



The first fossil Discolomatidae (Coleoptera) from Hispaniola

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Abstract

Discolomatidae are a small beetle family distributed in subtropical to tropical ecosystems. Many of the modern members of the genus *Fallia* Sharp inhabit Central America while some species occur on Hispaniola, the Galapagos Islands, and the Hawaiian islands. A new fossil species belonging to the same genus, *F. palaeodominicana* sp. nov., has been found in a piece of Dominican amber, and described as the first fossil member of the family. The presence of extant as well as extinct species of *Fallia* on Hispaniola provokes questions about the age and origin of the genus *Fallia* and how long ago it settled Hispaniola.

Keywords Coccinelloidea · *Fallia* · New species · Dominican amber · Paleontomology

Introduction

The family Discolomatidae Horn, 1878 has a complex taxonomic history (Cline and Ślipiński 2010), however recent molecular data has confirmed its placement in the superfamily Coccinelloidea (Robertson et al. 2015) within the bothriderid group of families (Bothrideridae Erichson, Ceryloniade Billberg, Discolomatidae Horn, Euxestidae Grouvelle, Murmidiidae Jacquelin Du Val, Teredidae Seidlitz) as a sister group to the newly erected family Murmidiidae. Monophyly of discolomatids is well supported by several unique apomorphies including adults with glandular openings lining the lateral pronotal and elytral margins and the meso- and metacoxaelong and transverse but nearly concealed by meso- and metaventral plates. The age of the family is estimated based on molecular phylogenetic reconstructions from around 110 Ma (Zhang et al. 2018) to 142 Ma (McKenna et al. 2015), but no fossil records had been found until now.

The biology of discolomatids is poorly studied, but in general they are regarded as fungivores (Cline and Ślipiński 2010), and have been found in leaf litter, subcortical spaces, compost heaps, and polypore fungi. Some species are thought to be myrmecophilous, and were collected in ant nests (Cline and Ślipiński 2010).

Discolomatidae is a relatively small beetle family containing about 400 extant species grouped in 16 genera (John 1959a; Cline and Ślipiński 2010). A majority of species are distributed in the Afrotropical and Oriental regions. The New World fauna consists of about 45 extant species belonging to 4 genera: *Discoloma* Erichson, 1845, *Fallia* Sharp, 1902, *Holophygus* Sharp, 1899 and *Solitarius* John, 1943 (Cline and Ślipiński 2010).

The genus *Fallia* Sharp contains 9 extant species (Fig. 1) (Sharp 1902; Scott 1908; John 1944, 1959b; see checklist in Cline and Shockley 2012). Most of the extant *Fallia* species inhabit Central America and Caribbean regions (5 species), two species are known from the Galapagos Islands and one from Bahia in Brazil (Fig. 1). The ninth species was described from the Hawaiian Islands, but its status as native or adventive has not been resolved (Cline and Shockley 2012). The genus is characterized by: antennae consisting of 8 or 9 antennomeres; meso-metaventral junction straight; pronotum truncate at anterior margin (not so rounded as in *Aphanocephalus* Wollaston, 1873); elytra with elytral margin narrow but entirely visible from above; and mesosternum longer than its width.

The age of Dominican amber deposits has been discussed by several authors and, based on the place of origin, it was

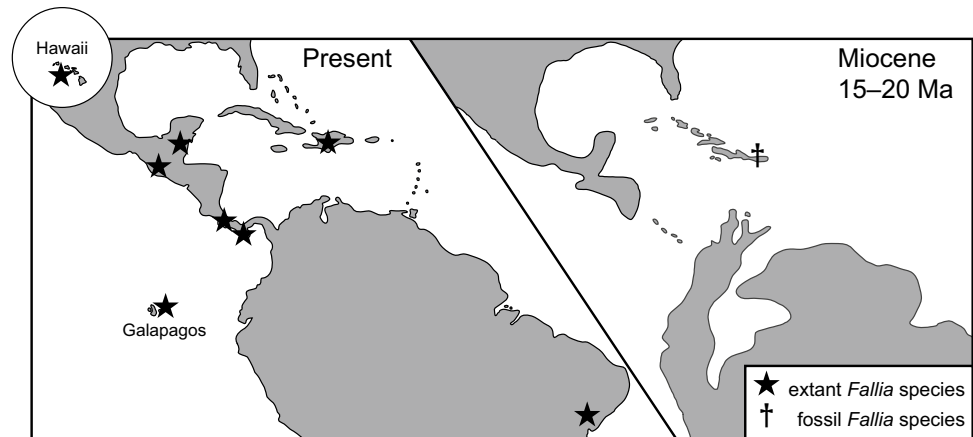
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Fig. 1 Distribution of extant and extinct species of the genus *Fallia* Sharp



concluded that it dated back to the early Middle Miocene (15–20 Ma) (Grimaldi 1994; Iturralde-Vinent and MacPhee 1996; Iturralde-Vinent 2001; Grimaldi and Engel 2005; Penney 2010). That period corresponds to the Middle Miocene Climate Optimum (MMCO) when a global warming period was occurring (You et al. 2009), and tropical zones had expanded their ranges (Pound et al. 2012). Fossils discovered from Dominican amber enable a possible reconstruction of the environment of the ‘Dominican amber forest’ as similar to that of present-day tropical moist forest (Poinar and Poinar 1999).

Materials and methods

This study is based on a Dominican amber piece that came from the private collection of Janusz Kupryjanowicz (Białystok, Poland), and will be deposited in the Andrzej Myrcha Nature Center at the University of Białystok (UCPUwB) with the collection number UCPUwB 1024. The material was polished manually with emery papers of different grain sizes and subsequently lustrated with polishing powder. The specimen was examined and photographed with a Leica M205A stereomicroscope with Leica DM 6000 digital camera attached to a Leica Application Suite LAS 3.7. Total length (TL) is defined as the distance from the anterior margin of the pronotum to the apex of the elytra, and total width was measured at the widest point across the elytra. Pronotal length (PL) was the length measured at the midline from the anterior to posterior margin, and pronotal width (PW) was measured at the widest point across the pronotum. Elytral length (EL) was measured from the anterior margin to the apex along the suture, and elytral width (EW) was measured at the widest point across both elytra. Mesosternal length (MsL) was the length measured at the midline from the anterior to posterior margin, and mesosternal width (MsW) was measured at the widest point across the metaventricle; metasternal length (MtL) and (MtW) were

measured as for mesosternum. Terminology used in this paper follows Cline and Ślipiński (2010), Lawrence et al. (2011) and Cline and Shockley (2012).

To confirm the origin of the amber sample designated as the holotype, Fourier transform infrared (FT-IR) spectra were obtained (Szwedo and Stroiński 2017; Szawaryn and Szwedo 2018) in the Laboratory of the International Amber Association, Gdańsk, Poland, with a Nicoletti S10 spectrometer with an attenuated total reflectance (ATR) accessory. A reference curve number in the collection archives serves as the registration number of the specimen, with suffix ‘IR’.

Systematic palaeontology

Order **Coleoptera** Linnaeus, 1758
 Suborder **Polyphaga** Emery, 1886
 Superfamily **Coccinelloidea** Latreille, 1807
 Family **Discolomatidae** Horn, 1878
 Subfamily **Aphanocephalinae** Grouvelle, 1912

Genus *Fallia* Sharp, 1902

Type species. *Fallia synthetica* Sharp, 1902, subsequent designation.

Fallia palaeodominicana sp. nov.

Figure 2a–g

Etymology. Specific epithet derived from the type locality—Dominican Republic, and prefix ‘palaeo’ meaning ancient.

Holotype. No 1024 (coll. J. Kupryjanowicz). Reference IR curves no. UCPUwB IR (Fig. 3) and deposited in UCPUwB. Piece of Dominican amber from La Toca Mines, transparent yellow, anterior right part of the inclusion covered with a milky veil. Cuticle brown without any trace of maculation. No syninclusions.

Locality and Horizon. Amber mine in the Cordillera Septentrional of the northern portion of the Dominican Republic, La Toca. Suite of clastic rocks from the upper part of the La Toca Formation, Early to early Middle Miocene 15–20 Ma (Iturralde-Vinient and MacPhee 1996).

Diagnosis. *F. palaeodominicana* is slightly more elongate than *F. iviei* with the length to width ratios 1.4 and 1.3, respectively. It is also rather flattened, while *F. iviei* is more hemispherical. The difference can be also observed in punctuation of pronotum and elytral disc which is fine in *F. iviei* and more coarse with punctures distributed more densely in *F. palaeodominicana*.

Description. Length = 1.78 mm; width = 1.28 mm; TL/EW = 1.39; PL/PW = 0.57; PL/EL = 0.43; PW/EW = 0.76; EL/EW = 1.00; MsL/MsW = 0.94; MtL/MtW = 0.32. Body round, slightly elongate (Fig. 2a, b), flattened (Fig. 2g); widest across middle of elytra; pronotal and elytral margins visible from above.

Head—Entirely visible (Fig. 2g), slightly declined, not retracted underneath pronotum (outstretched); eyes large; temples about $1.5 \times$ longer than eye length. Shape somewhat rectangular, lateral margins of fronto-clypeal region not distally convergent. Antennal insertions fully exposed, medially positioned on vertex between eyes. Surface glabrous with minute, irregular punctures. Antennal grooves short, extending along ventral margin of eye. Vertex convex. Fronto-clypeal suture conspicuous and evenly arcuate between antennal insertions. Clypeus large and moderately convex, about twice as broad as its length. Eyes prominent, rounded, coarsely faceted, with no interfacetal setae (Fig. 2e). Antennae 9-segmented with annulate 1-segmented club (Fig. 2e). Scape elongated, more than $2 \times$ longer than pedicel; pedicel barrel-shaped, antennomere 3 elongated about $1.5 \times$ longer than antennomere 4, antennomere 4 longer than pedicel; antennomere 5 about as long as pedicel; antennomeres 6–8 subequal slightly elongated, shorter than pedicel. Club elongate with broadly rounded apex and narrowed base; club as long as segments 5–8 combined. Terminal segment with apex bearing several elongate setae extending beyond the apical margin. Labrum transverse, about $2 \times$ broader than its length, anterior margin broadly concave. Mandibles apically bifid. Ventral mouthparts (including maxillary and labial palpi) clearly visible from below (Fig. 2g). Clypeo-labral suture concave. Maxillary palpi well-developed, 3-segmented, terminal segment conical with entire apex covered with sensory pegs. Labial palpi well-developed, 3-segmented, terminal segment conical with entire apex covered with sensory pegs.

Prothorax—Pronotum transverse, widest at posterior angles, flattened, coarsely punctate, with punctures more dense than those on elytra, separated by 1–2 times their

diameter. Anterior angles broadly rounded, posterior angles distinct. Lateral margins narrowly explanate, evenly and arcuately convergent toward anterior angles. Lateral marginal bead with 2 secretory pores, 1 near 0.2 and 1 near 0.8 length from posterior angles (Fig. 2b, g). Anterior margin broadly concave. Posterior margin broadly sinuate. Posterior margin bordered. Length between anterior margin of procoxal cavities and anterior margin of prosternum shorter than length of mesosternum (Fig. 2d). Prosternum with well-developed, oblique impressions anterior to coxal cavities extending antero-laterally from the procoxae, for reception of protibiae in repose (Fig. 2d). Prosternal process extending posterior procoxae; in lateral view, flat. Procoxal cavities separated by $1 \times$ procoxal cavity width.

Pterotorax—Scutellum visible, triangular (Fig. 2b); similar surface punctuation as on pronotum. Mesosternum well-developed, flat, and at same level as metasternum; surface punctuation faint. Meso-metasternal junction concave with anterior margin of metasternum broadly convex. Mesocoxal cavities separated by more than mesosternum length in midline. Metasternum transverse; metasternal disc punctuation faint, punctures minute; lateral regions of metasternum with rugose microsculpturing present. Postcoxal lines of mesocoxae absent on metasternum. Metacoxal cavities separated by almost $3 \times$ procoxal cavity width. Elytra with lateral margins narrowly explanate. Each elytron bearing 6 secretory pores along the lateral margin (Fig. 2b, e). Punctuation more fine and sparse than those on pronotum, with punctures separated by 3–4 times their diameter. Humeral angles not raised. Wings not visible.

Legs—Tibiae and femora strongly flattened (Fig. 2a, f). All femora excavated for reception of tibiae. All femora and tibiae elongate elliptical, widest near middle. Each tibia with small, stiff spines present along posterior margin. Tarsal formula 3–3–3 (Fig. 2f); tarsi simple with some projecting setae ventrally; claws simple with small basal angulation (Fig. 2c).

Abdomen—Abdomen with five ventrites (Fig. 2f). Abdominal ventrite 1 broadly truncate between metacoxae, large, about as long as ventrites 2–4 combined. Ventrites 2–4 subequal in length, ventrite 5 slightly longer, broadly rounded at posterior margin. Sex undetermined. Genitalia not visible.

Discussion

The Dominican amber inclusion described above can be immediately classified as a member of the family Discolomatidae because of the presence of a lateral row of six secretory pores on each elytron and two on each side of the pronotum, which is unique to this family of beetles. The beetle also possesses globular coxae and trimerous tarsi. Although the current classification system of Discolomatidae is

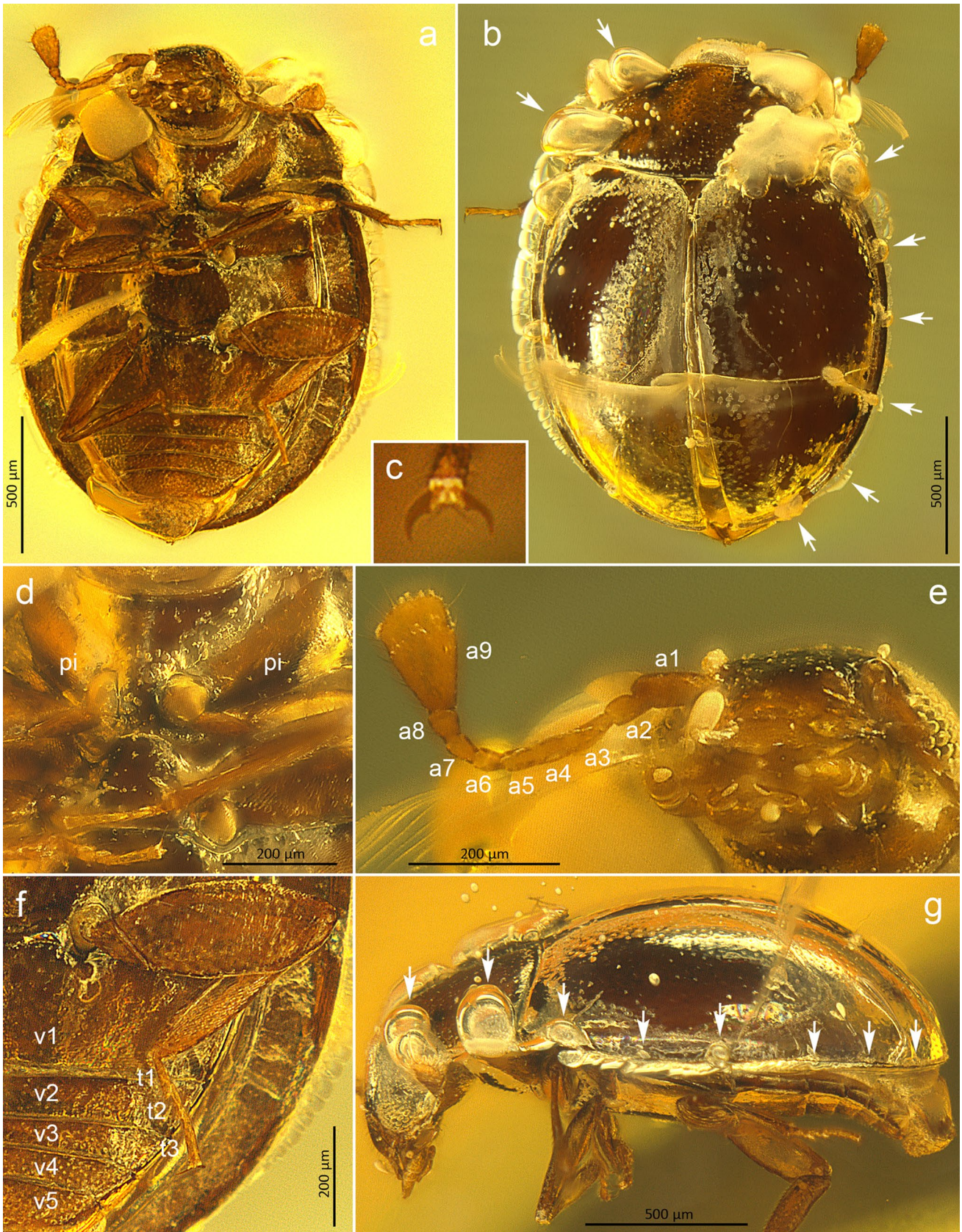


Fig. 2 *Fallia palaeodominicana* sp. nov., holotype UCPUwB 1024. **a** Habitus, ventral, **b** habitus, dorsal, **c** tarsal claw, **d** pronotum and mesoventrite, **e** head, mouthparts and antenna, **f** hind leg and abdomen, **g** habitus, lateral. Arrows indicate gland openings, a1—7 numbers of antennomeres, v1—5 numbers of ventrites, t1—3 numbers of tarsomeres. *pi* Prosternal impressions

typological, the following characters enable the authors to place the newly described species in the genus *Fallia*: head not covered by the pronotum, nine segmented antennae, elongated mesoventrite (not transverse as in *Aphanocephalus*), glabrous dorsal surface (setose in *Holophygus* Sharp, 1899, *Parafallia* Arrow, 1939), rounded elytral margin (not corrugated as in *Holophygus*, *Notophygus* Gory, 1834),

elytral margin with narrow lateral margin (broadly extended in *Discoloma* Erichson, 1845, *Cassidoloma* Kolbe, 1897).

No phylogenetic analysis is available for *Fallia* nor for Discolomatidae, thus any discussion about the biogeography and evolution of that genus in Mesoamerica is highly theoretical. Nonetheless, the presence of the extant *F. iviei* Cline and Shockley, as well as fossil species of *Fallia* on Hispaniola, provoke questions about the age of the genus *Fallia* and how long ago it settled the island. Was Hispaniola independently settled twice by the *Fallia* species (in Miocene and more recent times), or is *F. palaeodominicana* an ancestor of modern *F. iviei*? This newly described species is the first fossil representative recorded for the family

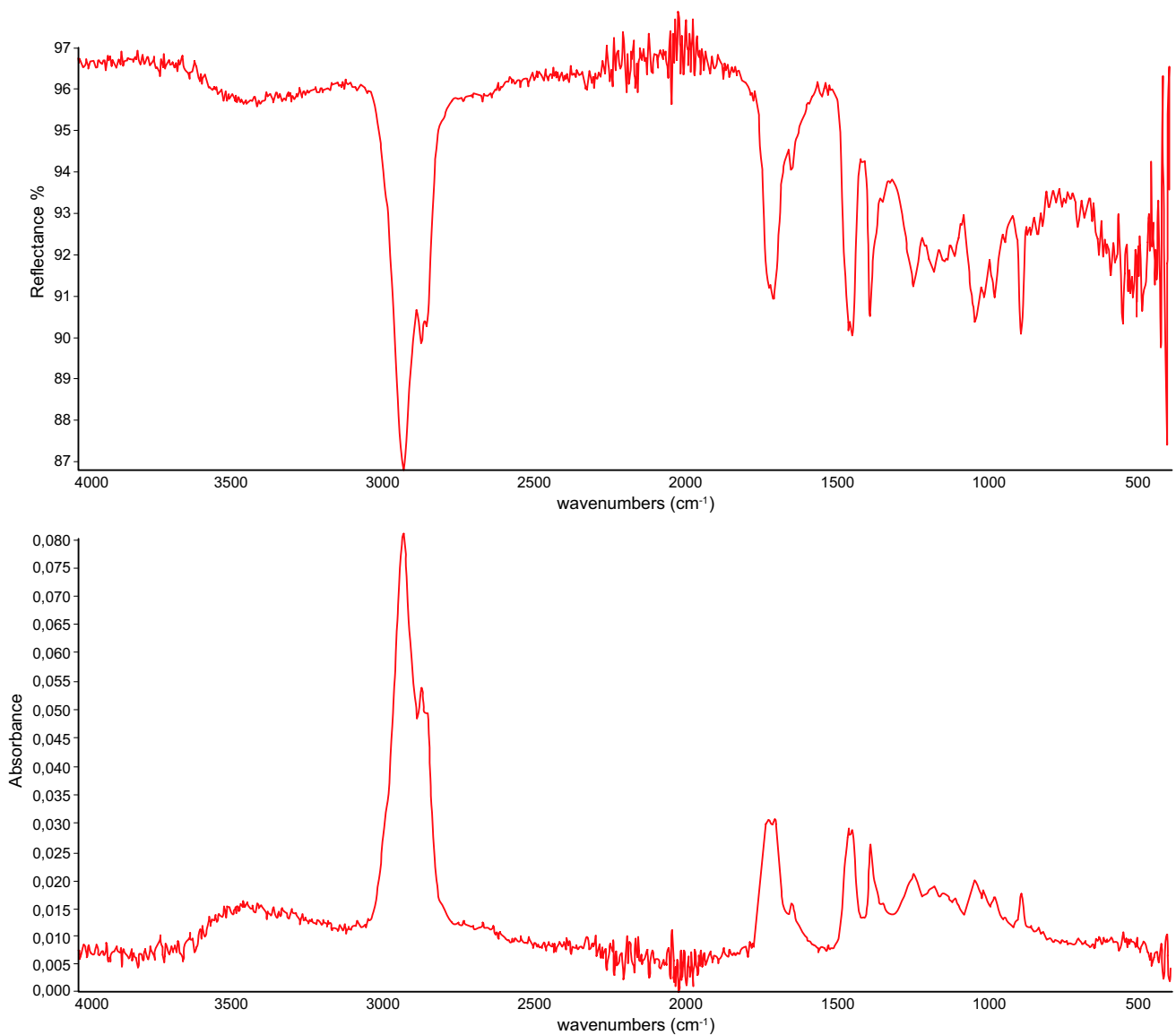


Fig. 3 FT-IR spectra of analysed amber piece UCPUwB 1024. Top—reflectance spectrum, bottom—absorbance spectrum

Discolomatidae, and it can be potentially used for time-tree calibration in the future phylogenetic analyses.

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