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First fossil oribatid mite from Lebanese amber (Acariformes, Oribatida, Neolioididae)

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Abstract

We describe herein *Neoliodes andreneli* sp. nov., an oribatid mite belonging to the family Neolioididae, from the Lower Cretaceous amber of Lebanon. The new taxa is characterized, illustrated, and its systematic position is discussed. *Neoliodes andreneli* sp. nov. constitutes the first mite to be described from the Lebanese amber, and the earliest oribatid mite in amber.

Keywords: mites, Oribatida, Neolioididae, *Neoliodes*, Lower Cretaceous, Lebanon, sp. nov.

Introduction

Lebanese amber is the oldest of fossiliferous Cretaceous ambers. More than 400 localities have been discovered, including 23 that have yielded highly diverse biological inclusions. More than 15,000 inclusions (mainly insects) have been found in this amber, with 232 described and named taxa including 222 insects and eight arachnids. The age of Lebanese amber is considered to be early Barremian (Maksoud *et al.*, 2017; Granier *et al.*, 2016). The formation of the amber in Lebanon corresponds to the beginning of the diversification of the flowering plants, a critical period for the study of the evolution, with extinction of many ancient insect groups and emergence of effectively modern lineages.

Oribatid mite fossil records are scarce, particularly in pre-Cenozoic strata, where they are usually overlooked due to their minute size. The earliest occurrence of oribatids comes from the Givetian (Middle Devonian) of Gilboa (Schoharie County, New York, USA) and from the Frasnian (Upper Devonian) of South Mountain (New York, USA) (Norton *et al.*, 1988; Subías & Arillo,

2002). To date, the earliest known fossil oribatid mites preserved in amber come from the Cretaceous: twelve species have been described from Albian Spanish amber (Arillo & Subías, 2000, 2002; Arillo *et al.*, 2008, 2009, 2010, 2012, 2016; Arillo *et al.* in press), one species is known from the Campanian Canadian amber (Sidorchuk & Behan-Pelletier, 2017) and two species are known from the Santonian amber of Taimyr, Northern Russia (Bulanova-Zachvatkina, 1974; Krivolutsky & Ryabinin, 1976).

The superfamily Neoliodoidea (with a single family Neolioididae Sellnick, 1928) comprises 52 extant species in 4 genera (*Neoliodes* Berlese, 1888; *Platyliodes* Berlese, 1916; *Poroliodes* Grandjean, 1934; and *Teleioloides* Grandjean, 1934) (Subías, 2004). Concerning extinct species, *Platyliodes* is the only genus previously known from the Cretaceous: *Platyliodes sellnicki* Arillo & Subías, 2016 in Spanish amber. Besides this species, the genus is also known from Baltic amber (Sellnick, 1918). *Neoliodes* has been found in Dominican, Mexican and Baltic ambers (Woolley, 1971; Heethoff *et al.*, 2009; Sellnick, 1918) while *Teleioloides* was recorded in Dominican amber (Norton & Poinar, 1993). There is no fossil record of *Poroliodes*.

Material and methods

The study was based on a single specimen (number HAM-1514, Azar collection), from the Lebanese Lower Cretaceous (Lower Barremian) amber outcrop of Hammana-Mdeyrij [Caza (Department) Baabda, Mouhafazet Jabal Loubnan (Mount Lebanon Governorate)], Central Lebanon (Figs 1, 2). The material



FIGURE 1. Hammana-Mdeyrif outcrop.

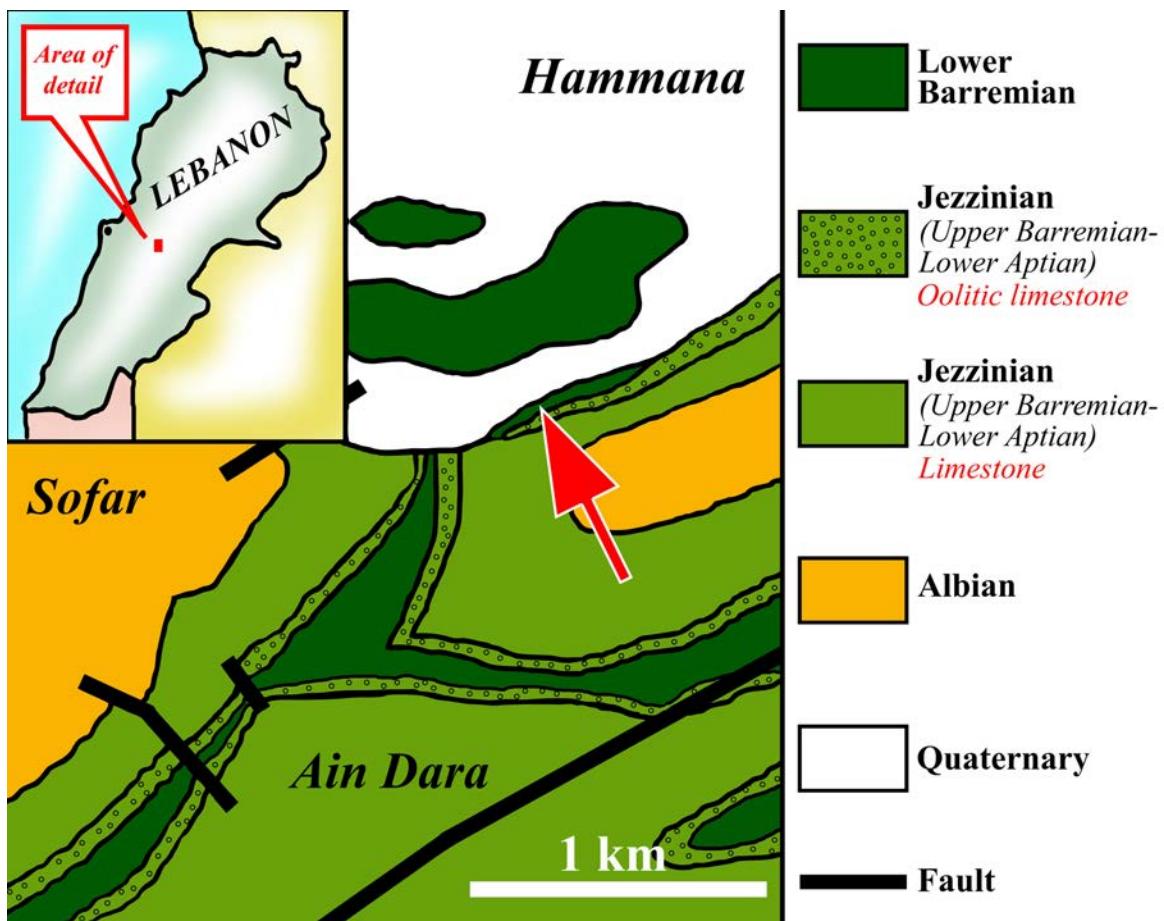


FIGURE 2. Geological map of the Hammana-Mdeyrif outcrop.

is housed in the Natural History Museum of the Lebanese University, Faculty of Sciences II, Fanar, Lebanon. The fossil was cut, polished and embedded between two microscopic coverslips with Canada balsam as medium, as described by Azar *et al.* (2003).

Drawings were made with the aid of an Olympus U-DA drawing tube attached to an Olympus BX50 compound microscope. Photomicrographs were executed using a Zeiss AXIO Imager.Z2 microscope with fluorescent light source and a Zeiss AxioCam HRc. Confocal laser photomicrographs (CLSM) was made with a Laser Scanning Microscope 510 Meta, Carl Zeiss.

Systematic palaeontology

Order Acariformes Zakhvatkin, 1952

Suborder Oribatida Dugès, 1834

Infraorder Brachypilina Hull, 1918

Superfamily Neoliodoidea Sellnick, 1928

Family Neoliodidae Sellnick, 1928

Genus *Neoliodes* Berlese, 1888

(= *Liodes* Heyden, 1826 *nom. praeoc.*)

(= *Udetaliodes* Jacot, 1929)

Type species. *Notaspis theleproctus* Hermann, 1804

***Neoliodes andreneli* Arillo & Subías sp. nov.**

(Figs 3–5)

Type material. Holotype, specimen number HAM-1514, Azar collection, deposited in the Natural History Museum of the Lebanese University, Faculty of Sciences II, Fanar, Lebanon.

Etymology. The specific epithet honours our colleague and friend André Nel.

Diagnosis. Small species of *Neoliodes*, with an irregular polygonal areolation in the posterior part of the notogaster and with a very long pretarsus.



FIGURE 3. *Neoliodes andreneli* sp. nov., photomicrograph of habitus. **A**, Dorsal view. **B**, Ventral view. Scale bars = 100 µm.

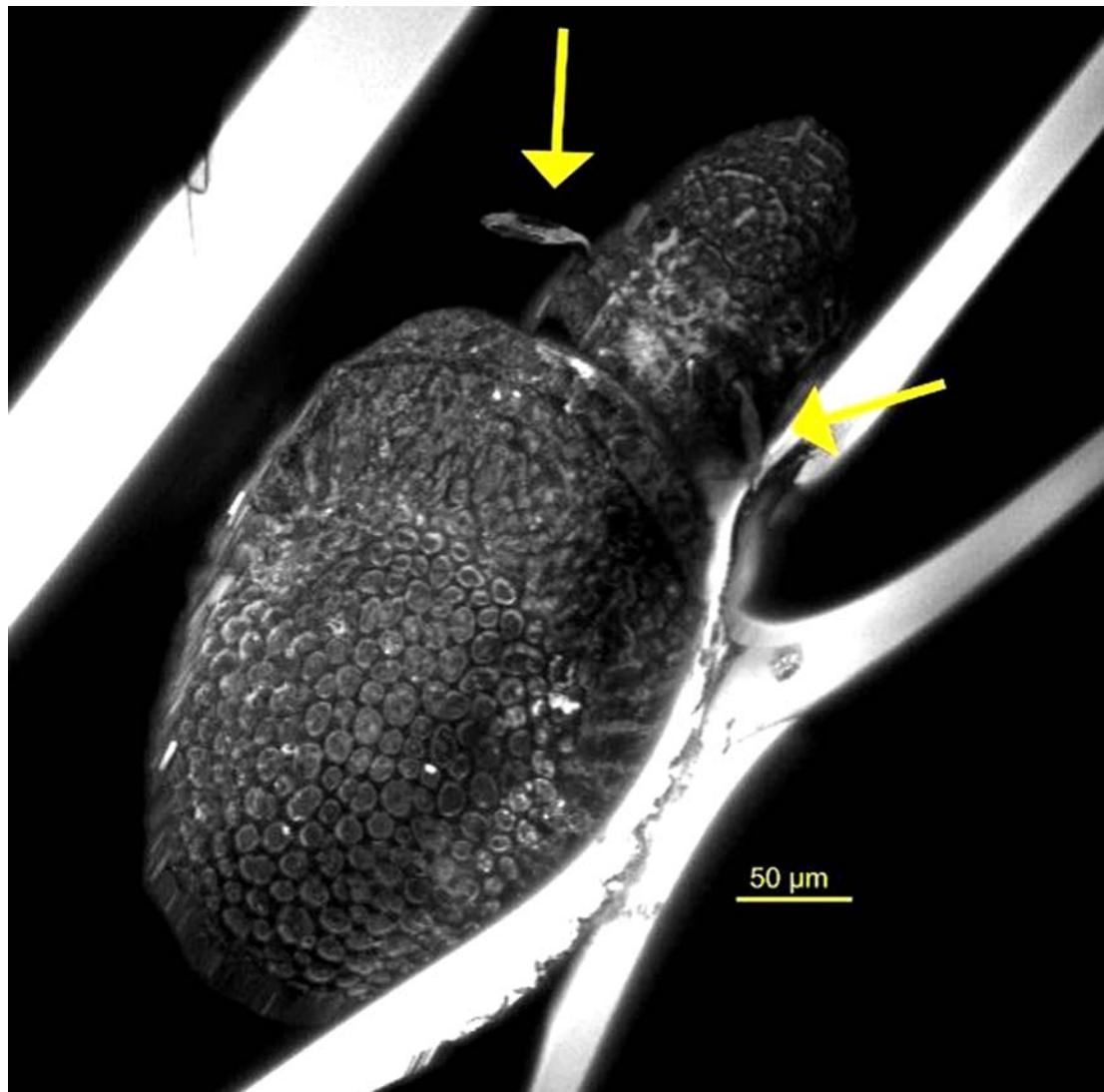


FIGURE 4. *Neoliodes andreneli* sp. nov., dorsal view. CLSM photograph. Yellow arrows show the sensilla.

Locality and horizon. The amber containing the studied mite is from the amber outcrop of Hammana-Mdeyrif [Caza (Department) Baabda, Mouhafazet Jabal Loubnan (Mount Lebanon Governorate); Lower Cretaceous (Lower Barremian)].

Description. Measurements: Length 422 µm, width 231 µm.

Prodorsum: Irregular sculpture on the surface, mainly on its anterior half. Arc-shaped costula on the anterior margin. Rostral setae short and dilated, interlamellar setae dilated and longer than rostral ones. Lamellar setae not present. Exobothridial setae not visible. Sensilla with a short stalk and a long, fusiform and slightly rugose head.

Notogaster: Oval shaped, anterior margin arched. Surface with an irregular polygonal areolation on its posterior margin, while the anterior margin bears fine lines partially arranged in rows. Lateral margins with the typical rib-like ridges. Notogastral setae not visible. Exuvial scalps not preserved.

Ventral side: Ventral plates closed behind anal plates. 7 pairs of genital setae (5+2) and 2 pairs of anal setae. Adanal and aggenital setae not visible.

Legs and chaetotaxy: Legs with short tibia and tarsi. Tarsi tridactylous with equal claws and with very long pretarsi. Some setae present, short and dilated as notogastral setae. Long solenidium present on tibia I.

Discussion

Poroliodes and *Neoliodes* share the synapomorphy of the absence of the lamellar setae while the other two genera in the family (*Platyliodes* and *Teleioloides*) share the plesiomorphic condition of the presence of lamellar setae. It is noteworthy to state that during our revision of extant species of *Neoliodes* we discovered that the species described as *Liodes ramosus* Hammer, 1971,

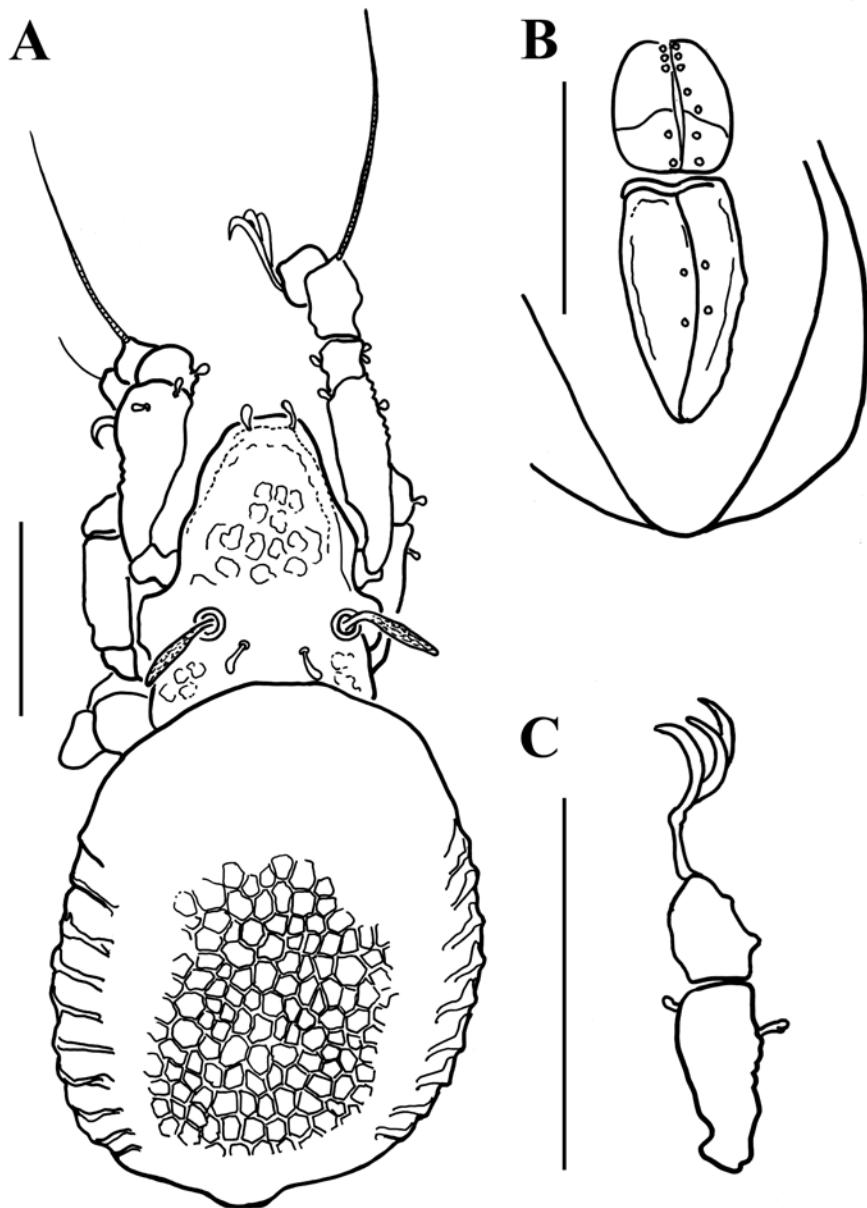


FIGURE 5. *Neoliodes andreneli* sp. nov., camera lucida drawings. **A**, Dorsal view. **B**, Ventral plate. **C**, Leg IV Camera lucida drawing. Scale bars = 100 µm.

and considered as belonging to the genus *Neoliodes* by Subías (2004) has well developed lamellar setae. We herein propose to transfer it to *Teleioloides*: *Teleioloides ramosus* (Hammer, 1971) comb. nov.

The main difference between *Poroliodes* and *Neoliodes* refers to the surface of dorsum and scalps, being finely punctate in *Poroliodes* while rugose with large, irregularly spaced spots and punctuation in *Neoliodes* (Balogh & Balogh, 1992). Supposedly, there is a further difference: two pairs of anal setae in *Poroliodes* vs three pairs in *Neoliodes*, but this trait is doubtful as it was not checked or indicated in some species.

Neoliodes is a cosmopolitan genus (except Antarctica) that includes 40 extant species, although a lot of them are

poorly described and considered as *species inquirenda* (Subías, 2004). Usually species are over 1000 µm in length and most of them bear an irregular dendrite pattern of ridges in the posterior part of the notogaster. Frequently adults keep the nymphal scalps and the descriptions of dorsal side ignore the real aspect of the surface.

A complete comparison of *Neoliodes andreneli* with other species of *Neoliodes* is difficult because some characters are not visible in the new species. Additionally, descriptions and figures of the extant species are often of poor quality.

Only two extant species, *Neoliodes mauritius* (Jacot, 1936) from Mauritius Island and *Neoliodes striatus* Warburton, 1912 from Seychelles Islands and Japan,

bear an irregular areolation in the posterior part of the notogaster as in *Neoliodes andreneli*. These two species are among the smallest species of the genus; 800–940 µm for *N. mauritius* and 800–900 for *N. striatus*, although *Neoliodes femoralis* Warburton, 1912 is even smaller (500 µm) and is considered by Subías (2004) as a synonym of *N. striatus*. *Neoliodes andreneli* is easily distinguished from those species due to its long pretarsi and minute size. Probably these pretarsi could represent an adaptation to tree bark climbing and, curiously, these two small extant species are sampled on bark (Aoki, 2006) or even on tree branches (Jacot, 1936; Sidorchuk, 2018).

Besides the long pretarsi, *Neoliodes andreneli*, sp. nov. has short tarsi on its legs, but this a common trait among the species of the genus, as in *N. kornhuberi* (Karpelles, 1883), *N. lamellatus* (Jacot, 1929) and *N. vermiculatus* (Jacot, 1924), and these species bear the common dendrite pattern on the notogaster.

Concerning fossil species, *Neoliodes brevitarsus* (Wolley, 1971) was described from Mexican amber as a species of *Scapheremaeus*. The single specimen is very fragmentary and is probably a larva (Norton & Poinar, 1993), and pretarsi are not developed on its legs.

Neoliodes dominicus Heethoff, Helfen & Norton, 2009 was described from Dominican amber. It is a large species (1170–1200 µm), but the notogaster surface is not visible due to the presence of exuvial scalps. The claws are normally developed, without pretarsi.

In Baltic amber, Sellnick (1918) described two species of *Neoliodes* but one of them, *Neoliodes ensigerus*, was transferred by Sellnick (1931) to *Platyliodes*. The second species, *Neoliodes quadriscutatus* Sellnick, 1918 has a particular shape of exuvial scalps, each ending in a pair of lobes. It is a large species (1000 µm) but the rest of the characters are poorly visible and the holotype is probably lost (Ezhova, 1995).

Conclusion

The Lower Cretaceous Lebanese amber is the oldest one with intensive biological inclusions. In most cases the inclusions in the Lebanese amber represent the earliest records of some recent and extant families of insects and terrestrial arthropods, or the latest record of extinct families. The importance of the Lebanese amber is not only due to its old age, but especially because its formation coincided with the renewal of the faunas resulting from the appearance and radiation of the flowering plants with all the contemporary co-evolution phenomena. The description here of *Neoliodes andreneli* sp. nov. is the first mite to be described from the Lebanese amber, and constitutes the earliest oribatid mite in amber, which

increases the knowledge of the Acari fauna of the Lower Cretaceous of the North-East Gondwanaland.

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