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### ► To cite this version:

Raman Patel, Rajendra Singh Rana, André Nel. First two cockroaches from the early Eocene of western Rajasthan, India (Insecta: Blattodea). *Zootaxa*, 2021, 4927 (3), pp.445-450. 10.11646/zootaxa.4927.3.8 . hal-03165409

**HAL Id: hal-03165409**

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Submitted on 10 Mar 2021

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1 **zootaxa**

2 **First two cockroaches from the early Eocene of western Rajasthan, India (Insecta:**  
3 **Blattodea)**

4

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16

17 **Abstract**

18 We describe the first two Blattodea from the early Eocene Palana Formation of the Gurha  
19 opencast lignite mine, western Rajasthan, India. Although it is not possible to attribute them  
20 to a precise family, these large wings suggest a warm and humid paleoclimate for the area at  
21 that time.

22

23 **Key words:** Insecta, Dictyoptera, wings, Paleogene, paleoclimate, India

24

25 If Dictyoptera are rather frequent in the fossil record since the late Carboniferous, they are  
26 mainly known from Europe, North and South America, and Northern and South-Eastern Asia

27 (Siberia, China, Myanmar). They are clearly less frequent from the sub-continent of India,  
28 with few Permian and Mesozoic fossils (Fletcher, 1920; Rao & Shah, 1959; Verma, 1967;  
29 Dutt, 1977; Srivastava, 1988; Pinto et al., 1992; Kapoor et al., 1993; Engel & Pérez-de La  
30 Fuente, 2012; Arya et al., 2005). Indeed, fossil insects are rarely recorded from India, even if  
31 it since a long time ago (Hislop & Hunter, 1855; Hislop, 1860); but with the recent exception  
32 of those from the early Eocene Cambay amber (see Rust et al., 2010).

33 Here we describe the first two cockroach's wings from the early Eocene Palana  
34 Formation of the Gurha opencast lignite mine, western Rajasthan, India. Shukla et al. (2014)  
35 already indicated the presence of insects from this mine. Patel et al. (2019a) recently  
36 described an orb-weaver spider (Araneae, Araneidae) and report only insects like *Formica* sp.,  
37 mayfly naiad, etc. (Patel et al., 2019b) from the same formation, otherwise known for their  
38 fossil pollen, leaves, flowers, fruits, (Shukla et al., 2014; 2018; Shukla & Mehrotra, 2019).

39 The sample site, also known as Gurha opencast lignite mine (72.52269°E, 27.5229°N),  
40 is located at 70 km from Bikaner (Fig. 1a). For the general geology of the subsurface Gurha  
41 lignite opencast mine (Fig. 1b). The site is comprised of multiple layers starting from the  
42 pebbly ash bed in the basement, followed by the Palana Formation. It consists of various  
43 layers with variable thicknesses, including the base of lignite (4.5 m). A (3.8 m) carbonaceous  
44 shale intercalated with a thin band of dirty maroon sandstone (12.0 cm), variegated clay (6.0  
45 m), carbonaceous shale, (3.7 m), variegated shale (3.5 m), and maroon shale (3.0 m),  
46 respectively. The Palana Formation is overlaid by the Kolayat Formation, which consists of  
47 variegated clays or fuller's earth (9.5 m), also overlaid by yellow ferruginous sandstones with  
48 lenses of clay and sandy shales (5.5 m), gritty sandstones, lime kankar (7.5 m) of the Jogira  
49 Formation, with recent alluvium and soil at the top (3.88 m).

50 The sedimentological and paleontological data, with plant leaves, rare fishes, and  
51 invertebrates, support a fluvio-lacustrine environment with the influence of volcanism at the

52 base for the Palana Formation. The pollen assemblages indicate an early Eocene (Ypresian)  
53 age (Shukla et al., 2014).

54 The specimens were recovered by hand picking from the thin, laminated,  
55 carbonaceous, and maroon shale beds of the Palana Formation exposed in the Gurha opencast  
56 lignite mine Bikaner District, Rajasthan, India. They were studied using a Leica MZ-6  
57 microscope. Photographs were taken using a Nikon D5500 DSLR camera and Olympus  
58 digital micropad 777 microscope. Specimens were at times treated with ethanol (95 %) on the  
59 surface to create greater contrast between the fossil and the surrounding matrix. The venation  
60 patterns were determined from composite line drawings of the part and counterpart, improved  
61 by using Corel draw X7 software. We follow the wing venation terminology of Snodgrass  
62 (1935) and Schubnel et al. (2020).

63 Wing venation terminology is abbreviated as follows:

64 **C:** costa; **Cu:** cubitus; **CuA:** cubitus anterior; **CuP:** cubitus posterior; **M:** media; **R:** radius;  
65 **RA:** radius anterior; **PCu:** postcubitus; **ScP:** subcosta posterior; **i:** forewing; **ii:** hind wing; **iii:**  
66 anal fan.

67 Catalogue number GU/R/B/G: Garhwal University/Rana/Bikaner/Gurha.

68

69 Superorder Dictyoptera

70 Order Blattodea Brunner von Wattenwyl, 1882

71 (Figs 2-3)

72 **Material.** Specimens GU/R/B/G/3009 (tegmen); GU/R/B/G/3004 (incomplete tegmen and  
73 incomplete hind wing); deposited in Department of Geology, HNB Garhwal University  
74 Srinagar Uttarakhand, India.

75 **Horizon and Locality.** Carbonaceous and maroon shale beds of the Palana Formation (early  
76 Eocene), Gurha opencast lignite mine Bikaner Rajasthan.

77 **Descriptions.**

78 Specimen (GU/R/B/G/3009) (Fig. 2). Incomplete tegmen with postero-apical part missing;  
79 original coloration not preserved; wing 24.8 mm long, about 8.2 mm wide; ScP ends on  
80 anterior margin, 8.8 mm from wing base, with weak anterior branches; R ends at wing apex,  
81 with numerous distally forked anterior branches, all parallel; area between R and anterior  
82 wing margin 2.6 mm wide; RA and RP not well differentiated; median area rather reduced,  
83 with few branches of M; CuA with numerous parallel branches covering a broad area;  
84 CuP+PCu strongly arched and concave; veins of postcubital-anal area all parallel and ending  
85 into CuP+PCu.

86 Specimen (GU/R/B/G/3004) (Fig. 3). Distal halves of a tegmen and a hind wing, darkened  
87 (original color); fragment of tegmen 16 mm long, about 5.5 mm wide (Fig. 3A); numerous  
88 anterior branches of R and area between R and anterior wing margin broad, ca. 2.3 mm wide  
89 (Fig. 3A); fragment of hind wing 6.7 mm long with numerous branches of main veins (Fig.  
90 3B) and a part of anal fan (Fig. 3C), partly folded below rest of wing so that cubital branches  
91 seem not to be parallel to anal fan.

92

### 93 **Discussion**

94 These two fossils obviously belong to the crown group of Blattodea. The tegmen of the  
95 specimen GU/R/B/G/3009 is very similar to the *Periplaneta* Burmeister, 1838 (Blattidae)  
96 because of the part of wing between costal margin and ScP with only few weak anterior  
97 branches of ScP, numerous parallel anterior branches of R/RA, strong stem of R/RA, M  
98 clearly independent of R, numerous parallel branches of M and CuA, M rather reduced  
99 compared to CuA, and numerous branches of PCu and anal veins ending in CuP+PCu (Rehn,  
100 1951: pl. 2, fig. 21; Li et al., 2018: fig. 2). But such characters are also present in *Epilampra*  
101 Burmeister, 1838 (Blaberidae). Therefore it is not possible to attribute it to a precise family.  
102 Blattidae and Blaberidae are quite ‘distant’ in the dictyopteran phylogeny (Legendre et al.,  
103 2015).

104 Sample GU/R/B/G/3004 consists of the costal part of the tegmen and the distal two-  
105 third of the hind wing of the same specimen. After the smaller width of the area between  
106 anterior margin of the forewing and R/RA, it corresponds to a taxon different from  
107 GU/R/B/G/3009. But the absence of the basal parts of wings forbids us to even tentatively  
108 compare it to any extant group.

109 Nevertheless, the presence of these rather large cockroaches in this outcrop is of  
110 interest because they suggest a warm and humid paleoclimate for the area during the early  
111 Eocene, in accordance to the results of Shukla et al. (2014).

112

### 113 **Acknowledgements**

114 We are grateful to the authorities of the Gurha opencast East Lignite Mine, Bikaner,  
115 Rajasthan, India (C. Chowdhury, G. Stayanarayana, General Manager and V. Acharya,  
116 Geologist) for their kind permission and supports during field investigation. We are also  
117 thankful to the Mr. Lokesh Adhikari and Mahendra Kumar, HNB Garhwal University,  
118 Srinagar, Uttarakhand for providing necessary facilities during Lab work. We also thank the  
119 Dr. Hukam Singh, BSIP, Lucknow for their time in providing useful comments.

120

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192

193 **FIGURE 1.** (A) Location map of Gurha opencast lignite mine near Bikaner, western  
194 Rajasthan, India; (B) Stratigraphy and lithology exposed in Gurha opencast lignite mine.  
195 Scale bar in meters.

196 **FIGURE 2.** (A) GU/R/B/G/3009; (B) features mark in GU/R/B/G/3009; (C) line diagram of  
197 GU/R/B/G/3009. Scale bars = 2 mm.

198 **FIGURE 3.** (A) GU/R/B/G/3004, part of tegmen; (B) GU/R/B/G/3004, part of hind wing; (C)  
199 GU/R/B/G/3004, part of hind wing; (D) tegmen and hind wing of modern *Periplaneta banksi*  
200 Hanitsch, 1931.

201

202





