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BOLBOCERATINE SCARABS OF GENERA *Bolbohamatum* KRIKKEN, 1980 AND *Bolbogonium* BOUCOMONT, 1911 (COLEOPTERA: GEOTRUPIDAE) FROM CENTRAL INDIA

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Abstract
This study includes a taxonomic account of four species of genus *Bolbohamatum*; *B. calanus* (Westwood, 1848), *B. phallosum* Krikken, 1980, *B. marginale* Krikken, 1980 and *B. laterale* (Westwood, 1848) and one species of genus *Bolbogonium*; *B. insidiosum* Krikken, 1977 from Central India (Madhya Pradesh and Chhattisgarh). The pronotal ornamentation and external male genitalia of *Bolbohamatum* species has been diagnosed with the incorporation of an identification key to the species from Central India. A checklist containing 19 Indian species of both genera (*Bolbohamatum* and *Bolbogonium*) has also been prepared with their distribution in different states of India as well as outside of India.

***Keywords*:** dung beetles, pronotal ornamentation, external male genitalia, distribution, India.

Introduction

Bolboceratine scarabs in the family Geotrupidae are commonly called Earth-boring dung beetles because adults of most species provision larvae in earthen burrows with dead leaves, cow dung, horse dung, or humus. The family Geotrupidae currently includes 620 species belonging to 68 genera in three subfamilies; Taurocerastinae, Bolboceratinae and Geotrupinae (Scholtz & Browne, 1996). The first comprehensive study of Asian Bolboceratinae was carried out by Westwood (1848, 1852), which considered 29 species to be in one genus *Bolboceras*. Later, several new species names were added based on the materials from tropical and eastern Asia. Boucomont (1911) proposed *Bolbogonium* as a subgenus for *Bolboceras*. A series of taxonomic publications on Asian Bolboceratinae were then made by Krikken (1977ab, 1978ab, 1979, 1980, 1984), Carpaneto *et al*. (1993), Masumoto (1984), Li *et al*. (2008), Nikolajev (1979ab, 2003, 2008), Ochi

& Kawahara (2002), Ochi & Masumoto (2005) and Ochi *et al.* (2010, 2011). Krikken (1977a,b) raised the subgenus *Bolbogonium* to the genus level and described seven new species, along with producing a key to all ten Asian species. Subsequently, Krikken (1980) proposed the genus *Bolbohamatum* for four species to be combined with *Bolboceras*, while also describing nine new species and discussing the significance of external male genitalia and pronotal ornamentation in the accurate identification of the various species. Recently, Karl *et al*. (2006) catalogued Bolboceratine scarabs of the Palaearctic region. The present study includes taxonomic information for four species of *Bolbohamatum* and one species of *Bolbogonium* from the Madhya Pradesh and Chhattisgarh states in India and also incorporates new distributional records of these beetles. A checklist of both genera from India is included.

Materials and methods

Specimens for the study were collected using light trap from various protected areas by scientific teams of ZSI based in Jabalpur, Madhya Pradesh. Pinned specimens were identified with the help of available taxonomic revisions of the studied genera (Krikken, 1977b, 1980). Specimens were examined under a binocular microscope (Leica M205 A) and photographs were taken with the help of an attached digital camera. Male specimens were dissected, with the abdomen separated from the body and the aedeagus extracted from the abdomen. The genitalia were then cleaned and softened in a dish of hot water and further cleaned in a hot water solution of 10% KOH. All parts of the aedeagus were washed in 95% ethanol and photographed. After examination, the genitalia were stored in a glass vial containing 70% ethanol.

The details of specimens examined, registration number of specimens, distribution inside and outside India, main diagnostic characters, description, illustration of external male genitalia, and identification key to the species level within the genus *Bolbohamatum* are provided. The classification adopted in the article is after Smith (2006). Identified specimens were deposited in ZSI, Jabalpur, Madhya Pradesh (India).

Results and Discussion

Four species of the genus *Bolbohamatum*; *B. calanus* (Westwood 1848), *B. phallosum* Krikken 1980, *B. marginale* Krikken 1980 and *B. laterale* (Westwood 1848) and one species of genus *Bolbogonium*; *B. insidiosum* Krikken 1977 were studied from the states Madhya Pradesh and Chhattisgarh. *Bolbohamatum calanus*, *B. laterale* and *B. phallosum* are recorded for the first time from Madhya Pradesh, while *Bolbohamatum marginale* and *B. calanus* constitute new reports for Chhattisgarh. The identification of these species is based on the structure of external male genitalia, pronotal ornamentation and clypeal dentations, which are shown in figures 1 to 9. *Bolbogonium insidiosum* shows variations in the structure of clypeofrons (Fig. 9). The checklist for 19 Indian species of both *Bolbohamatum* (11 species) and *Bolbogonium* (8 species), along with their distribution within and outside of India, are provided in Table 1.

Systematic Account

Family: Geotrupidae Latreille, 1802
Subfamily: Bolboceratinae Mulsant, 1842
Tribe: Eubolbitini Nikolajev, 1970

Genus *Bolbohamatum* Krikken, 1980

Bolbohamatum Krikken, 1980: 5 (Type species: *Scarabaeus cyclops* Olivier, 1789: 60)

The genus includes the species, presenting one of the largest Bolboceratine scarabs which are distributed in both the Palaearctic and Oriental geographic regions. It likely evolved on the Indian subcontinent and spread at a relatively late stage through Myanmar into Sundaland and China (Krikken, 1980).

Generic diagnosis: Metasternum anterroiorly always with a small spiniform protrusion and with anterior lobe narrowly separating middle coxae. Head of males with a pair of tubercles on clypeus. Pronotum in case of male possess median and lateral protrusions with the surface between them usually concave. Fore tibia with 7-10 external denticles.

Identification key to the species of *Bolbohamatum* Krikken, 1980 from Central India:

1. Lateral tubercles of pronotum well developed but not marginally situated. Apex of parameres not with reflexed paramerites ……..……..…….. 2

Lateral tubercles of pronotum well developed or completely reduced or absent if present then marginally situated. Apex of parameres dorsally with short reflexed paramerites ……..……..……. 3

2. Dorsally the parameres moderately sclerotized, relatively narrow and with poorly developed paramerite. Ventral side of parameres devoid of distinct paramerites. Basal capsule relatively narrow ……..……..…….. *Bolbohamatum calanus*

Dorsally the parameres foliate and ventrally with a pair of more or less glider-like paramerites. Basal capsule in lateral view distally strongly emarginated ……..…… ……..…….. *Bolbohamatum phallosum*

3. Paramedian tubercles of pronotum closely approximated and separated by less than to inter-ocular distance while lateral tubercles well developed and marginally situated ……..…….…. *Bolbohamatum marginale*

Paramedian tubercles of pronotum not closely approximated and separated by more than inter-ocular distance while lateral tubercles absent …….. *Bolbohamatum laterale*

***Bolbohamatum calanus* (Westwood, 1848)**

Bolboceras calanus Westwood, 1848a: 385, (description, distribution).
Bolboceras tumidulus Westwood, 1852: 22, (description, distribution, illustration).
Bolbohamatum calanus Krikken, 1980: 20, (description, keyed, distribution, illustration, comb. nov.).

***Specimens examined*:** Chhattisgarh: ZSI/CZRC-A/16601; male (Length: 15.0 mm; width: 10.0 mm); Barnavapara camp, Barnavapara Wildlife Sanctuary, Raipur (21° 24.00' N, 82° 25.314' E; alt. 303.8 m); K. Chandra & party, 01 July 2011, light trap. Madhya Pradesh: ZSI/CZRC-A/16602; male (Length: 16.0 mm; width: 9.0 mm); Forest Rest House, Bandhavgarh National Park, Umaria, K. Chandra, 10 August 2005, light trap; ZSI/CZRC-A/16603; male (Length: 17.0 mm; width: 9.0 mm), Karmajhiri, Pench Tiger Reserve, Seoni; K. Chandra, 13 June 2001.

***Diagnosis*:** (Fig. 1). Brown, shiny and pilosity yellow brown. Cephalic tubercles more or less dentiform, isolated and placed simply on clypeal disc. Dorsal outline of left mandible sinuate lobate. Pronotum with a pair of feebly developed, slightly transverse median tubercles with lateral callosities. Pronotum abundantly punctate, but never densely punctate throughout. Paramedian tubercles separated by less than inter-ocular distance. Lateral impression of pronotum shallow.

Figure 1: *B. calanus* (scale: 5 mm), ZSI/CZRC-A/16601, Barnawapara Wildlife Sanctuary, 2011.

***External male genitalia*:** (Fig. 2) Dorsally, the parameres moderately sclerotized, relatively narrow and with poorly developed paramerite while the ventral side of parameres devoid of distinct paramerites. Basal capsule relatively narrow.

***Geographical distribution*:** India: Assam, Bihar, Chhattisgarh, Karnataka, Madhya

Pradesh, Maharashtra, Tamil Nadu, West Bengal and Uttarakhand. Elsewhere: Bangladesh and Java.

***New state and district record*:** Chhattisgarh (Raipur) and Madhya Pradesh (Umaria and Seoni).

Figure 2: Dorsal & ventral view of external male genitalia of *B. calanus* (scale: 2 mm), ZSI/CZRC-A/16601.

Bolbohamatum phallosum Krikken, 1980

Bolbohamatum phallosum Krikken, 1980: 21, (description, keyed, distribution, illustration).

Specimens examined: Madhya Pradesh: ZSI/CZRC-A/16604; male (Length: 15.0 mm; width: 9.0 mm); Turiya, Pench Tiger Reserve, Seoni; K. Chandra, 23 June 2001; light trap; ZSI/CZRC-A/16779; male (Length: 17.0 mm; width: 11.0 mm); Kisli Rest House, Kanha National Park, Mandla; M. Limje & party, 13 September 2003; light trap; ZSI/CZRC-A/16780; male (Length: 16.0 mm; width: 10.0 mm); Kisli Rest House, Kanha National Park, Mandla; M. Limje & party; 09 September 2003.

***Diagnosis*:** (Fig, 3). Brown, shiny and pilosity yellow brown. Clypeus with a pair of dentiform tubercles. Pronotum with closely approximated paramedian tubercles and lateral protrusion not shifted to antero-lateral corner. Juxtasutural punctures of elytra sub obsolete and discal striae shallowly impressed and finely punctate. Elytral inter-striae very slightly convex and minutely and sparsely punctured.

***External male genitalia*:** (Fig. 4) Dorsally, parameres foliate and ventrally with a pair of more or less glider-like paramerites. In lateral view, the basal capsule distally strongly emarginated.

***Geographical distribution*:** India: Madhya Pradesh, Maharashtra and East India.

***New state and district record*:** Madhya Pradesh (Seoni and Mandla).

***Remarks*:** *B. calanus* (Westwood, 1848) and *B. phallosum* Krikken, 1980 show close resemblance in their morphological characters and cannot be separated on the basis of external characters only, but the phalli of both the species are very different and only the characters of the phallus distinguish both the species.

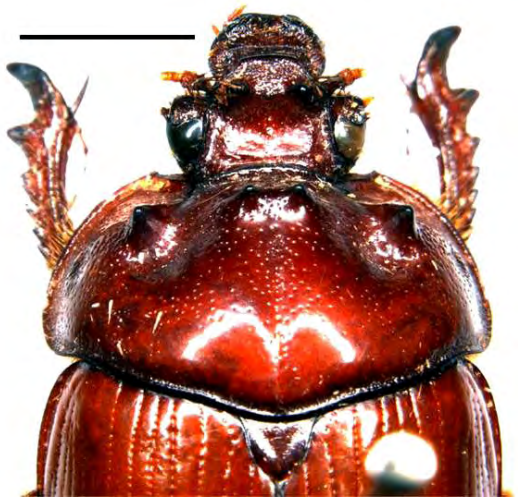

Figure 3: *B. phallosum* (scale: 5 mm), ZSI/CZRC-A/16604, Pench Tiger Reserve, 2001.

Figure 4: Dorsal & ventral view of external male genitalia of *B. phallosum* (scale: 2 mm), ZSI/CZRC-A/16604.

Bolbohamatum marginale Krikken, 1980

Bolbohamatum marginale Krikken, 1980: 30, (description, keyed, distribution, illustration).

Specimens examined: Chhattisgarh: ZSI/CZRC-A/16599; male (Length: 16.0 mm;

width: 9.0 mm); Ataria Forest House, Amarkantak Biosphere Reserve, Bilaspur; A. Singh & party; 18 April 2004; light trap. Madhya Pradesh: ZSI/CZRC-A/16600; male (Length: 15.0 mm; width: 9.0 mm); Kisli, Kanha National Park, Mandla; M. Limje & party, 13 September 2003; light trap.

***Diagnosis*:** (Fig. 5). Dorsal outline of left mandible lobate. Clypeus with a pair of dentiform tubercles each placed against lateral margin. Pronotum with strongly approximated paramedian tubercles and a pair of lateral tubercles situated almost marginally. Median longitudinal zone and lateral declivities of pronotum densely and coarsely punctured while impression between paramedian and lateral tubercles virtually devoid of punctures and opaque. Fore tibia with seven external denticles.

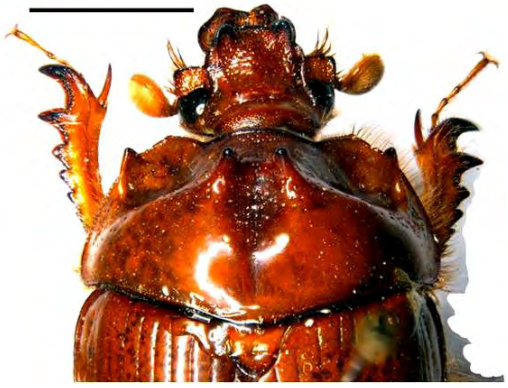

Figure 5: *B. marginale* (scale: 5 mm), ZSI/CZRC-A/16599, Amarkantak Biosphere Reserve, 2004.

***External male genitalia*:** (Fig. 6) Parameres reduced and basal capsule enlarged. Basal capsule of the phallus very robust in comparison to *B. laterale* (Westwood, 1848) and *B. kuijteni* Krikken, 1980.

Figure 6: Dorsal & ventral view of external male genitalia of *B. marginale* (scale: 2 mm), ZSI/CZRC-A/16599.

Remarks: The species can be easily distinguished from its close relatives in having pronotal lateral tubercles situated almost marginally and very closely approximated paramedian tubercle.

***Geographical distribution*:** India: Chhattisgarh, Madhya Pradesh, Tamil Nadu, Karnataka and Uttarakhand. Elsewhere: West Pakistan.

***New state and district record*:** Chhattisgarh (Bilaspur) and Madhya Pradesh (Mandla).

Bolbohamatum laterale (Westwood, 1848)

Bolboceras lateralis Westwood, 1848: 385 (description, distribution).

Bolbohamatum laterale, Krikken, 1980: 33, (description, keyed, distribution, illustration, comb. nov.)

Specimens examined: Madhya Pradesh: ZSI/CZRC-A16730; male (Length: 19.0 mm; width: 12.0 mm); Sitapar, Singhori Wildlife Sanctuary, Raisen; D. K. Harshay, 16 September 2009; day collection.

***Diagnosis*:** (Fig. 7) Cephalic tubercles dentiform and placed on lateral margins. Paramedian tubercles of pronotum well separated by more than inter ocular distance. Lateral tubercles almost absent. Median cavity of pronotal disc absent. Punctation on pronotal disc abundant. Front tibia with eight denticles.

Figure 7: *B. laterale* (scale: 5 mm), ZSI/CZRC-A/16730, Singhori Wildlife Sanctuary, 2009.

***External male genitalia*:** (Fig. 8) Apex of parameres dorsally with short reflexed paramerites. Basal capsule of phallus is robust but not too much extant as of *B. marginale* Krikken, 1980.

***Geographical distribution*:** India: Assam, Maharashtra, Madhya Pradesh, Jammu & Kashmir and Karnataka.

***New state and district record*:** Madhya Pradesh (Raisen).

***Remarks*:** The species can be easily distinguished from its close members, *B. marginale* Krikken, 1980 and *B. kuijteni* Krikken, 1980 having only one pair of lateral pronotal protrusions and abundantly punctate pronotum.

Figure 8: Dorsal & ventral view of external male genitalia of *B. laterale* (scale: 2 mm), ZSI/CZRC-A/16730.

Tribe: Bolbelasmini Nikolajev, 1996

Genus *Bolbogonium* Boucomont, 1911

Bolbogonium Boucomont, 1911: 340 (as subgenus of *Bolboceras* Kirby; Type species: *Bolboceras triangulum* Westwood, 1852: 342).
Bolbogonium Krikken, 1977: 79 (stat. nov.).

***Generic diagnosis*:** Middle coxae widely separated by an anterior lobe of pyriform metasternal disc. First antennal club segment on proximal side shiny and glabrous distinctly separated from surrounding pubescent surface. Seven elytral striae between elytral suture and humeral umbone and all virtually reaching base.

***Bolbogonium insidiosum* Krikken, 1977**

Bolbogonium insidiosum Krikken, 1977: 95, (description, keyed, distribution, illustration).

Specimens examined: Madhya Pradesh: ZSI/CZRC-A/16605; male (Length: 9.0mm & width: 5.5mm); Kartoli, Singhori Wildlife Sanctuary, Raisen (23° 11.200' N, 78° 12.085' E); S. S. Talmale; 13 December 2010; ZSI/CZRC-A/16778; male (Length: 8.0mm & width: 5.0mm); Bhamori rest house, Singhori Wildlife Sanctuary, Raisen; S. Sambath & Party; 17 September 2011; day collection.
***Diagnosis*:** (Fig. 9 a, b) Yellowish brown, shiny and pilosity yellowish. Clypeal surface regulate punctate. Frons with three small isolated tubercles between eye-canthi. Vertex with large U shaped, sparsely punctate impression. Pronotum with anterior declivity impressed and punctation generally sparse. Scutellum finely punctate. Elytral striae deeply impressed well defined and with large punctures. Elytral stria two extending further caudad. Front tibia with 8-9 denticles.
***Geographical distribution*:** India: Madhya Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh.
***New district record*:** Madhya Pradesh **(**Raisen).
***Remarks*:** The species shows variation in the shape of clypeus, ornamentation of frons and vertex. (Fig. 9 a, b).

Figure 9: Variation of *B. insidiosum* (scale: 2 mm), ZSI/CZRC-A/16605 & 16778, Singhori Wildlife Sanctuary, 2010 & 2011.

Table 1: Checklist of genera *Bolbohamatum* and *Bolbogonium* from India

Name of the species	Distribution	
	India (states)	Elsewhere
Genus *Bolbohamatum* Krikken, 1980		
B. cyclops (Olivier, 1789)	Bihar, Himachal Pradesh, Madhya Pradesh, New Delhi, Uttarakhand, Uttar Pradesh and West Bengal	Nepal
B. calanus (Westwood, 1848)	Assam, Bihar, Chhattisgarh, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal and Uttarakhand	Bangladesh and Java
B. phallosum Krikken, 1980	Chhattisgarh, Maharashtra and Madhya Pradesh	
B. pseudogrande Krikken, 1980	Assam and Himachal Pradesh	
B. robustum Krikken, 1980	Himalayan Region	
B. laevicolle (Westwood, 1848)	Assam, Maharashtra, Orissa and Himalayan Region	Bangladesh
B. pyramidifer Krikken, 1980	Orissa	
B. meridionale Krikken, 1980	Puducherry	
B. marginale Krikken, 1980	Chhattisgarh, Madhya Pradesh, Tamil Nadu, Karnataka and Uttarakhand	Pakistan
B. kuijteni Krikken, 1980	Maharashtra	
B. laterale (Westwood, 1848)	Maharashtra, Madhya Pradesh, Sikkim, Jammu & Kashmir, Karnataka and West Bengal	
Genus *Bolbogonium* Boucomont, 1911		
B. bicornutum Krikken, 1977	West Bengal	
B. howdeni Krikken, 1977	Bihar	Pakistan Afghanistan
B. impressum (Wiedemann, 1823)	Himachal Pradesh and Uttarakhand	Bangladesh
B. insidiosum Krikken, 1977	Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh	
B. davatchii (Baraud, 1973)	Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh and Uttarakhand	Iran (Nikolajev, 2008)
B. punctatissimum (Westwood, 1852)	Uttar Pradesh	
B. scurra Krikken, 1977	Tamil Nadu	
B. triangulum (Westwood, 1852)	Andhra Pradesh, Bihar, Madhya Pradesh, Himachal Pradesh, Uttar Pradesh, Uttarakhand and West Bengal	Myanmar, Bangladesh Pakistan

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