleontología y Museo de Paleontología de Guadalajara "Federico A. Solorzano Barreto, p. 120.

Ovalles-Damián, E., Alvarado-Ortega, J., Blanco-Piñón, A., 2006. Los peces fósiles del Cretácico Inferior de Ocozocoautla, Chiapas. In: Memorias del X Congreso Nacional de Paleontología. Sociedad Mexicana de Paleontología, México, p. 61.

Paiva, R.J.C., Souza-Filho, J.F., 2015. A new species of *Dolicholana* Bruce, 1986 (Isopoda, cymothoidea, Cirolanidae), the first record of the genus from the atlantic ocean. Zootaxa 4039, 276–288.

Rafinesque, C.S., 1815. Analyse de la nature ou tableau d l'univers et des corps organisées. Publisher unknown, Palermo, p. 224.

Rodcharoen, E., Bruce, N.L., Pholpunthin, P., 2016. Description of four new species of the *Cirolana 'parva* group' (Crustacea: Isopoda: Cirolanidae) from Thailand, with supporting molecular (COI) data. J. Nat. Hist. 50, 1464–5262.

Roger, J., 1946. Invertébrés des couches à Poissons du Crétacé supérieur du Liban. Étude paléobiologique des gisements. In: Mémoires de la Société géologique de France, (Nouvelle série), vol. 51, pp. 1–92.

Schädel, M., van Eldijk, T., Winkelhorst, H., Reumer, J.W.F., Haug, J.T., 2020. Triassic Isopoda – three new species from Central Europe shed light on the early diversity of the group. Bull. Geosci. 95, 145–166.

Secretan, S., 1975. Les crustacés du Monte Bolca, pp. 315–424. In: Studi e ricerche sui giacimenti Terziari di Bolca, II, Museo Civico di Storia Naturale di Verona, vol. 1. Miscellanea paleontologica, pp. 315–425.

Serrano-Sánchez, M.L., Vega, F.J., Bruce, N., 2006. Isopod and tanaidacean crustaceans (Peracarida) from the cretaceous (albian) of Chiapas, southern Mexico: systematic and paleoecological implications. Geol. Soc. Am. Abst. 38 (7), 67.

Serrano-Sánchez, M.L., Vega, F.J., Coutino, M.A., 2007. Terrestrial isopods included in Miocene amber from Chiapas, Mexico. Geol. Soc. Am. Abst. 39 (6), 76–77.

Serrano-Sánchez, M.L., Nagler, C., Haug, C., Haug, J.T., Centeno-García, E., Vega, F.J., 2016. The first fossil record of larval stages of parasitic isopods: cryptoniscus larvae preserved in Miocene amber. Neues Jahrbuch Geol. Palaontol. Abhand. 279, 97–106.

Sidabalok, C.M., Bruce, N.L., 2017. Review of the species of the *Cirolana 'parva*-group' (Cirolanidae: Isopoda: Crustacea) in Indonesian and Singaporean waters. Zootaxa 4317, 401–435.

Stebbing, T.R.R., 1893. A History of Crustacea. Recent Malacostraca. Kegan Paul, Trench, Trubner & Co. Ltd., London, xvii, p. 466.

Stebbing, T.R.R., 1905. Report on the Isopoda collected by professor herdman, at ceylon. In: 1902. Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar, 1905, vol. 4. Supplementary Report, pp. 47–64.

Vega, F.J., García-Barrera, P., Coutiño, M., Nyborg, T., Cifuentes-Ruiz, P., González-Rodríguez, K., Martens, A., Delgado, C.R., Carbot, G., 2003. Early Cretaceous arthropods from plattenkalk facies in Mexico. Contrib. Zool. 72, 187–189.

Vega, F.J., Bruce, N.L., Serrano, M.L., Bishop, G.A., Perrilliat, M.C., 2005. A review of the lower cretaceous (Tlayúa Formation: albian) Crustacea from tepexi de Rodríguez, Puebla, Central Mexico. Bull. Mizunami Foss. Mus. 32, 25–30.

Vega, F.J., Nyborg, T.G., Perrilliat, M.C., 2006. Mesozoic and tertiary Crustacea from Mexico. In: Vega, F.J., Nyborg, T.G., Perrilliat, M.C., Montellano Ballesteros, M., Cevallos Ferriz, S.R.S., Quiroz Barroso, S.A. (Eds.), Studies on Mexican Paleontology, vol. 24. Topics in Geobiology, pp. 79–100.

Vega, F.J., Charbonnier, S., Gómez-Pérez, L.E., Coutiño, M.A., Carbot- Chanona, G., Távora, V., Serrano-Sánchez, M.L., Téodori, D., Hernández-Monzón, O., 2018. Review and additions to the maastrichtian (late cretaceous) Crustacea from Chiapas, Mexico. J. S. Am. Earth Sci. 85, 325–344.

Vega, F.J., Bruce, N.L., González-León, O., Jeremiah, J., Serrano-Sánchez, M.L., Alvarado-Ortega, J., Moreno-Bedmar, J.A., 2019. Lower cretaceous marine isopods (Isopoda: Cirolanidae, Sphaeromatidae) from the san juan Raya and Tlayúa formations, Puebla, Mexico. J. Crustac Biol. 39 (2), 121–135.

Vonk, R., Latella, L., Zorzin, R., 2015. Eocene isopods of Pesciara di Bolca (Italy) revisited. J. Crustac Biol. 35 (4), 540–546.

Wägele, J.-W., 1989. Evolution und phylogenetisches System der Isopoda. Stand der Forschung und neue Erkenntnisse. Zoologica 140, 1–262.

Wägele, J.-W., Brandt, A., 1988. *Protognathia* n.gen. *bathypelagica* (schultz, 1977) rediscovered in the weddell sea: a missing link between the Gnathiidae and the Cirolanidae (Crustacea, Isopoda). Polar Biol. 8, 359–365.

White, A., 1850. Part IV.– Crustacea. In: List of the Specimens of British Animals in the Collection of the British Museum, vols. i–iv. British Museum, London, pp. 1–141.

Wieder, R.W., Feldmann, R.M., 1992. Mesozoic and cenozoic fossil isopods of north America. J. Paleontol. 66, 958–972.