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New Eocene damselflies and first Cenozoic damsel-dragonfly of the isophlebiopteran lineage (Insecta: Odonata)

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Abstract

The study of a new specimen of *Petrolestes hendersoni* from the Eocene Green Formation allows a more precise description of the enigmatic damselfly and the diagnosis of the Petrolestini. *Petrolestes messelensis* **sp. nov.** is described from the Eocene Messel Formation in Germany, extending the distribution of the Petrolestini to the European Eocene. The new damsel-dragonfly family Pseudostenolestidae is described for the new genus and species *Pseudostenolestes bechlyi*, from the Eocene Messel Formation. It is the first Cenozoic representative of the Mesozoic clade Isophlebioptera.

Key words: Insecta, Messel, Eocene, Green River and Messel Formations, USA, Germany

Introduction

If the damselfly fossil record is well documented for the Oligocene and the Miocene (Nel and Paicheler 1992, 1993), it is far from being the case for the period Upper Cretaceous – Eocene, which is crucial for knowledge of the diversification of the modern fauna. Few outcrops of these periods have given well-preserved fossils. Therefore all newly found material can be of great importance for our understanding of the processes of this diversification. Here we describe a new, well-preserved damselfly from the Green River Formation (USA) and a small series of wings from Messel (Germany).

The Eocene Green River Formation in the USA is well known as a very rich Konservat-Lagerstätte with vertebrates, plants, and insects (Grande 1984). This formation "encompasses a five m.y. period between ca. 53.5 and 48.5 Ma" (Smith *et al.* 2003). Many of these fossils are in exquisite state of preservation with some soft structures and traces of coloration preserved. Only few Odonata have been described from this formation, viz. the 10 Zygoptera *Dysagrion fredericii* Scudder, 1878, *Dysagrion lakesii* Scudder, 1890, *Dysagrion packardii* Scudder, 1885, *Eocalopteryx atavina* Cockerell, 1920, *Protamphipteryx basalis* Cockerell, 1920, *Eopodagrion scudderi* Cockerell, 1920, *Zacallites balli* Cockerell, 1928, *Eolestes synthetica* Cockerell, 1940, *Labandeiraia americaborealis* Petrulevičius *et al.* 2007, and *Litheuphaea coloradensis* Petrulevičius *et al.* 2007, plus an alleged libelluloid abdomen (*Stenogomphus scudderi* Cockerell, 1921) (Scudder, 1892; Cockerell 1920, 1921, 1928, 1940; Petrulevičius *et al.* 2007), and a new family of anisopteran Cavilabiata (Zairi *et al.*, submitted). Grande (1984: fig. IV.18) also figured a nearly complete Odonata as a Libellulidae from the Green River Formation, but this fossil is clearly a Calopterygoidea.

The fossils from Messel are preserved in organic-rich claystones (oil shale) which were deposited in a former maar lake (e.g. Schulz *et al.* 2002, Felder & Harms 2004). The Messel oil shale is dated to about 47 Ma (lower Middle Eocene; Franzen 2005; Mertz & Renne 2005), and is well known for its exceptionally well-preserved flora and fauna (e.g. Schaal & Ziegler 1992). The ongoing excavations have yielded a multitude of insect fossils that comprise a very diverse fauna (e.g. Lutz 1990; Wedmann 2005; Wedmann *et al.* 2007, 2009, 2011; McNamara *et al.* 2011; Dlussky & Wedmann 2012). Odonata are rather scarce, generally preserved as isolated wings, unlike the other insects (Lutz 1987; Wedmann 2005).

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