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1 A new micropterigid moth from the ‘mid’–Cretaceous Burmese amber (Insecta: Lepidoptera)

2

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9

10 Abstract. *Sabatinca pouilloni* Ngô-Muller and Nel sp. nov., the fourth Micropterigidae moth
11 from the ‘mid’-Cretaceous Burmese amber, is described and illustrated. Its hind wing R is
12 complete, a symplesiomorphic character state only present in the extant New Zealand
13 ‘*Sabatinca calliarcha* clade’. The new fossil species does not belong to the same group than
14 the three previously micropterigid species from the same amber, suggesting that the genus
15 *Sabatinca* diversified earlier than 100 Ma, well before the recently proposed date of 80 Ma.

16

17 Keywords

18 Zeugloptera; *Sabatinca*; sp. nov.; dating

19

20 Introduction

21 Moths are rather rare in the fossil record, especially for the Mesozoic. Furthermore, they are
22 frequently difficult to separate from the two other amphiesmenopteran orders Trichoptera
23 Kirby, 1813 and Tarachoptera Mey, Wichard, Müller & Wang, 2017 on the sole basis of their
24 wing venation, especially for the Liassic taxa (Ansorge, 2002, 2003; Sohn et al., 2012).
25 Nevertheless, they can be of a great interest for the phylogenetic analysis and past history of

26 the order, especially for the most ‘basal’ non-Glossata groups that lack proboscis. If we do not
27 consider some fossils of uncertain affinities, four families of this kind are recorded for the
28 Mesozoic, viz. the Eolepidopterigidae Rasnitsyn, 1983, the Mesokristenseniidae Huang, Nel &
29 Minet, 2010, the Ascololepidopterigidae Zhang, Shih, Labandeira & Ren, 2013, and the
30 Micropterigidae Herrich-Schäffer, 1855. Only the Micropterigidae are known by Mesozoic
31 fossils in amber, while the three other families are based on compression fossils that give
32 relatively less information (Sohn et al., 2015).

33 The entomofauna of the ‘mid’-Cretaceous Burmese (Myanmar) amber is one of the richest
34 known for the Mesozoic, but it currently comprises only six recorded Lepidoptera, viz. a
35 Douglasiidae, a Gelechiidae, a Gracillariidae, and three Micropterigidae (Zhang et al., 2017;
36 Poinar, 2019; Ross, 2019), plus a larger still undescribed Macroheterocera (Huang, pers.
37 comm.). Here we describe a new Micropterigidae, different from those already described.

38

39 Material and methods

40 The type of *Sabatinca pouilloni* gen. et sp. nov. (Muséum National d’Histoire Naturelle, Paris,
41 France) is embedded in a small clear piece of amber. It was prepared using a diamond disk and
42 examined using Nikon binocular microscopes SMZ 1500 and SMZ25. Photographs were taken
43 with a Nikon camera D800, and the images were treated with Adobe Photoshop Element 12
44 and CS6. The piece of Burmese amber was found in deposits in the Hukawng Valley (Kachin)
45 of Myanmar (Yin et al., 2018: fig. 1A). The age of amber is confirmed by radiometric analysis
46 of zircons as earliest Cenomanian, *ca.* 99 Ma. (Shi et al., 2012).

47 We follow the most recent classification of the Lepidoptera proposed by Regier et al. (2015:
48 table 1), with the correspondence to that of Van Nieuwerkerken et al. (2011).

49 The paper is registered in the Zoobank at [urn:lsid:zoobank.org:pub:795B28B1-99F9-4AC0-](https://zoobank.org/pub:795B28B1-99F9-4AC0-986B-33CC05B7063A)
50 986B-33CC05B7063A

51

52 Systematic palaeontology

53 Order Lepidoptera Linnaeus, 1758

54 Suborder Zeugloptera Chapman, 1917

55 Superfamily Micropterigoidea Herrich-Schäffer, 1855

56 Family Micropterigidae Herrich-Schäffer, 1855

57 Genus *Sabatinca* Walker, 1863

58

59 *Sabatinca pouilloni* Ngô-Muller and Nel sp. nov.

60 Figures 1-5

61 The species is registered in the Zoobank at [urn:lsid:zoobank.org:act:CDE8ED0A-B9FF-4C43-](https://zoobank.org/urn:lsid:zoobank.org:act:CDE8ED0A-B9FF-4C43-A1E8-D18D3B33A669)

62 [A1E8-D18D3B33A669](https://zoobank.org/urn:lsid:zoobank.org:act:CDE8ED0A-B9FF-4C43-A1E8-D18D3B33A669)

63 Material. Holotype MNHN.F.A71311 (female, specimen 25, collection Jean-Marc Pouillon),

64 stored in the collections of the Muséum National d'Histoire Naturelle, Paris, France.

65 Etymology. In honour of Dr Jean-Marc Pouillon, who donated the type specimen to the MNHN,

66 Paris.

67 Diagnosis. Forewing Sc and R forked, with sc-r ending basal of fork of R; Rs anteriorly

68 pectinate; no crossvein ir; Rs4 pre-apical; Hind wing Sc and R simple, well separated and

69 complete; sc-r present.

70 Locality and horizon. Hukawng Village, Kachin State, Northern Myanmar; 'mid'-Cretaceous.

71 Description. Body length 2.7 mm. Forewing length 2.5 mm; hind wing length 2.4 mm.

72 Head with tufts of very long piliform scales on frons and vertex. Antennae short, nearly

73 forewing length; scape greatly swollen with a distinct indentation on its mesial surface; pedicel

74 swollen, markedly wider than basal flagellomeres (large arrow on Fig. 4A); flagellum filiform

75 to submoniliform, with flagellomeres barrel-shaped, basal flagellomeres relatively long,

76 subsequent flagellomeres markedly shorter; ascoid sensillae present in the first 10 basal
77 flagellomeres (arrow on Fig. 4A), but with basal arrangement indiscernible, absent in the seven
78 more distal flagellomeres, which are shorter than the basal ones. Two ocelli. Maxillary palpus
79 with four visible segments (Fig 1C), folded between first and second visible segments; second
80 visible segment longest (arrow on Fig. 1C), last segment shortest, clawlike and tapering to
81 terminal end). Labial palpus quite shorter, three-segmented. Mandibles present, sclerotized, but
82 detailed structure indiscernible. Labrum not visible.

83 Spur formula 0-0-4 (Figs. 4 and 5A). Epiphysis arising from the inner wall of foretibia.
84 Metafemur swollen, metatibia with spines. Tarsus with five tarsomeres.

85 Scales covering both fore- and hindwings, but their shape hardly visible. Fore- and hindwings
86 of nearly the same lengths with pointed apices (Fig. 2). Margins of fore- and hindwings with
87 very long hair-like setae, almost reaching 0.3 mm (Fig. 2B). Forewing index (ratio of wing
88 width/wing length) 0.32; no pterostigma; humeral vein absent; Sc forked; sc-r absent; R deeply
89 bifurcating; Rs four-branched; branching points of R and Rs1 to Rs3 linearly aligned; crossvein
90 ir absent; Rs4 terminating slightly ante-apically; M forking to M1+2 and M3, M1+2 further
91 forking to veins M1 and M2; no intermedian (im) cross-vein; CuA bifurcating; CuP simple and
92 straight; anal veins not visible (Fig. 2A and B; drawing on Fig. 3A). Hind wing shorter than
93 forewing, wing index 0.95; four frenular bristles (wing coupling apparatus) on anterior margin.
94 Sc and R simple, separated with a sc-r crossvein; Rs four-branched; M three-branched; CuA
95 bifurcating; CuP and anal vein simple (Fig. 2C; drawing on Fig. 3B).

96 Abdomen 1.8 mm long, 0.48 mm wide; female genitalia partly visible.

97

98 Discussion.

99 *Sabatinca pouilloni* sp. nov. belongs to the Lepidoptera because of the following
100 synapomorphies, after Huang et al. (2010): presence of overlapping scales on the body and the

101 four wings, a fore tibia epiphysis; absence of apical spur on foretibia; free section of M1 meeting
102 crossvein r-m and markedly angulate at this junction. The absence of proboscis excludes
103 affinities with the Glossata Fabricius, 1775. More precisely, the Lophocoronidae Common,
104 1973 (Lophocoronina Common, 1990) have a very short proboscis but the five-segmented
105 maxillary palps of *Sabatinca pouilloni* sp. nov. exclude affinities with this group (Common,
106 1973). The Eriocraniidae Rebel, 1901 (Dacnonypha Hinton, 1946) and the Neopseustidae
107 Hering, 1925 (Neopseustina Davis & Nielsen, 1980) and other Hepialoidea Stephens, 1829
108 have easily visible and long proboscis (Davis, 1978, Davis and Nielsen, 1980). The Heteroneura
109 Tillyard, 1918 wing venation are quite different from that of *Sabatinca pouilloni* sp. nov. Six
110 groups remain possible, viz. the Jurassic-Cretaceous suborder Eolepidopterigina Rasnitsyn,
111 1983 (Eolepidopterigidae Rasnitsyn, 1983), the Jurassic Mesokristenseniidae and
112 Ascololepidopterigidae, the Zeugloptera Chapman, 1917 or Micropterigiodea Herrich-
113 Schäffer, 1855 (Micropterigidae Herrich-Schäffer, 1855), the Aglossata Speidel, 1977 or
114 Agathiphagoidea Kristensen, 1967 (Agathiphagidae Kristensen, 1967), and the
115 Heterobathmiina Kristensen & Nielsen, 1979 or Heterobathmioidea Kristensen & Nielsen,
116 1979 (Heterobathmiidae Kristensen & Nielsen, 1979).

117 *Sabatinca pouilloni* sp. nov. shares with the Eolepidopterigidae the three-branched M, but
118 strongly differs from this family in the pattern of the branches of Rs, viz. pectinate vs. double-
119 forked; midtibia with only one pair of spurs instead of two (Rasnitsyn, 1983, 1984; Zhang et
120 al., 2013, 2015). *Sabatinca pouilloni* sp. nov. greatly differs from the Ascololepidopterigidae
121 in the presence of four metatibial spurs and M three-branched (Zhang et al., 2013). *Sabatinca*
122 *pouilloni* sp. nov. has no medial spurs on mid-tibia (spur formula 0-0-4), unlike the
123 Agathiphagidae (spur formula 1-4-4). *Sabatinca pouilloni* sp. nov. has no apical mid-tibial
124 spurs as for the Micropterigidae and Heterobathmiidae, while the Mesokristenseniidae have
125 only one. The absence of foretibial spurs is a putative synapomorphy of *Sabatinca pouilloni* sp.

126 nov. with the Micropterigidae, Heterobathmiidae, and the Glossata. The forewing M with three
127 branches of *Sabatinca pouilloni* sp. nov. is a derived character supposed to have evolved
128 independently in Micropterigidae and Glossata. The hind wing Sc simple of *Sabatinca pouilloni*
129 sp. nov. is a putative apomorphy shared by all Lepidoptera except the Agathiphagidae.
130 *Sabatinca pouilloni* sp. nov. has a sc-r crossvein in hind wing, a putative plesiomorphy present
131 in Trichoptera, the Agathiphagidae, and many Micropterigidae. Like most lepidopterans,
132 *Sabatinca pouilloni* sp. nov. has an unforked hind wing R vein. *Sabatinca pouilloni* sp. nov.
133 has no hind wing areole (crossvein ir absent), while a closed areole occurs in
134 Mesokristenseniidae, certain Zeugloptera, the Aglossata, some Heterobathmiina, and a few
135 Glossata; however this character is homoplastic. Huang et al. (2010: 882) regarded ‘the loss of
136 the hind wing areole as an autapomorphy of the Myoglossata, independently evolved in the
137 Acanthoctesia’. *Sabatinca pouilloni* sp. nov. has no forewing areole between Rs3 and Rs4+5,
138 unlike the Agathiphagidae, many Micropterigidae, the Heterobathmiidae, and the
139 Mesokristenseniidae. *Sabatinca pouilloni* sp. nov. has the dorsal surface of mid tibia with a two
140 spines and the lateral surface with three spines, a situation different from that of the
141 Mesokristenseniidae that have the dorsal surface with a row of three or four pairs of spines.
142 *Sabatinca pouilloni* sp. nov. differs from the unique genus *Heterobathmia* of the family
143 Heterobathmiidae in the forked Sc and R and the absence of the ir crossvein (Kristensen and
144 Nielsen, 1979; 1998).

145 Within the Micropterigidae, *Sabatinca pouilloni* sp. nov. does not fall in the Northern
146 Hemisphere genera because its R is deeply furcate (Hashimoto, 2006; Imada and Kato, 2018),
147 viz. in *Micropterix* Hübner, 1825, *Paramartyria* Issiki, 1931, *Palaeomicroides* Issiki, 1931,
148 *Melinopterix* Imada and Kato, 2018, *Issikiomartyria* Hashimoto, 2006, *Epimartyria*
149 Walsingham, 1898, *Vietomartyria* Hashimoto and Mey, 2000, *Kurokopteryx* Hashimoto, 2006,
150 and *Neomicropteryx* Issiki, 1931.

151 The hind wing with R1 vein distinct in basal half and the antennal scape greatly swollen
152 with a distinct indentation on its mesial surface support an attribution to the ‘sabatincoid’ group
153 of genera (Gibbs, 2010; Gibbs and Kristensen, 2011). The forewing R forked supports an
154 attribution to the ‘*Sabatinca* sensu stricto’ lineage. The three-segmented labial palp makes it
155 fall in the genus *Sabatinca* Walker, 1863, while *Palaeomicra* Meyrick, 1886 has a two-
156 segmented labial palp (Gibbs, 2010). Affinities with the Neotropical genus *Hypomartyria*
157 Kristensen & Nielsen, 1982 are excluded because of the absence of a crossvein ir in fore- and
158 hind wings; the four-branched Rs excludes affinities with the Neotropical genus *Squamicornia*
159 Kristensen & Nielsen, 1982 (Kristensen & Nielsen, 1982: figs 3 & 32).

160 Sohn et al. (2012) listed six fossil genera in the Micropterigidae, viz. *Auliepterix* Kozlov,
161 1989, *Baltimartyria* Skalski, 1995, *Electrocrania* Kusnezov, 1941, *Moleropterix* Engel and
162 Kinzelbach, 2008, *Palaeosabatinca* Kozlov, 1989, and *Parasabatinca* Whalley, 1978.

163 The Mesozoic genera *Palaeosabatinca* and *Auliepterix* and the Baltic amber genus
164 *Electrocrania* differ from *Sabatinca pouilloni* sp. nov. in the simple forewing R (Kusnezov,
165 1941; Kozlov, 1988, 1989; Kurz, 2015). The Baltic amber genus *Baltimartyria* differs from
166 *Sabatinca pouilloni* sp. nov. in the presence of a crossvein ir in fore- and hind wing (Skalski,
167 1995; Mey, 2011). The earliest Eocene genus *Moleropterix* is based on an incomplete wing
168 from the Moler Formation in Denmark. It differs from *Sabatinca pouilloni* sp. nov. in the Rs
169 branches with a double fork instead of being pectinate (Engel and Kinzelbach, 2008). The
170 Cretaceous *Parasabatinca* differs from *Sabatinca pouilloni* sp. nov. in the simple R and Rs not
171 anteriorly pectinate (Whalley, 1978).

172 Many characters that are diagnostic of *Sabatinca* are not visible on *Sabatinca pouilloni*
173 sp. nov., especially abdominal structures (Gibbs and Lees, 2014: 245). Zhang et al. (2017) listed
174 the characters ‘Rs4 terminating post-apically’ and ‘hind wing with R partly or completely
175 coalescent with Sc’ as typical of *Sabatinca*. The first character is not shared by *Sabatinca*

176 *pouilloni* sp. nov., but we consider that it is not sufficient to separate it from this genus. The
177 second character is not discriminating because the extant New Zealand species of the ‘*S.*
178 *calliarcha* clade’ (e.g. *Sabatinca calliarcha* Meyrick, 1912, *S. heighwayi* Philpott, 1927, *S.*
179 *lucilia* Clarke, 1920, *S. weheka* Gibbs, 2014, and *S. pluvialis* Gibbs, 2014), have hind wing vein
180 R basally well-defined and well separated from Sc, as in *Sabatinca pouilloni* sp. nov. (Philpott,
181 1927; Gibbs, 2014; Gibbs and Lees, 2014: 244, fig. 2), but this character is likely a
182 symplesiomorphy. *Sabatinca pouilloni* sp. nov. differs from *Sabatinca calliarcha* in the
183 absence of the crossvein ir (Gibbs, 2014).

184 Zhang et al. (2017) revised and/or described three micropterigid species from the
185 Burmese amber and attributed them to *Sabatinca*. *Sabatinca perverta* Cockerell, 1919 shares
186 with *Sabatinca pouilloni* sp. nov. the anteriorly pectinate Rs without crossvein ir but differs
187 from it in the fused hind wing Sc and R. *Sabatinca cretacea* Zhang Wang, Shih & Ren, 2017
188 differs from *Sabatinca pouilloni* sp. nov. in the presence of a crossvein ir in forewing and the
189 fused hind wing Sc and R. *Sabatinca limula* Zhang Wang, Shih & Ren, 2017 differs from
190 *Sabatinca pouilloni* sp. nov. in the presence of a crossvein ir in forewing and the crossvein sc-
191 r ending at the fork of R. Lastly they all differ from *S. pouilloni* in rounded wing apices.

192

193 Remark. The Liassic Archaeolepidae Whalley, 1985 are based on forewings with very
194 incomplete venation, very hard to compare to the other Mesozoic moths. *Archaeolepis* Whalley,
195 1985 differs from *Sabatinca pouilloni* sp. nov. in a shorter fork of R (Whalley, 1985). Ansoerge
196 (2002, 2003) described or revised a series of Liassic Amphiesmenoptera based on wings. They
197 all differ from *Sabatinca pouilloni* sp. nov. in the pattern of Rs with a double fork, instead of
198 being pectinate.

199

200 Conclusion

201 *Sabatinca pouilloni* sp. nov. shares with the New Zealand ‘*calliarcha* species group’ the
202 character state ‘hind wing vein R basally well-defined and well separated from Sc’ but it is
203 putatively plesiomorphic, and not sufficient to attribute it to this clade (Gibbs and Lees, 2014:
204 fig. 6). *Sabatinca pouilloni* and the three Burmese amber *Sabatinca* species of Zhang et al.
205 (2017) belong to two clearly different groups of species on the basis of the shape of hind wing
206 vein R (Gibbs and Lees, 2014). The latter authors dated the separation of the *Sabatinca* groups
207 of species around 80 Ma, clearly more recent than these Burmese fossils. Thus these fossils
208 may help precise the dating of this genus’s origin and history.

209 The discovery of *Sabatinca pouilloni* sp. nov. confirms the rather important diversity of the
210 non-Glossata Lepidoptera during the Mesozoic, with no less than six clades:
211 †Eolepidopterigidae, †Mesokristenseniidae, †Ascololepidopterigidae, Micropterigidae, plus
212 the Agathiphagidae and Heterobathmiidae, still unknown in the fossil record, but certainly
213 present according to phylogenetic analysis (Sohn et al., 2015: fig. 2; Regier et al., 2015: fig. 2).
214 It is not currently possible to determine when the Mesozoic families became extinct and why
215 the Micropterigidae are still relatively more diverse (with ca. 160 extant species), than the
216 Agathiphagidae and Heterobathmiidae (two and three species, respectively). Micropterigidae
217 are either detritivores or bryophyte-feeders as larvae (Imada et al., 2011), Agathiphagidae live
218 on the gymnosperm genus *Agathis* (Araucariaceae) Only the Heterobathmiidae live on the
219 angiosperm genus *Nothofagus* (Fagaceae) (Kristensen and Nielsen, 1983), which was clearly
220 not a condition *sine qua non* for their diversification.

221

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225

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384 **Fig. 1.** *Sabatinca pouilloni* Ngô-Muller and Nel sp. nov., holotype MNHN.F.A71311, habitus:
385 A. Dorsal view; B. Ventral view; C. Head, arrow maxillary palp. Scale bars = 1 mm (A-B); 0.2
386 mm (C).

387 **Fig. 2.** *Sabatinca pouilloni* Ngô-Muller and Nel sp. nov., holotype MNHN.F.A71311, wings:
388 A. Forewing costal part; B. Forewing; C. Hind wing. Scale bars = 1 mm.

389 **Fig. 3.** *Sabatinca pouilloni* Ngô-Muller and Nel sp. nov., holotype MNHN.F.A71311,
390 reconstructions of wings: A. Forewing; B. Hind wing. Scale bar = 0.5 mm.

391 **Fig. 4.** *Sabatinca pouilloni* Ngô-Muller and Nel sp. nov., holotype MNHN.F.A71311: A.
392 Antenna; B. Fore and mid legs (arrow). Scale bars = 0.2 mm.

393 **Fig. 5.** *Sabatinca pouilloni* Ngô-Muller and Nel sp. nov., holotype MNHN.F.A71311: A. Hind
394 leg; B. Terminalia. Scale bars = 0.2 mm.

395

A



B









