A mite of the family Tanaupodidae (Arachnida, Acari, Parasitengona) from the Lower Cretaceous of France

Mark L. I. JUDSON
Muséum national d'Histoire naturelle,
Département Systématique et Évolution, CNRS UMR 5202,
case postale 53, 57 rue Cuvier, F-75231 Paris cedex 05 (France)
judson@mnhn.fr

Joanna MĄKOL
Wrocław University of Environmental and Life Sciences,
Department of Zoology and Ecology,
Kożuchowska 5B, PL-51-631 Wrocław (Poland)
and Wrocław University of Environmental and Life Sciences,
Institute of Natural Sciences,
Norwida 25, PL-50-375 Wrocław (Poland)
joanna.makol@up.wroc.pl

Judson M. L. I. & Mąkol J. 2009. — A mite of the family Tanaupodidae (Arachnida, Acari, Parasitengona) from the Lower Cretaceous of France. *Geodiversitas* 31 (1): 41-47.

ABSTRACT
Atanaupodus bakeri n. gen., n. sp. is described from a postlarval specimen in amber from Archingeay, France (Albian, Lower Cretaceous). This mite is placed in the Tanaupodidae Thor, 1935 because of its general similarity to the extant genus *Tanaupodus* Haller, 1882, but this assignment is provisional because several important characters cannot be observed in the single available fossil. Extant *Tanaupodus* species are associated with freshwater habitats in Europe, which concord with the high frequency of aquatic taxa observed in Archingeay amber. This is the first fossil record of Tanaupodidae and the oldest described representative of the Parasitengona in amber. The use of the "*Lassenia* organ" in phylogenetic analyses of Parasitengona is criticized because its presence is symplesiomorphic within this group.

KEY WORDS
Arachnida,
Acari,
Parasitengona,
Tanaupodidae,
amber,
fossil,
Cretaceous,
France,
new genus,
new species.

RÉSUMÉ
Un acarien de la famille Tanaupodidae (Arachnida, Acari, Parasitengona) du Crétacé inférieur de France.
Atanaupodus bakeri n. gen., n. sp. est décrit à partir d'un spécimen postlarvaire dans l'ambre d'Archingeay, France (Albien, Crétacé inférieur). Cet Acarien est classé parmi les Tanaupodidae Thor, 1935 du fait de sa ressemblance avec le genre actuel *Tanaupodus* Haller, 1882 mais cette position est provisoire car plusieurs caractères importants ne sont pas visibles sur l'unique exemplaire. Des espèces actuelles de *Tanaupodus* sont associées aux habitats d'eau douce en Europe, ce qui s'accorde bien avec la fréquence élevée des taxons aquatiques dans l'ambre d'Archingeay. Celui-ci est le premier fossile connu des Tanaupodidae et le plus ancien représentant des Parasitengona à être décrit de l'ambre. L'utilisation de "l'organe *Lassenia*" dans des analyses phylogénétiques des Parasitengona est critiquée car sa présence est symplésiomorphe au sein de ce groupe.

MOTS CLÉS
Arachnida,
Acari,
Parasitengona,
Tanaupodidae,
ambre,
fossile,
Crétacé,
France,
genre nouveau,
espèce nouvelle.

INTRODUCTION

Although mites are one of the most abundant components of amber faunas, they have been inadequately studied due to practical difficulties in examining such small inclusions. Those of Cretaceous ambers are particularly poorly known, despite the obvious interest of their greater age, and only 11 species of Acari have been named to date: one Bdellidae Dugès, 1834 and one Erythraeidae Robineau-Desvoidy, 1828 (Prostigmata) from Canadian amber (Campanian) (Ewing 1937; Vercammen-Grandjean 1973); one Camisiidae Oudemans, 1900, one Plateremaeidae Trägårdh, 1931 (Oribatida) and two Anystidae Oudemans, 1936 (Prostigmata) from Siberian amber (Caenomanian-Santonian) (Bulanova-Zachvatkina 1974; Krivolutsky & Rjabinin 1976; Zacharda & Krivolutsky 1985); one species of the tick family Ixodidae Dugès, 1834 (Ixodida) from New Jersey amber (Turanian) (Klompen & Grimaldi 2001); one †Archaeorchestidae Arillo & Subías, 2000 and one Cepheidae Berlese, 1896 (Oribatida) from Álava amber (Albian) (Arillo & Subías 2000, 2002); one Cheyletidae Leach, 1815 (Prostigmata) and one Ixodidae from Burmese amber (Albian) (Cockerell 1917; Poinar & Brown 2003). Non-amber fossils of mites are very rare from this period, but Dunlop (2007) has recently described an erythraeoid from the Lower Cretaceous (Aptian) Crato Formation of Brazil. Summaries of the literature on Acari from other geological periods are given by Bernini (1991), Witaliński (2000) and Dunlop (2007). The earliest confirmed reports of mites in the fossil record are from the Lower Devonian (Hirst 1923; Norton *et al.* 1988; Kethley *et al.* 1989); Bernini *et al.* (2002) have described an oribatid mite from the Lower Ordovician of Sweden, but the assignment of this fossil to the derived group Brachypilina has raised questions concerning its true age (Lindquist 2002).

The fossil mite described here was found in amber from Archingeay-Les Nouillers (Charente-Maritime, France), which has been dated as being as uppermost Albian (Lower Cretaceous; *c.* 100 Ma) (Néraudeau *et al*. 2002; Perrichot 2004). The botanical source of the amber has been identified as conifers of the genus *Agathoxylon* Hartig, 1848 (Araucariaceae) (Néraudeau *et al*. 2002), although Perrichot (2005) suggests that part of the amber might be derived from Cheirolepidiaceae. A notable feature of this amber is the relatively high frequency of ground-litter inclusions and aquatic or hygrophilous arthropod groups. The mite is here identified as a member of the Tanaupodidae Thor, 1935, which are relatively basal Parasitengona (Welbourn 1991; Söller *et al*. 2001; Wohltmann 2001, 2006). Tanaupodidae are often associated with freshwater habitats (Wohltmann *et al.* 2007) and their larvae, when known, are parasitic on Diptera, Homoptera and Collembola (Newell 1957; Zhang 1998a, b; Baquero *et al*. 2003).

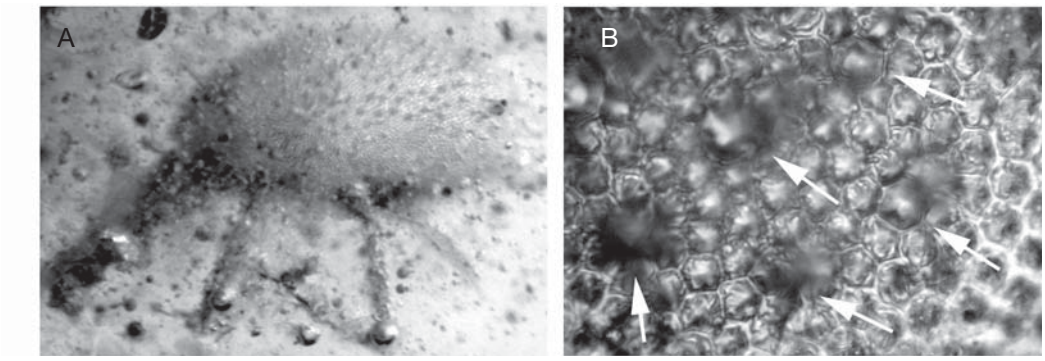

FIG. 1. — *Atanaupodus bakeri* n. sp., holotype: **A**, lateral view; **B**, detail of integument above level of coxa IV, arrows indicate positions of setae. Body length 730 µm.

MATERIAL AND METHODS

The sample (ARC 115) in which the mite was found was a "litter-bearing" piece of amber that contained 77 other arthropods, a partial feather and plant fragments of Araucariaceae (Perrichot 2004, 2005). The mite was prepared as a small shard mounted in epoxy resin between two cover-slips. Observations and drawings were made using a Leitz Laborlux S microscope, equipped with a drawing tube. Photographs were taken using a Nikon Coolpix 995 digital camera mounted on the same microscope. Measurements were taken with an ocular micrometer and are given in micrometres (µm).

SYSTEMATICS

Family TANAUPODIDAE Thor, 1935

Atanaupodus n. gen.

TYPE SPECIES. — *Atanaupodus bakeri* n. sp.

ETYMOLOGY. — The generic name is formed by adding the prefix *a-* (not) to *Tanaupodus*, which itself was presumably derived from the Greek ταναοσ (elongate) and πους, ποδος (foot); gender masculine.

DIAGNOSIS (POSTLARVAL STAGE). — Tanaupodidae of typical facies (Figs 1A; 2A), with idiosomal setae set on platelets, integument strongly papillate. Naso apparently well developed. Two pairs of sessile eyes. Form of crista metopica unknown; probably with one pair of prodorsal trichobothria. Legs robust, all segments smooth; femora divided; setae simple; leg claws strong and simple; tarsus I only moderately enlarged.

REMARKS

The papillate sculpturing of the integument and the platelets at the setal bases are similar to those seen in the extant genus *Tanaupodus* Haller, 1882. However, the new genus differs in having the surfaces of the legs smooth (reticulate in *Tanaupodus*) and all leg setae simple (at least some plumose setae present in *Tanaupodus*).

Atanaupodus bakeri n. sp.
(Figs 1; 2)

HOLOTYPE. — Active postlarval stage (probably a deutonymph), preserved in a very turbid fragment of amber (ARC 115.8R) from Archingeay-Les Nouillers, Charente-Maritime, France: Lower Cretaceous, uppermost Albian, lithological subunit A1 *sensu* Néraudeau & Moreau (1989). Deposited in Palaeoentomological collection of the Muséum national d'Histoire naturelle, Paris. Specimen only visible in lateral view and difficult to study because of numerous small bubbles and debris in the amber. Distal end of left leg IV and most parts of the right legs lost.

ETYMOLOGY. — This species is dedicated to the acarologist Dr Richard ("Sandy") A. Baker (Leeds University), who was the first author's Ph.D. supervisor.

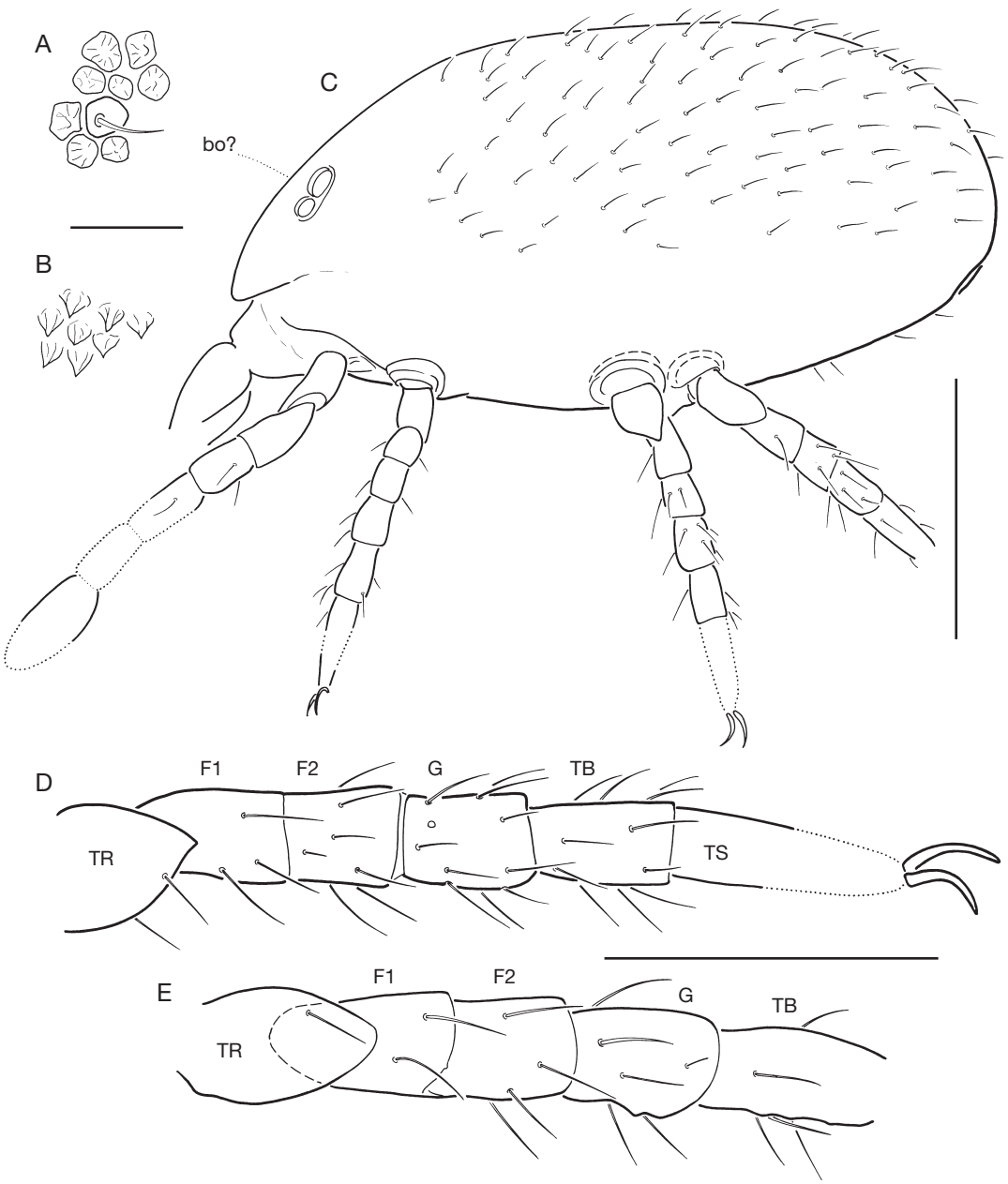

FIG. 2. — *Atanaupodus bakeri* n. sp., holotype: **A**, detail of hysterosomal papillae and seta, view perpendicular to surface; **B**, oblique view of hysterosomal papillae; **C**, habitus, lateral view; **D**, left leg III, dorso-antiaxial view; **E**, left leg IV, dorso-antiaxial view (distal end lost). Abbreviations: **bo?**, possible trichobothrium; **F1**, basifemur; **F2**, telofemur; **G**, genu; **TB**, tibia; **TR**, trochanter; **TS**, tarsus. Scale bars: A, B, 10 µm; C, 200 µm; D, E, 100 µm.

DESCRIPTION

All setae simple and acuminate; those of idiosoma approximately 28 long, numerous, irregularly arranged and inserted on platelets that are slightly larger and more strongly sclerotized (rims darker, slightly orange in colour) than the surrounding

papillae. Idiosoma 730 long, 350 deep; integument with slightly crenulate papillae with a pentagonal or hexagonal base (Figs 1B; 2A, B). Aspidosoma apparently with a small, blunt, anteroventrally-directed naso; two pairs of well-developed lateral eyes, which are contiguous and sessile; crista metopica not visible, but the probable presence of a pair of trichobothria at the level of the eyes is inferred from a string of bubbles (Fig. 2C: *bo*?). Legs (Fig. 2D, E) robust; tarsus I moderately expanded; cuticle of all segments smooth; all setae simple; legs I-III with a pair of long, simple claws (end of leg IV missing). Leg lengths (trochanter to tarsus): I 460, II 340, III 330, IV unmeasurable.

DISCUSSION

The small size of the holotype of *A. bakeri* n. sp. indicates that it probably belongs to the deutonymphal stage; the length of the idiosoma in adults of extant European Tanaupodidae is about 1000 µm (Wohltmann *et al.* 2007). Due to the lateral position of specimen, some characters, such as details of the gnathosoma, the structure of the crista metopica, the genital and anal openings, and the presence or absence of a pregenital tubercle cannot be determined, but the general shape of the body, the presence of a distinct protrusion of the aspidosoma (naso), the form of the eyes and the dorsal opisthosomal setae, and presence of asetose papillae on the idiosomal surface make the family affiliation of studied specimen very likely.

Unfortunately, the systematic position and composition of the Tanaupodidae are unclear at present, which means that *Atanaupodus* n. gen. cannot be used to assign minimal ages to other groups within the Parasitengona. However, it is clear that Parasitengona had undergone significant diversification by the Early Cretaceous, because the family Smaridídae is known from Lebanese amber (Azar 2007) and a possible member of the Erythraeidae has been described from the Crato Formation of Brazil (Dunlop 2007). Welbourn (1991) proposed two synapomorphies for Tanaupodoidea (containing only the family Tanaupodidae): the presence of a "*Lassenia* organ" and the presence of a pregenital tubercle. Wohltmann (2001) interpreted the "*Lassenia* organ" as a possible homologue of the glandularia of Hydrachnidia and suggested that Tanaupodidae might be more closely related to Hydrachnidia than to terrestrial Parasitengona. Despite this, he treated the Tanaupodidae as a family of the Trombidioidea, rendering the latter polyphyletic in terms of the phylogeny he presented. The use of the "*Lassenia* organ" to define clades within the Parasitengona is problematic. According to Judson (1994), this organ is homologous with gland dg_5, which is present in many other groups of Prostigmata, including the outgroup (Anystidae) used in Wohltmann's (2001) analysis. This means that its presence would be symplesiomorphic for Parasitengona and thus irrelevant for determining phylogenetic relationships within this group. A more detailed phylogenetic analysis of Parasitengona has been carried out by Wohltmann (2006), whose results indicate that Tanaupodidae are polyphyletic, with some members being related to Erythraeoidea/Calyptostomatoidea and others occupying basal positions within Trombidioidea. However, the characters responsible for these positions were not indicated on the cladogram and the type genus (*Tanaupodus*) was not included in the analysis, which means that no conclusions can yet be drawn concerning the composition of Tanaupodidae. It is clear that the Tanaupodidae are in urgent need of revision, for which it will be particularly important to identify the larvae of *Tanaupodus*.

Acknowledgements
We are indebted to André Nel, Vincent Perrichot and Gaël de Ploëg for the opportunity to study this interesting fossil and to Dany Azar for skilful preparation of the piece. Helpful comments on the text were provided by Antonio Arillo, Annemarie Ohler, Vincent Perrichot and an anonymous referee. Our thanks also go to Andreas Wohltmann for constructive criticism of an earlier version of the manuscript. Part of the work was carried out during a SYNTHESYS visit by the second author to the Muséum national d'Histoire naturelle, Paris, funded by the European Community IHP programme. This work is a contribution to the project AMBRACE

no. BLAN07-1-184190), funded by the Agence nationale de la Recherche (ANR).

REFERENCES

ARILLO A. & SUBÍAS L. S. 2000. — A new fossil oribatid mite, *Archaeorchestes minguezae* n. gen. n. sp. from the Spanish Lower Cretaceous amber. *Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg* 84: 231-236.

ARILLO A. & SUBÍAS L. S. 2002. — Second fossil oribatid mite from the Spanish Lower Cretaceous amber. *Eupterotegaeus bitranslamellatus* n. sp. (Acari, Oribatida, Cepheidae). *Acarologia* 42: 403-406.

AZAR D. 2007. — Preservation and accumulation of biological inclusions in Lebanese amber and their significance. *Comptes Rendus Palevol* 6: 151-156.

BAQUERO E., MORAZA M. L. & JORDANA R. 2003. — A new species of *Polydiscia* (Acari, Prostigmata, Tanaupodidae) with reference to its host: a new species of *Deuterosminthurus* (Collembola, Symphypleona, Bourletiellidae). *Zootaxa* 188: 1-16.

BERNINI F. 1991. — Fossil Acarida. Contribution of palaeontological data to acarid evolutionary history, *in* SIMONETTA A. & MORRIS S. C. (eds), *The Early Evolution of Metazoa and the Significance of Problematic Taxa*. Cambridge University Press, Cambridge: 253-262.

BERNINI F., CARNEVALE G., BAGNOLI G. & STOUGE S. 2002. — An Early Ordovician oribatid mite (Acari: Oribatida) from the island of Öland, Sweden, *in* BERNINI F., NANNELLI R., NUZZACI G. & DE LILLO E. (eds), *Acarid Phylogeny and Evolution: Adaptation in Mites and Ticks*. Kluwer Academic Publishers, Dordrecht: 45-47.

BULANOVA-ZACHVATKINA E. M. 1974. — A new genus of mite (Acariformes, Oribatei) from the Upper Cretaceous of Tamyr. *Palaeontological Journal*, Washington 8: 247-250.

COCKERELL T. D. A. 1917. — Arthropods in Burmese amber. *Psyche* 24: 40-44.

DUNLOP J. A. 2007. — A large parasitengonid mite (Acari, Erythraeoidea) from the Early Cretaceous Crato Formation of Brazil. *Fossil record, Mitteilungen aus dem Museum für Naturkunde in Berlin* 10: 91-98.

EWING H. E. 1937. — Insects and arachnids from Canadian amber: Arachnida order Acarina. *University of Toronto Studies* (Geol.) 40: 56-62.

HIRST S. 1923. — On some arachnid remains from the Old Red Sandstone (Rhynie Chert Bed, Aberdeenshire). *Annals and Magazine of Natural History* 12: 455-474.

JUDSON M. 1994. — Studies on the morphology and systematics of the Teneriffiidae (Acari, Prostigmata). 1: A new species of *Neoteneriffiola* from Namibia. *Acarologia* 35: 115-134.

KETHLEY J., NORTON R. A., BONAMO P. M. & SHEAR W. A. 1989. — A terrestrial alicorhagiid mite (Acari, Acariformes) from the Devonian of New York. *Micropaleontology* 35: 367-373.

KLOMPEN H. & GRIMALDI D. 2001. — First Mesozoic record of a parasitiform mite: a larval argasid tick in Cretaceous amber (Acari: Ixodida: Argasidae). *Annals of the Entomological Society of America* 94: 10-15.

KRIVOLUTSKY D. A. & RJABININ B. A. 1976. — Oribatid mites in Siberian and Far East amber. *Doklady Akademii nauk SSSR* 230: 945-948.

LINDQUIST E. E. 2002. — Book review: *Acarid Phylogeny and Evolution: Adaptation in Mites and Ticks*, by F. Bernini, R. Nannelli, G. Nuzzaci and E. de Lillo (eds). *Experimental and Applied Acarology* 25: 917-920.

NEWELL I. M. 1957. — Studies on the Johnstonianidae (Acari, Parasitengona). *Pacific Science* 11: 396-466.

NÉRAUDEAU D. & MOREAU P. 1989. — Paléoécologie et paléobiogéographie des faunes d'échinides du Cénomanien nord-aquitain (Charente-Maritime, France). *Geobios* 22: 293-324.

NÉRAUDEAU D., PERRICHOT V., DEJAX J., MASURE E., NEL A., PHILIPPE M., MOREAU P., GUILLOCHEAU F. & GUYOT T. 2002. — Un nouveau gisement à ambre insectifère et à végétaux (Albien terminal probable) : Archingeay (Charente-Maritime, France). *Geobios* 35: 233-240.

NORTON R. A., BONAMO P. M., GRIERSON J. D. & SHEAR W. A. 1988. — Oribatid mite fossils from a terrestrial Devonian deposit near Gilboa, New York. *Journal of Paleontology* 62: 259-269.

PERRICHOT V. 2004. — Early Cretaceous amber from south-western France: insight into the Mesozoic litter fauna. *Geologica Acta* 2: 9-22.

PERRICHOT V. 2005. — Environments paraliques à ambre et à végétaux du Crétacé nord-aquitain (Charentes, Sud-Ouest de la France). *Mémoires de Géosciences Rennes* 118: 1-213.

POINAR G. JR & BROWN A. E. 2003. — A new genus of hard ticks in Cretaceous Burmese amber (Acari: Ixodida: Ixodidae). *Systematic Parasitology* 54: 199-205.

SÖLLER R., WOHLTMANN A., WITTE H. & BLOHM D. 2001. — Phylogenetic relationships within terrestrial mites (Acari: Prostigmata, Parasitengona) inferred from comparative DNA sequence analysis of the mitochondrial cytochrome oxidase subunit I gene. *Molecular Phylogenetics and Evolution* 18: 47-53.

VERCAMMEN-GRANDJEAN P. H. 1973. — Study of the "Erythraeidae, R. O. M. No. 8" of Ewing, 1937. *Proceedings of the 3rd International Congress of Acarology, Prague, 1971*: 329-335.

WELBOURN W. C. 1991. — Phylogenetic studies of the terrestrial Parasitengona, *in* DUSBÁBEK F. & BUKVA V. (eds), *Modern Acarology*. Academia, Prague; SPB Academic Publishing, The Hague, 2: 163-170.

WITALIŃSKI W. 2000. — *Aclerogamasus stenocornis* sp. n., a fossil mite from the Baltic amber (Acari: Gamasida: Parasitidae). *Genus* 11: 619-626.

WOHLTMANN A. 2001. — The evolution of life histories in Parasitengona (Acari: Prostigmata). *Acarologia* 41: 145-204 (dated 2000, published 2001).

WOHLTMANN A. 2006. — The phylogenetic relationships of and within the Microtrombidiidae (Acari: Prostigmata: Parasitengona), *in* GABRYŚ G. & IGNATOWICZ S. (eds), *Advances in Polish Acarology*. Wydawnictwo SGGW, Warszawa: 436-457.

WOHLTMANN A., GABRYŚ G. & MĄKOL J. 2007. — Acari: terrestrial Parasitengona inhabiting transient biotopes, *in* GERECKE R. (ed.), *Süßwasserfauna von Mitteleuropa*, *7/2-1, Chelicerata: Araneae, Acari I.* Spektrum Elsevier, München: 158-240.

ZACHARDA M. & KRIVOLUTSKY ["KRIVOLUCKIJ"] D. A. 1985. — Prostigmatic mites (Acarina: Prostigmata) from the Upper Cretaceous and Paleogene amber of the USSR. *Věstnik československé Společnosti zoologické* 49: 147-152.

ZHANG Z.-Q. 1998a. — An unusual early-derivative larva of Parasitengona (Acari: Prostigmata) and proposal of a new superfamily. *Systematic and Applied Acarology* 3: 159-170.

ZHANG Z.-Q. 1998b. — Biology and ecology of trombidiid mites (Acari: Trombidioidea). *Experimental and Applied Acarology* 22: 139-155.

Submitted on 12 October 2007;
accepted on 10 June 2008.