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Rhagidiidae (Acari, Eupodoidea) from Baltic amber

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Abstract. The first known fossils of the mite family Rhagidiidae, representing at least two species, are recorded from Baltic amber (Eocene). One of these is described as *Zachardia flexipes* n. gen. n. sp., which appears to differ from extant Rhagidiidae in having the femur of legs I and II divided into three segments. A second species is tentatively assigned to the extant genus *Poecilophysis* CAMBRIDGE, but the condition and probable immaturity of the single available specimen preclude a formal description.

Key words: Acari, Rhagidiidae, Baltic amber, fossils, taxonomy, new genus, new species.

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I. INTRODUCTION

Rhagiidae are common, fast-moving, predatory mites, found in terrestrial habitats throughout the world. Although they are usually ground-dwelling, their abundance makes it surprising that they have not been recorded as fossils before. This might be partly due to their weak sclerotization, which means that they may be poorly preserved even in amber. Such small fossils can also be difficult to study, and it is not always possible to observe sufficient details to make meaningful comparisons with extant taxa.

Here we report the presence of two species of Rhagidiidae in Baltic amber. One of the specimens examined is a well preserved adult, which we describe as a new genus and species. It appears to differ from all other Rhagidiidae in having the femora of the anterior legs divided into three secondary segments. The other specimens are a probable tritonymph of the extant genus *Poecilophysis* O. P. CAMBRIDGE and an early nymph that cannot be identified to genus.

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II. METHODS

Observations were carried out using a compound microscope, using both reflected and transmitted light. Drawings were made with an attached drawing tube and measurements were taken using an ocular micrometer. Photographs were taken using a stereomicroscope and reflected light. The terminology used follows LINDQUIST & ZACHARDA (1987), except that we use the term coxa instead of coxisternal plate. Measurements are given in millimetres to avoid the ambiguities involved in rounding up figures expressed in micrometers and the difficulties in obtaining precise values for fossils. Measurements of leg segments were taken as their greatest length, seen in dorsal view; the width of the chelicera was measured in dorsal view and does not correspond to the 'dorsoventral width' (more correctly depth) usually reported in the literature.

III. SYSTEMATIC PART

Superfamily: **Eupodoidea**

Family: **Rhagidiidae** OUDEMANS, 1922

Zachardia n. gen.

D i a g n o s i s. Large Rhagidiidae of typical facies, but with femora of legs I and II long and divided into three segments. Rhagidial organs present on tarsi of legs I and II, consisting of 3 recumbent solenidia aligned diagonally in a common depression. Notogastral chaetotaxy orthotrichous; prodorsal trichobothria (sc_1) long, thin and finely ciliated, distinctly shorter than sc_2; v_2 level with sc_1, slightly anteriad of sc_2; v_1 paired, similar in form to sc_1 (possibly trichobothrial). Proral ('subterminal') setae (*p*) of legs normal. Leg claws with ventrobasal spurs ('clawlets'); empodia ciliate, as long as lateral claws and not broadened.

Type species: *Zachardia flexipes* n. sp.

E t y m o l o g y. Patronym (gender feminine) dedicated to Miloslav ZACHARDA, in recognition of his contributions to the systematics of Rhagidiidae.

D i s t r i b u t i o n. Known only from Baltic amber (Upper Eocene).

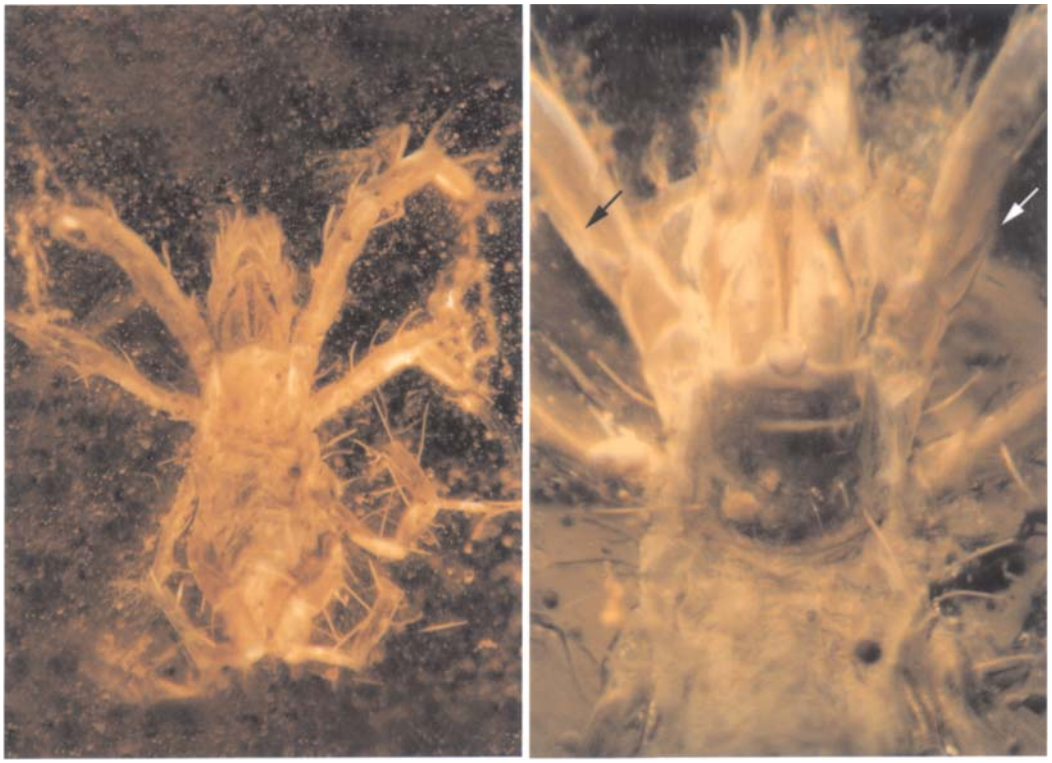
R e m a r k s. *Zachardia* n. gen. apparently differs from all known Rhagidiidae in having the femora of legs I and II divided by two secondary joints. However, because this interpretation cannot be considered certain from a single specimen and would, in any event, be autapomorphic, other characters are required to justify the new genus. Depending on whether the distal seta of the chelicera is considered to lie in an open pit, *Zachardia* will key out to either *Rhagidia* THORELL or *Foveacheles* ZACHARDA in ZACHARDA's (1980) key. It differs from *Rhagidia* and most *Foveacheles* in having only 3 rhagidial solenidia on tarsus I and II. In this respect, it resembles the subgenus *Foveacheles* (*Ternirhagidia*), but can be separated from the latter by the more distal position of seta *chb* on the chelicera and the longer rhagidial solenidia of tarsus I, which lie in a common depression (in *Ternirhagidia* they are set in individual depressions).

Zachardia flexipes n. sp.

(Figs 1–7)

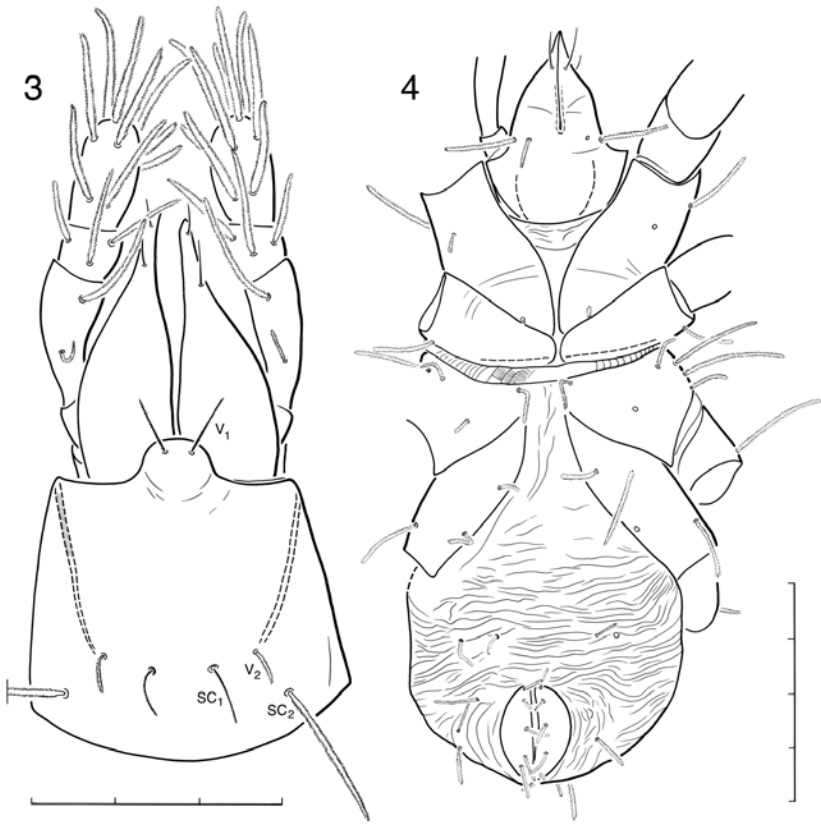
D i a g n o s i s: as for genus.

M a t e r i a l e x a m i n e d. Holotype: adult (probably female) in Baltic amber, *ex* J. WUNDERLICH collection (F351/BB/AC/CJW), deposited in Naturmuseum Senckenberg, Frankfurt am Main. The specimen is in good condition but lacks left leg III. The amber is rather turbid, due to the presence of small, organic debris and small, evenly distributed bubbles. This, together with the nature of some of the other inclusions (moss, a collembolan, two heterostigmatic mite larvae and a medium-sized dipteran larva), suggests that the resin was produced in or near the ground.



Figs 1-2. *Zachardia flexipes* n. sp., holotype. 1. Dorsal view of fossil. 2. Detail, showing basal joints of legs I (arrowed).

D e s c r i p t i o n. Large species of typical facies (Figs 1–2), idiosomal length (contracted) 1.13 mm. Non-sclerotized parts very finely plicate, cuticle of hysterosoma thrown into coarser, irregular folds. Setae finely ciliated (ciliation finer than shown in figures, apart from figures 2 and 7). Prodorsal shield (Fig. 3) roughly quadrate (0.38 × 0.36 mm), with well-marked apodemes running from anterolateral margin to v_2. Naso large, bearing short, fine setae v_1 (0.07 mm); v_2 (0.13 mm) similar in size to sc_1 (0.16 mm); sc_2 longer (0.20 mm) and thicker than other prodorsal setae; v_1 and sc_1 thin and very finely ciliated, base of v_1 not visible, but the similarity to sc_1 suggests that it is also bothridial. Notogaster orthotrichous; c_1 0.11 mm and c_2 0.20 mm long, cupules not visible; genital opening near posterior end of body; each genital plate with 5 setae. Coxae II and III separated by only a short distance (Fig. 4); setal formula probably 3–1–6–3; coxa IV long (0.36 mm). Subcapitulum without distinctive features, four pairs of setae present, adoral setae simple. Chelicera (Fig. 3) moderately elongate (length 0.35, breadth 0.12 mm), with two setae, basal seta (*cha*) inserted near base of fixed finger, distal seta (*chb*) smaller – not obviously set in a depression, but optical conditions unfavourable; fingers not obviously arched (as far as can be judged in dorsal view). Palp (Fig. 3) moderately long, segment lengths: femorogenu 0.18, tibia 0.06 and tarsus 0.13 mm; setal formula at least 0–2–3–9; tarsal solenidion could not be observed. Legs I and II with tripartite femora; femur I 0.70 mm long (basifemur 0.22 mm, mesofemur 0.29 mm, telofemur 0.22 mm), femur II 0.40 mm long (telofemur 0.18 mm); femora of legs III and IV bipartite, joint well developped. Femoral setae: leg I 1+4+5, leg II 1+4+5, leg III 3?+4?, leg IV 3?+4?. Rhagidial organs of tarsi I and II with 3 solenidia (Fig. 7), which are longitudinally striated and arranged obliquely to axis of tarsus in a common depression; tarsi III–IV without rhagidial solenidia; famulus (*e*) ('stellate seta') of tarsus I beside basalmost rhagidial solenidion (Fig. 7), form not determined; famulus of tar-

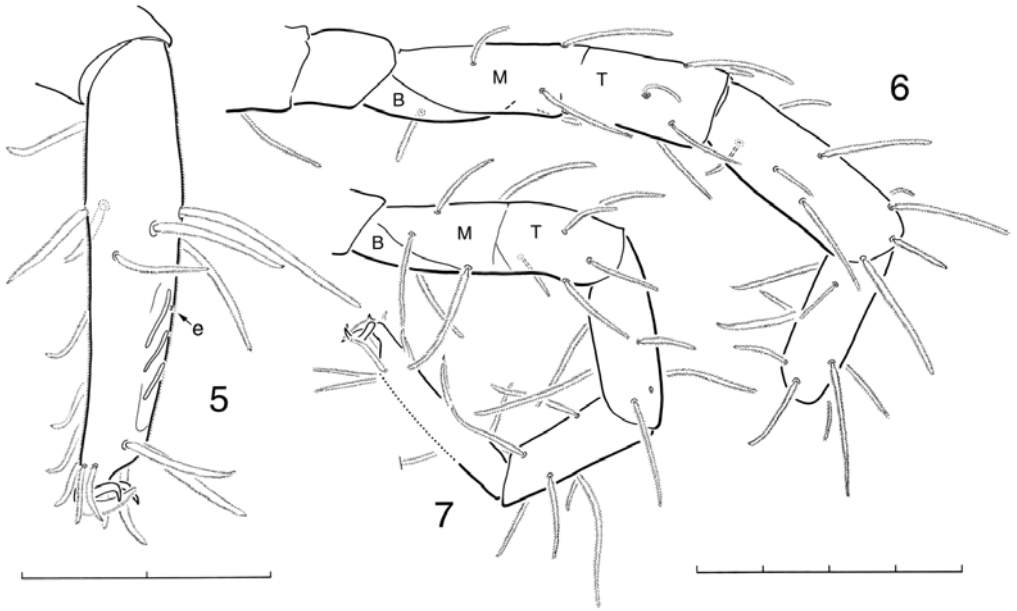


Figs 3-4. *Zachardia flexipes* n. sp., holotype. 3. Anterior part of body, dorsal view, showing prodorsal shield, chelicerae and palps. 4. Ventral view of body; appendages omitted apart from coxae, trochanters of left legs and base of right palp; right coxa III and area immediately behind coxa IV obscured. Divisions of scale lines = 0.1 mm.

sus II ('spiniform seta') not observed; empodia setulose, not broadened, as long as claws; claws with ventrobasal spurs ('clawlets'). No solenidia, apart from those of the rhagidial organs, could be seen on the legs, but not all segments can be seen in suitable orientations.

R e m a r k s. Apart from the femoral divisions of the anterior legs, *Zachardia* is very similar to modern Rhagidiidae. It is therefore natural to question whether the proximal joint described for femora I and II is real or just an artefact of preservation. Although the legs can only be adequately studied in dorsal view, the same structure can be seen in the same position on both pairs of anterior legs. Unlike legs III–IV, the anterior have not collapsed in the fossil and seem to be in a fairly natural state. It therefore seems unlikely that the joints represent post-mortem folding of the cuticle, even if this possibility cannot be ruled out entirely.

Another obvious question is whether the femoral joints are primitive or secondary. The mesotelofemoral joint of *Zachardia* clearly corresponds to the division of the femur seen in other Rhagidiidae and Eupodoidea in general. In other words, the basi- and mesofemur of *Zachardia* together correspond to the basifemur of other Rhagidiidae. ZACHARDA (1980) considered the joint between the basifemur and telofemur to be vestigial in Rhagidiidae, whereas BAKER (1990) did not consider these to be separate segments, implying that they were secondarily subdivided in the Eupodoidea, based on the lack of a separate musculature. The problem of the femoral segmentation of actinotrichid mites in general was considered by GRANDJEAN (1952, 1954), who concluded that the



Figs 5-7. *Zachardia flexipes* n. sp., holotype. 5. Tarsus of left leg I, anterodorsal view. 6. Right leg I, posterodorsal view of coxa to tibia. 7. Right leg II, posterodorsal view (to same scale as Fig. 6). Abbreviations: B = basifemur; e = famulus, M = mesofemur; T = telofemur. Divisions of scale lines = 0.1 mm.

presence of a separate basi- and telofemur was a primitive character. The same conclusion was reached by SHULTZ (1989) in a general study of arachnid legs, and we adopt it here. According to this interpretation, the lack of muscle insertions on the telofemur would be the result of secondary loss.

In contrast, the separation of the basi- and mesofemur of *Zachardia* is most parsimoniously interpreted as a secondary formation, based on its absence in other Rhagidiidae and the remaining eupodoid families. Indeed, only two families of actinotrichid mites—the Sphaerolichidae and Labidostommidae – have a tripartite femur, and neither of these families is closely related to the Rhagidiidae. The tripartite femur of *Zachardia* would therefore be the result of the retention of a primitive joint (meso-telofemoral) and the subsequent acquisition, in phylogenetic time, of a secondary (basi-telofemoral) joint. It is interesting to note that the femoral divisions of the anterior legs of *Zachardia* are similar to those of the Sphaerolichidae (GRANDJEAN 1939) terms of the chaetotaxy, but this might simply be due to functional constraints. It is evident that secondary divisions will tend to appear between verticils of setae, which means that if one begins with similar chaetotaxies, it would not be surprising to find secondary joints appearing at similar positions in different groups. The formation of the basal joint could be correlated with the elongation of the femur in *Zachardia*, conferring additional flexibility.

Poecilophysis O. P. CAMBRIDGE, 1876

Poecilophysis? sp.

M a t e r i a l e x a m i n e d. One specimen, probably a tritonymph, lying near the surface of a piece of amber containing a number of inclusions (e.g. moss, small leaf, fly, collembolan and possible faecal pellet) (F90/BB/AC/CJW; in private collection of J. WUNDERLICH, Strau-

benhardt). The legs of the mite are rather crumpled and parts of left legs II–IV are missing, but the condition of the specimen is otherwise fair. It lies with its venter closest to the surface of the amber; further preparation would be needed to study the dorsal surface of the body and the legs, but this would be difficult to do without damaging the other inclusions.

D e s c r i p t i v e n o t e s. Idiosomal length about 0.75 mm. Chelicerae with long, thin, strongly arched fingers. Palp with tarsus long (about 0.12 × 0.04 mm). Genital segment with 4 pairs of setae. Genital plates each with 4 setae. Anterior legs long, others fairly robust. Leg setae unusually long (e.g. dorsal seta of femur IV 0.28 mm) and fine (some setae dislodged by struggling). Empodia ciliate, not broadened, as long as lateral claws.

R e m a r k s. This assignment of this fossil is mainly based on the form of the chelicerae, which, although not conclusive, strongly suggests the extant genus *Poecilophysis*.

Rhagidiidae indet.

M a t e r i a l e x a m i n e d. 1 nymph (F343/BB/AC/CJW; in private collection of J. WUNDERLICH, Straubenhardt) in a clear piece of amber that also contains two small flies.

R e m a r k s. The small size of this specimen (idiosomal length 0.48 mm) suggests that it is either a proto- or deutonymph. It is in a rather crumpled state and has not been studied in detail.

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