Zootaxa 4786 (2): 283–288
https://www.mapress.com/j/zt/

Correspondence

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)
https://doi.org/10.11646/zootaxa.4786.2.10
http://zoobank.org/urn:lsid:zoobank.org:pub:486F9438-8161-47C1-8219-EB426C67DD1F

Two fossil thrips from Ethiopian amber (Thysanoptera) with description of *Merothrips aithiopicus* sp. n. (Thysanoptera: Merothripidae)

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Amber has rarely been found in Africa and only a few samples with fossil inclusions are known (Kiefert *et al.* 2015). The most important fossiliferous find was reported from an outcrop at the north-western Plateau of Ethiopia a decade ago, revealing diverse inclusions of arthropods, plant remains, fungi and microorganisms (Schmidt *et al.* 2010). Initially, this amber was classified as originating from the mid-Cretaceous. Later studies, however, have raised questions about this determination and indicated a much younger age: Cenozoic, likely Miocene (Coty *et al.* 2016, Perrichot *et al*. 2016, Perrichot *et al*. 2018). The contradictory—and rather controversial discussed—new dating was based on spectroscopic analyses, revised palynological data and more comprehensive palaeoentomological results showing that insect fossils mostly belong to extant families and genera. In total, Schmidt *et al.* (2010) reported 22 insects from eight identified orders including two specimens of Thysanoptera: "an undetermined, wingless thrips" (obviously a larva) and a female associated with Merothripidae. A more detailed analysis of these specimens is the objective of the present study; regarding the larva, only a rough classification and description is given, as fossil larvae cannot be definitely associated with adult specimens.

Merothripidae represents a small group of thrips that have retained primitive features concerning both their way of life and their character states (Mound *et al.* 1980). Extant species are found on dead twigs or in leaf litter where they feed on fungal mycelia. In this way of life they have retained a feature of the earliest thrips' ancestors that are presumed to have been fungivorous in detritus (Grimaldi & Engel 2005; Mound 1997). A similar feeding behaviour is known from insect groups closely related to Thysanoptera such as Psocoptera and Zoraptera. The origin of Thysanoptera from this lineage, however, is indicated more particularly by ancestral plesiomorphic features that have been kept in some taxa, notably within the Merothripidae (Mound & O'Neill 1974). These thrips have retained well-developed tentoria with anterior and posterior arms (Bhatti 2006), trichobothria on abdominal tergite ten (Moritz 2006) and in females a pair of lobes on the posterior margin of the seventh abdominal sternite. This latter structure is interpreted as a reduced eighth sternite (Mound *et al.* 1980), which is lacking in most other Thysanoptera (see Mound & O'Neill 1974). At present, Merothripidae includes 17 extant and 6 fossil species (ThripsWiki 2020). Two of these fossils date back to the Cretaceous: *Jezzinothrips cretacicus* zur Strassen from Hauterivian Lebanese amber, and *Myanmarothrips pankowskiorum* Ulitzka from Cenomanian Burmese amber; the other species are Paleogenic and have been described exclusively from Baltic Eocene amber: *Merothrips balticus* Ulitzka, *M. dietrichi* (Schliephake), *M. fritschi* Priesner and *Praemerothrips hoodi* Priesner (see Priesner 1924, 1929; zur Strassen 1973; Ulitzka 2015, 2018; Ulitzka & Mound 2017). In addition, some further finds associated with Merothripidae appear worth mentioning here: two specimens of *P. hoodi*, one from Rovno Eocene amber (Shmakov & Perkovsky 2009) and one described as a neotype from Baltic Eocene amber (Ulitzka 2015); an undetermined specimen from Mexican Late Oligocene/Early Miocene Chiapas amber (Hurd *et al.* 1962); and a female of the extant species *M. fusciceps* Hood & Williams from subfossil Columbian copal (Ulitzka 2017).

The present study deals with two amber inclusions that came from the eastern part of the North-western Plateau of Ethiopia. The outcrop is located on the slopes of the Wenchit River valley near to the village of Midda (10°08'45''N, 38°57'56''E). The amber pieces were ground and polished to obtain necessary optical conditions (see Schmidt *et al.* 2010). Both fossils are deposited in the collection of the Naturhistorisches Museum Wien, Vienna, Austria. Examination was carried out using a Zeiss Stemi SV11 Apo stereomicroscope and a Zeiss Standard microscope with the following objectives: Zeiss Plan 10/0,22 160/-, Nikon M Plan 20 x ELWD 210 mm and Nikon M Plan 40 x ELWD 0.5NA 210 mm. Illumination involved merging transmission light with two or three white-light-LED incident illuminators. White paper was used as a diffusor for incident illumination to prevent reflections in the amber; different coloured paper sheets were inserted under the sample to get the inclusion in better contrast to the yellowish translucent amber. The picture of the larva

Accepted by L. Mound: 5 May 2020; published: 2 Jun. 2020

was created with darkfield illumination. Images were taken with a digital camera attached to the microscopes (Canon EOS 70D), and these were produced using Helicon Focus software. Nik Sharpener Pro and Adobe Photoshop were used for final colour adjustment and sharpening. Regarding the larva, the setae are designated according to Vierbergen *et al.* (2010).

Merothrips aithiopicus sp. n. (Figs 1–4)

Female macroptera. Body protracted (probably by deformation of the resin), antennae therefore torn into single segments and many setae slightly pulled away from their former points of attachment (fig. 2); head crushed dorsally at base, pronotum dented (fig. 2); all legs angled; right wings overlapping on top of the body, left fore wing torn off and lying approximately 4.5mm away, left hind wing slightly spread (fig. 1). Main colour greyish brown (fig. 1); antennae, head, pronotum and forelegs darker; all major setae dark as well as wing veins and fringes; fore wings tinged grey-brown, hindwings shaded slightly pale grey.

Head (fig. 2) wider than long, cheeks slightly rounded towards base; most head setae not ascertainable, except a pair of conspicuous ocellar setae (s3) and a pair of long postocular setae attached closely to the hind margin of the eyes. Eyes large, with about 15–20 facets, their front margin protruding over base of antennae. Mouth cone short. Antennae moniliform (figs 1, 2), 8-segmented, with all segments bearing long setae; segments I not clearly visible; segments II–IV inverse conically shaped, III and IV tapering distally; V–VII barrel-shaped, VIII spindle-shaped; shape of apical sensoria on III and IV transvers, however, not clearly assessable (only visible on the right antenna). Pronotum without visible sculpturing; trapezoidal, with longitudinal sutures near the lateral margins; length/width ration not assessable (deformed); with one pair of strong anteroangular setae, three pairs of anteromarginal setae and one pair of posteroangular setae (the slightly weaker setae lying close to both posteroangular setae most likely derive from the coxae, c.f. fig. 2: sco), posteromarginal setae not visible. Mesonotum transversally striate in front of median setae but smooth towards hind margin (fig. 2); lateral setae strong. Fore wings narrow, with two longitudinal veins and a cross vein one third of the wing length away from the base (fig. 3); first vein with a row of 17, second vein with 15 setae; clavus with one marginal seta; wing fringes long and straight. Fore femora stout; middle and hind femora not enlarged (fig. 1). All tibiae dorsally bearing a long median seta; distal tooth on fore tibiae not assessable (possibly broken off). Tarsi two-segmented; basal tarsomere of fore tarsi with a long apical seta. Abdominal tergites with faint lines of transverse sculpture; tergites IX and X with long setae; tergite X with a pair of trichobothria with long axial setae (fig. 4). Sternites without accessory setae. Ovipositor weak.

Measurements. Female NHMW, N6974; in microns: Body length 872. Head, length 72; width about 48. Eyes, length 29; width 14. Hind ocelli, diameter 16. Ocellar setae s3 48; postocular setae 19. Prothorax, length about 84; width not measurable (deformed); anterior marginal setae 7–9, anteroangular setae 17, posteroangular setae 42, discal setae 10–12. Pterothorax, largest width 101. Mesonotal setae s1 10, distance between s1 29. Abdomen, length 476; largest width 132 (at segment VI). Antennae stretched over 286 (sum of the length of all segments 159); length (largest width) of segment I about 7 (12), II 21 (16), III 24 (16), IV 24 (12), V 19 (10), VI 19 (8), VII 19 (7), VIII 26 (7). Fore wings, length 420; width in the middle 14; wing fringes 120–180.

Specimen studied. Holotype female; fossil from Ethiopian amber collected near Alem-Ketema, Ethiopia (10°08’45’’N, 38°57’56’’E), see also Schmidt *et al.* (2010). Stored in the collection of the Naturhistorisches Museum Wien, Vienna, Austria; NHMW, N6974.

Syninclusions: many particles of plant detritus, lawns of spherical and rod-shaped bacteria, fungal mycelia and some spores as well as a nematode and a small part of another arthropod.

Etymology. The species epithet *aithiopicus* derives from the classical Greek word *Αιθιοπία* (*Aithiopia*), the ancient geographical name for a historic region in Africa, which included *Ethiopia*, the country where the amber deposit is located.

Diagnosis. Even though the pair of lobes on the posterior margin of the seventh abdominal sternite is not visible the form of the antennal sensoria (fig. 2), the presence of trichobothria on abdominal tergite X (fig. 4), the shape of the wings with pointed tips (fig. 3) as well as the enlarged fore femora (figs 1, 2) indicate that the new species is attributable to Merothripidae. Species associated with this family usually have nine-segmented antennae, apart from members of *Merothrips* Hood, which have eight antennomeres. The classification of the new species into this genus is also supported by the trapezoidal pronotum, the wing venation and the chaetotaxy of the wing scale (c.f. Bhatti 2006; Mound & O’Neill 1974).

As mentioned above, three further fossil *Merothrips*-species are known, all described from Baltic Eocene amber: *M.*

balticus, *M. dietrichi* and *M. fritschi*. From *M. balticus* the new species (as well as *M. dietrichi* and *M. fritschi*) can be easily distinguished by the presence of only one pair of posteroangular pronotal setae (fig. 2). In *M. dietrichi* these setae are short (23) but longer in *M. aithiopicus* sp. n. (42) and *fritschi* (43–52). The holotype of *M. fritschi*, unfortunately, was lost during the Second World War (Ulitzka 2015), but the description by Priesner (1924) provides sufficient detail to distinguish it from *M. aithiopicus* sp. n.: the new species is slightly smaller, but it has proportionally much shorter fore wings and less protruding hind femora. Furthermore, *M. fritschi* has antennal segments I and II dark whereas the distal segments are clear, the new species, however, has completely dark antennae (fig. 1).

Compared to extant species *M. aithiopicus* sp. n. resembles *M. productus* Hood, but has a less elongated head.

Thripidae, *cf. Scirtothrips* Shull (Figs 5–7)

Second instar larva, *female.* Body dorsoventrally compressed and considerably shrunk after the fossil resin had hardened. Thus, the former shape has left an imprint, which partly shows finest structures. Due to this process, the right side of the thorax was detached from the amber, and the right legs were torn off the body (fig. 5). Body sculptured with scattered tiny round plaques with minute, barely visible microtrichia (fig. 4). Colour: uniformly pale brownish.

Head retracted under pronotum and deformed, hardly any structures recognizable except stemmata on the left side and short, apically expanded d3 setae; mouth cone short and rounded. Antennae 7-segmented (fig. 7); segments III and IV annulated with rings of microtrichia; V short (about one fifth as long as IV); at least one inner sense cone present on segments III, IV and VI. Thoracic features barely assessable; prothoracic setae short and expanded (only two setae visible). Many abdominal features clearly visible in the imprint; tergites with dorsal setae short, these setae slightly longer on IX, d2 blunt to slightly expanded; VIII and IX without campaniform sensilla; segment IX with 5 pairs of setae (fig. 6), without posteromarginal teeth. Spiracles on abdominal segments II and VIII most likely not developed.

Measurements. *Second instar larva*, *female* NHMW, N6967a; in microns (all measures refer to the imprint, not to the shrunken body): Body length 902. Head, length including mouth cone 106; width 84; head seta d3 9. Thorax, length about 275; largest width (at metathorax) 180. Prothoracic setae 6. Abdomen, length 525; largest width 366; segment XI, setae d1 12, d2 10, d3 7. Antennae, length 120; length (largest width) of segment I about 10 (19), II 14 (14), III 34 (17), IV 36 (17), V 7 (6), VI 7 (4), VII 12 (4).

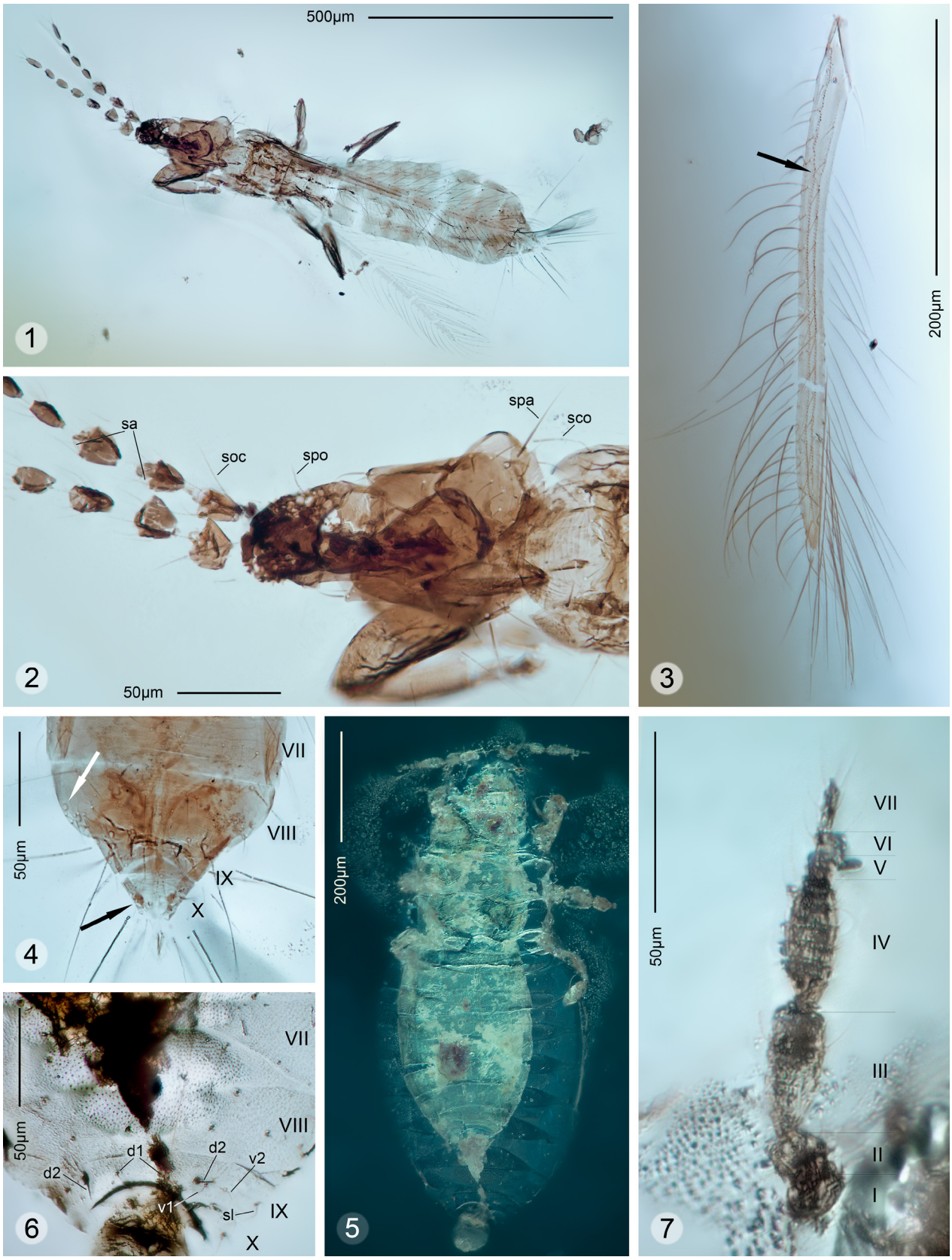
Specimen studied. Second instar larva, female; fossil from Ethiopian amber collected near Alem-Ketema, Ethiopia (10°08’45’’N, 38°57’56’’E), see also Schmidt *et al.* (2010). Stored in the collection of the Naturhistorisches Museum Wien, Vienna, Austria; NHMW, N6967a.

Syninclusions: lawns of spherical bacteria, plant detritus and stellate plant trichomes, a nematode as well as remnants of different insects (two Coleopteran fragments, legs of an undetermined Diptera, one Mymaridae).

Diagnosis. Due to the conspicuously short antennal segment V the larva is clearly attributable to Thripidae (fig. 7). Larvae of this family can be distinguished from those of other thrips in having antennal segment V shorter than one-half of the length of IV (Vance 1974, Vierbergen *et al*. 2010). Furthermore, it is a second stage larva and a female, because abdominal segment IX bears five pairs of setae (Vance 1974) (fig. 6). Several other features strongly resemble those of some extant *Scirtothrips*-larvae, particularly the body sculpture with scattered plaques bearing tiny microtrichia (c.f. Vierbergen *et al*. 2010, p. 113, figs 83 & 86). This classification might also be supported by the presence of short and apically expanded setae visible at the head and pronotum and, furthermore, by lacking abdominal spiracles. The latter feature, however, is not clearly assessable and these organs—and possibly other characteristics—are possibly concealed by the poor preservation. Thus, the classification at genus level remains rather presumptive and is based on empirical facts.

Conclusion

It is not the main purpose of the present study to review the age of Ethiopian amber, but nevertheless the findings may provide some clues in this regard. *M. aithiopicus* sp. n. is related within the Merothripidae to a genus, which dates back to the Palaeogene and which still exists in the extant fauna. Similarly, the larva associated with Thripidae at least belongs to a family also showing large diversity only since the Paleogene. Even if members of both families are known since the Cretaceous (Nel *et al.* 2010, Shmakov 2009, Ulitzka 2018), the fossils examined here resemble rather modern species and may indicate that the amber was formed in a later era.



FIGURES 1–7. Ethiopian amber fossils. *Merothrips aithiopicus* **sp. n.** holotype female 1–4: **(1)** dorsal view; **(2)** head, prothorax and metathorax (sa- sensory areas; soc- ocellar setae s3; spo- postocular setae; spa- pronotal posteroangular setae; sco- coxal setae); **(3)** left fore wing (cross vein indicated); **(4)** abdominal segments VII–X (spiracles indicated white, trichobothria indicated black). Thripidae, *cf. Scirtothrips,* female second instar larva 5–7: **(5)** dorsal view; **(6)** imprint of caudal abdominal segments (d1–d3- dorsal setae; sl- lateral seta; v1–v2- ventral setae); **(7)** right antenna.

Acknowledgements

I would like to express my sincere thanks to Mag. Matthias Svojtka (Department of Paleontology, University of Vienna, Austria) for the opportunity to examine these valuable amber fossils. I also thank Dr. Arnold H. Staniczek (Department of Entomology, Stuttgart State Museum of Natural History, Stuttgart, Germany) for sending helpful papers. For linguistic revisions I would like to thank my colleague Marita Stöbener-Grabert (Freie Waldorfschule Offenburg, Germany). Furthermore, I am grateful to two referees for help and advice in improving this paper.

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