Entomon 41(4) : 265-282 (2016)
Article No. ent. 41402

Report of dung beetles (Scarabaeidae: Scarabaeinae) attracted to unconventional resources, with the description of three new species

Seena Narayanan Karimbumkara[1,2] and Dharma Rajan Priyadarsanan[1*]

[1]Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Srirampura, Jakkur P.O., Bangalore 560 064, India. [2]Research Scholar (Part- time), Sree Narayana College, Kannur 670007, Kerala, India (Affiliated to Kannur University). Email: priyan@atree.org

ABSTRACT: Dung beetles found attracted to and feeding on resources other than animal excreta and vertebrate carcasses were collected from different parts of India. Out of the 13 species collected nine were from millipede, three from snail and one from fungus. Of these three species *Onthophagus jwalae, O. pithankithae* and *O. tharalithae* are new to science; the former two were found feeding on millipede carcasses while the latter on a dead snail. *O. rudis* Sharp was found feeding both on live and dead millipedes. © 2016 Association for Advancement of Entomology

KEYWORDS: Coprophagy, fungus, millipede, necrophagy, saprophagy, snail

INTRODUCTION

Though the true dung beetles generally feed and breed in vertebrate excreta, many can survive on vertebrate carcasses and hence are termed as copro-necrophagous. Among the species which are carrion feeders a few are obligatory, while a few are reported feeding on insects and millipede carcasses (Pereira and Martinez, 1956; Howden and Young, 1981; Janzen, 1983; Gill, 1991) and even on decaying vegetable substances (Arrow, 1931). The ancestral scarabaeines were either saprophagous or fungivorous (Philips, 2011) and the availability of greater quantity of mammalian dung after the divergence of mammals, promoted the evolution of coprophagy from saprophagy (Cambefort, 1991).

The shift from coprophagy to necrophagy in most tropical forests can be attributed to the absence of large herbivores and to relative scarcity of necrophagous insects which can be potential competitors for the dung beetles (Halffter and Matthews, 1966). Necrophagy helps to acquire the required nitrogen content to build up muscles and in the case of females to mature their eggs. The mobile adults opt for more nitrogen rich omnivore dung or carcass for their nutritional requirements while they provide their brood with more abundant, carbohydrate rich herbivore dung (Hanski and Cambefort, 1991; Halffter and Matthews, 1966). It has been reported that a few such necrophagous species have opportunistically turned to predation (Halffter and Matthews, 1966).

There are several records of dung beetles being attracted to millipede defensive secretions and feeding on their carcasses (Krell *et al.,* 1997; Kon

* Author for correspondence

et al., 1998; Krell, 1999; Brühl *et al.,* 2003; Schmitt *et al.,* 2004; and Krell, 2004). Such dung beetles are attracted only to the millipedes belonging to the orders Spirostreptida and Spirobolida which can be attributed to the chemical composition of their defensive secretions which contain quinone derivatives i.e. 2-methyl-3-methoxy-1, 4-benzoquinone and 2-methyl-1, 4-benzoquinone (Smolanoff *et al.*, 1975). *Onthophagus latigibber* d'Orbigny, *O. bartosi* Balthasar and *O. mankonoensis* Balthasar were found to be attracted to fresh specimens of dead millipedes even before the defensive secretions had evaporated (Krell *et al.,* 1997). The few species which use the defensive secretions of diplopods as olfactory attractant for resource tracing have a major advantage by being the first to utilize this resource. In millipedes, the defensive secretions also act as pheromones for intraspecific communication. They use the defensive secretion as sexual signals during copulation (Haacker, 1974). There were reports of necrophagous scarab beetles, *Onthophagus rudis* Sharp and *O. penicillatus* Olsoufieff belonging to the sub- genus *Parascatonomus*, being attracted to a diplopod copulating pair which were soaked in their stinky secretion. It was observed that although the dung beetles just hid near the diplopod pairs, they did not try to attack or prey on the live diplopods (Kon *et al.,* 1998; Masumoto, 2001). The majority of the dung beetle species found to be feeding on the millipedes belong to the genus *Onthophagus* Latreille (Halffter and Matthews, 1966; Cambefort, 1983). In South Africa the genus *Sceliages* Westwood makes brood balls using millipede carcasses (Bernon, 1981). Further there have been reports of *Deltochilum kolbei* Paulian, *D. valgum acropyge* Bates and species of *Canthon* Hoffmannsegg predating and feeding on live millipedes (Halffter and Matthews, 1966; Cano, 1998; Villalobos, 1998; Larsen *et al.,* 2009).

Though there have been several previous records of dung beetles feeding on millipede carcasses and being attracted to their defensive secretions, there has been no report of dung beetles feeding on live millipedes from the India Subcontinent. In this paper, we report the observational record of thirteen dung beetle species being attracted to unconventional resources like millipedes, snails and fungus, out of which three species are new to science. The dung beetles discussed here were collected during various field trips to different parts of India.

MATERIALS AND METHODS

The beetles which were found feeding on resources other than animal excreta and vertebrate carcasses were picked up randomly during the various field visits and were preserved in 95% alcohol, brought to the lab, pinned, dried, identified, labelled and stored in the insect collection at ATREE Insect Museum, Bangalore (AIM-B).

The aedeagus was gently pulled out using forceps and needle through the opening of the pygidium after it was relaxed using a mixture of benzene, acetone and alcohol in the ratio 10:45:45. It was then point-mounted, measured and described. Both the insect and aedeagus was measured using micrometer fixed to a Mikrotek Binocular microscope. Species identification was carried out using the keys in Arrow (1931) and Balthasar (1963). Original literatures were referred for those species which were described later. Those which could not be keyed out to any known species were compared with the nearest species, designated as new and described.

Details of abbreviations for measurements are as follows: Total body length (TL) = distance from apex of clypeus to tip of pygidium; body width (BW) = maximal distance between lateral elytral margins; pronotal length (PL) = medial length of pronotum; pronotal width (PW) = maximal width of pronotum; elytral length (EL) = elytral sutural length; head length (HL) = medial length of head; head width (HW) = maximal distance between the sides of head.

Aedeagus measurements: Length of phallobase (LP) = distance from base of phallobase to the point of articulation with parameres; breadth of phallobase (BP) = broadest width of the phallobase; length of parameres (Lp) = distance from the point of articulation with phallobase to the tip; breadth of parameres base (BpB) = width of parameres at

the base; breadth of parameres tip (BpT) = width of parameres at the tip.

Images were taken using Canon 70D SLR camera mounted with Canon MP- E 65 mm macro lens and twin-lite flash. Combine ZM stacking software was used to stack the series of images taken at different focal points and the scale for the images were provided using Image J Software.

RESULTS

Out of the 13 species of Scarabaeine dung beetles recorded, nine species, *Onthophagus arboreus* Arrow, *O. coeruleicollis* Arrow, *O. malabarensis* Boucomont, *O. pygmaeus* (Schaller), *O.* (*Parascatonomus*) *rudis* Sharp, *O. tritinctus* Boucomont, *O. vultur* Arrow and two new species, *O. jwalae* and *O. pithankithae* were found feeding on millipede.Two species, *O. furcicollis* Arrow, along with another new species, named *O. tharalithae* were found feeding on dead giant African snail (*Achatina fulica* Bowdich), while another species, *O. igneus* was found feeding on dead unidentified snails. A single specimen of *Delopleurus parvus* (Sharp) which was considered to be rare, as they were not common in collections using dung baits was found under a puffball fungus. *O.* (*Parascatonomus*) *rudis* is seen attracted to the defensive secretion of an injured live millipede (Spirostreptida) and were also collected on dead millipede. One individual of this species was noticed as trying to gain entry into a millipede which was running about in distress and another of the same species was found inside the body of that millipede, which might have entered through its damaged posterior segments.

The following are the diagnostic characters to distinguish these species and descriptions of the three new species.

***Delopleurus parvus* (Sharp)**
(Plate 1, Image a)

Coptorrhina parva Sharp, 1875: 47 (original description),
Arrow, 1931: 410, 411 (key & description);
Balthasar, 1963: 278 (monograph);
Frovlov, 2014 (revision);
Delopleurus cardoni Paulian 1934 (synonym).

Diagnosis: Black, shining, highly convex; antennae and mouth- organs red, antennal club yellow; clypeus quadridentate; head densely rugosely punctured; basal margin of the pronotum with series of minute notches, median groove extending to quarter; elytra finely striate, striae with strong widely spaced punctures, deep angular sinuation on outer margin little behind the shoulder; pygidium reflexed ventrally, strongly transverse, its surface smooth, hollowed except for an abruptly raised margin; metasternum smooth, unpunctured, sides of metasternum fairly closely and shallowly pitted.

Measurement: TL = 5 - 6 mm, BW = 3 - 4 mm, PL = 2.13 mm, PW = 3.48 mm, EL = 3.05 mm, HL= 1.42 mm, HW = 2.13 mm.

Material examined: 1ex. (♂, AIM-B_ Co/ Sc1000133), "India, Karnataka, Regional Reference Standards Laboratory Campus, Jakkur, Bangalore; 5. VIII. 2012, Collected by Seena Narayanan Karimbumkara (SNK)".

Distribution: India: Odisha, Tamil Nadu, Kerala, Karnataka.

Type: Muse´um National d'Histoire Naturelle (MNHN), Paris, France (M. Rene Oberthür's collection).

Remarks: This species was found under a pufball fungus (Basidiomycota). Eventhough the genus *Delopleurus* is classified withdung beetles, they have been always been reported to be associated with basidiomycetes (Frolov, 2014).

***Onthophagus arboreus* Arrow**
(Plate 1, Image b)

Arrow, 1931: 222, 225 (original description);
Balthasar, 1963: 276 (monograph).

Diagnosis: Dark metallic green or coppery, elytra black, antennae bright orange, upper surface with inconspicuous pale setae; elongate- oval, highly convex, deeply waisted; head short, broad, flat, sides

bluntly angulate before the eyes; clypeus transversely rugose, front margin rounded; pronotum with strong longitudinal median impression posteriorly, front angles very blunt; elytra shallowly striate, intervals slightly convex, not very shining, finely sparingly asperate- punctate; pygidium shining, not closely nor very finely punctured; metasternum produced into a blunt process anteriorly, finely and very sparsely punctured in the middle, coarsely shallowly at the sides. Both sexes are alike except for the difference in the clypeus and the teeth of the front tibia.

Measurement: TL = 4.5 - 5.6 mm, BW = 2.8 - 3.1 mm, PL = 1.8 - 2 mm, PW = 2.6 - 2.8 mm, EL = 2.1 - 2.3 mm, HL = 1.2 - 1.3 mm, HW = 1.6 - 1.7 mm.

Material examined: 2 exs.(1♂, AIM-B_Co/Sc1000134 &1♀, AIM-B_ Co/Sc1000135), "India, Kerala, Kollam, Njarakkal, 9.X.2012, Coll. Priyadarsanan Dharma Rajan (PDR)".

Distribution: India: Uttarakhand, Bihar, Karnataka, Kerala.

Type: Natural History Museum, London (BMNH).

Remarks: This species was collected from the millipede *Trigoniulus corallinus* (Spirobolida: Trigoniulidae).

***Onthophagus coeruleicollis* Arrow**
(Plate 1, Image c)

Arrow, 1907: 430 (original description);
Arrow, 1931:184,185 (key & description);
Balthasar, 1963: 314 (monograph).

Diagnosis: Body broadly oval, highly convex; opaque above, shining beneath, head and pronotum deep blue or bluish- green, antennae and mouth organs bright yellow, elytra yellow with black transverse bands and spots; upper side covered with minute but numerous yellow hairs; head long and flat, clypeus produced into a blunt reflexed lobe, ocular lobes gently rounded, posterior part of the head semicircular; pronotum very convex, densely covered with fine oval granules, a slight smooth oblique impression at the base on each side; front angles of pronotum bluntly produced; elytra finely striate, intervals flat and finely granulate; pygidium strongly, fairly closely punctured; metasternal shield rather strongly, fairly closely punctured with its anterior edge vertical in the middle, sides of the metasternum moderately finely punctured.

Male: Clypeus densely punctured, vertex closely granulate; front tibia slightly elongate, teeth short, terminal spur very short and blunt. Female: Head closely granular; front tibia broad, terminal spur moderately long and pointed.

Measurement: TL = 6 - 8 mm, BW = 3.2 - 3.8 mm, PL = 2.4 - 2.6 mm, PW = 2.9 - 3.4 mm, EL = 2.3 - 2.7 mm, HL = 1.4 - 1.5 mm, HW = 1.6 - 1.9 mm.

Material examined: 4 exs. (1♂&1♀, AIM-B_ Co/Sc1000136- 137 from "India, Karnataka, Bangalore, Bannerghatta: Forest trail, 3.VI. 2010, Coll. SNK& PDR", from dead millipede;1♂, AIM-B_ Co/Sc1000138 from live millipede baited pitfall trap, "India, Karnataka, Bangalore, Srirampura, 26.IX.2011, Coll. PDR and SNK"and 1♂, AIM-B_ Co/Sc1000139, from millipede carcass "India, Andhra Pradesh, Maredumilli, 21. VII. 2015, Coll. Rajkamal Goswami (RG)".

Distribution: India: Karnataka,Maharashtra, Madhya Pradesh Odisha, Andhra Pradesh.

Type Depository: BMNH.

Remarks: This species was collected feeding on millipede carcass and from pitfalls baited with live millipede which released their defensive secretion.

***Onthophagus furcicollis* Arrow**
(Plate 1, Image d)

Arrow, 1931: 270, 276 (key & description);
Balthasar, 1963: 359 (monograph);
Scheuern, 1988 (description of female).

Diagnosis: Broadly oval, compact, convex; black, moderately shining, head slightly metallic; antennae, mouth parts and tarsi reddish, elytra with a red spot on shoulder and four others on posterior margin; upper surface with short setae; head smooth with

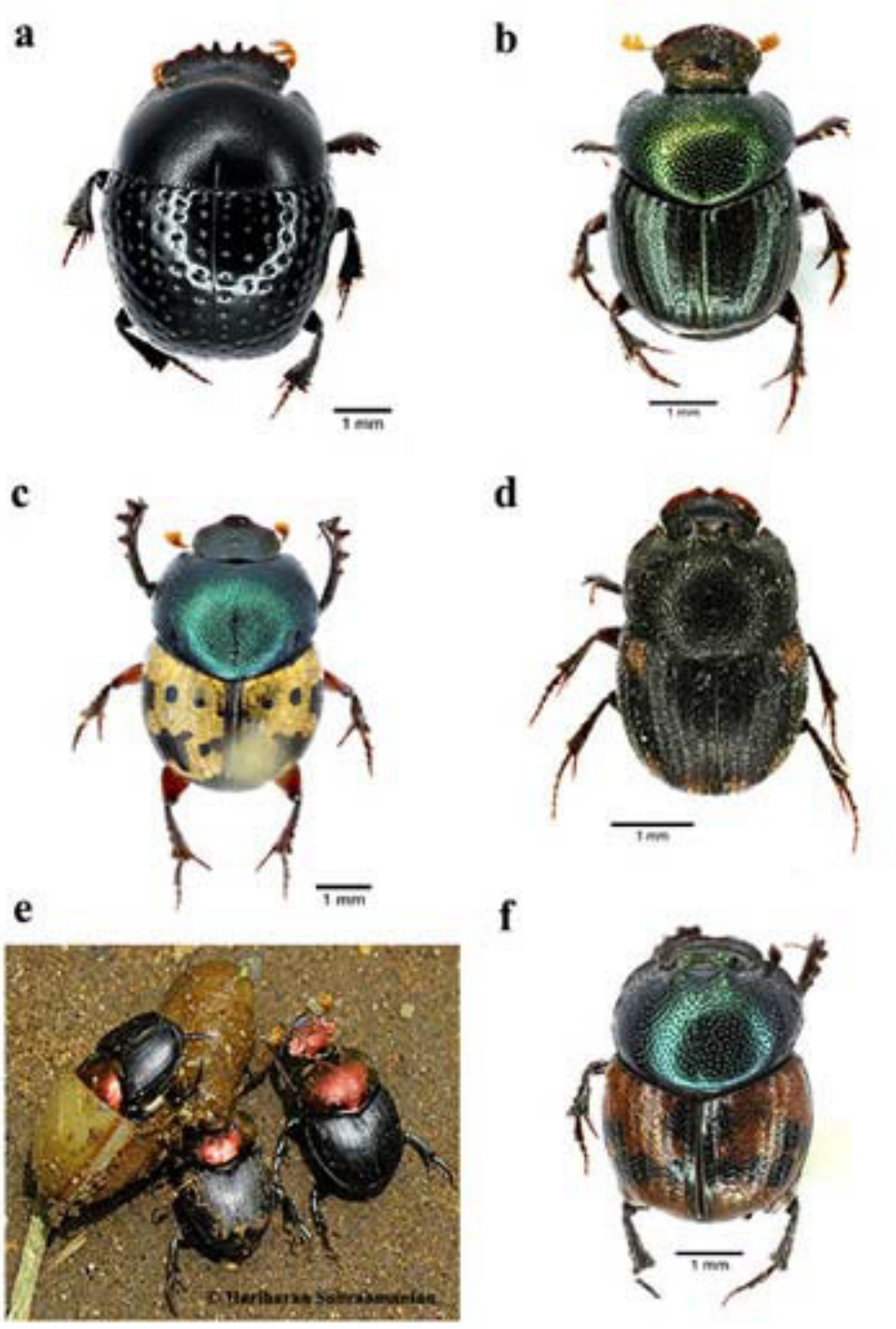

Plate 1. Image (a) ***Delopleurus parvus*** **(b)** ***Onthophagus arboreus*** **(c)** ***O. coeruleicollis*** **(d)** ***O. furcicollis*** **(e)** ***O. igneus*** **(f)** ***O. malabarensis***

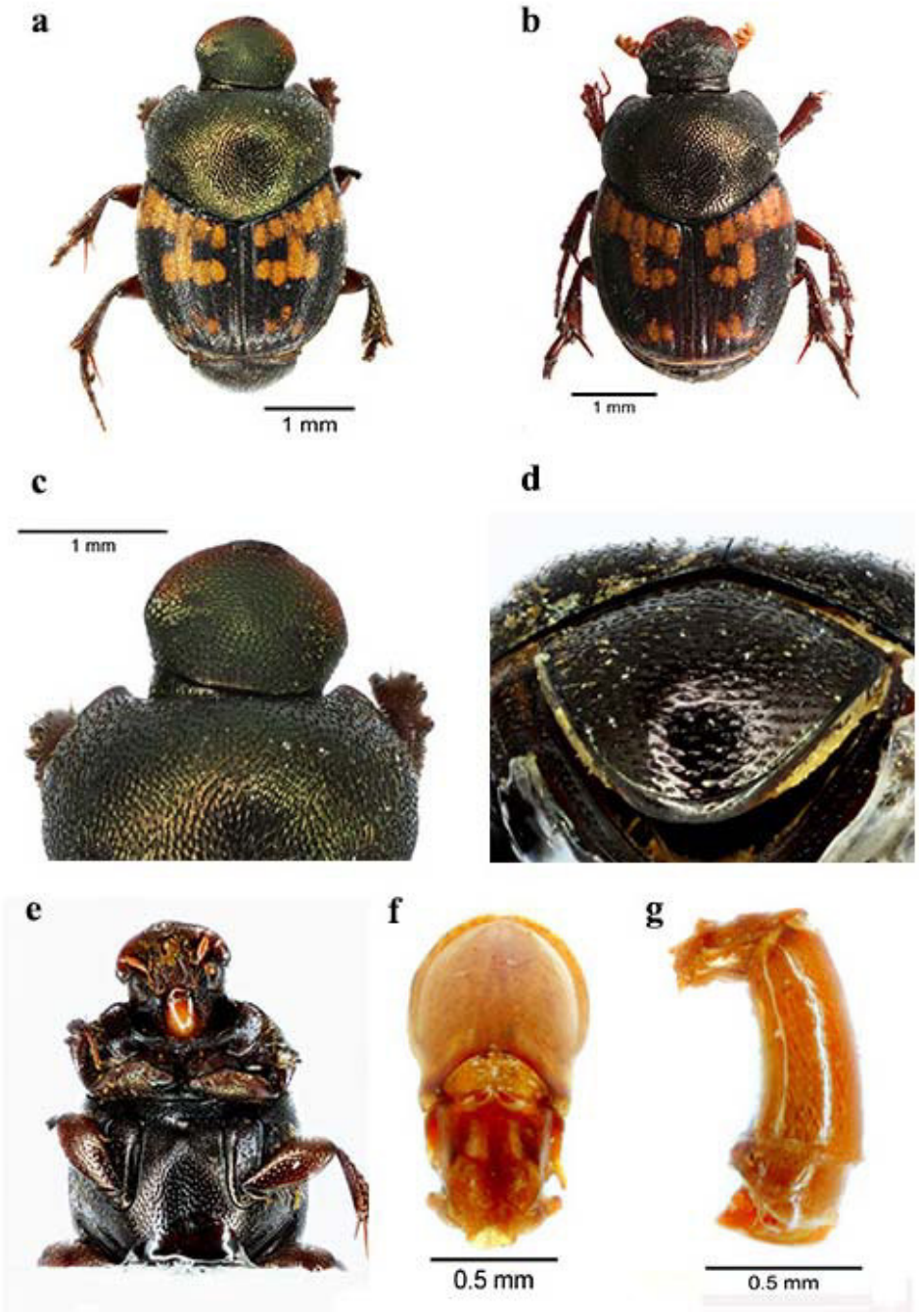

Plate 2. Image Holotype *Onthophagus jwalae* sp. nov.
(a) Dorsal habitus, male (b) Dorsal habitus, female; Male- (c) Head (d) Pygidium
(e) Ventral habitus; Genitalia- (f) apical view (g) lateral view

a few scattered puncture; clypeus bilobed; pronotum with close, large umbilicate punctures; elytral striae with chains of large annular punctures which are not contiguous, intervals asperately punctured; large annular punctures on pygidium; few scattered punctures on metasternal shield, sides of metasternum with fairly close annular punctures.

Male: Clypeal margin slightly bilobed in front with the lobes bluntly rounded; frontal carina absent, head with short straight horn between the eyes; front margin of pronotum with broad horizontal bifurcate process projecting over the head. Female: Clypeus sharply notched in front with lobes sharp, angulate, separated from forehead by a curved carina, there is a slightly elevated carina between the eyes; pronotum with a pair of tubercles behind the front margin.

Measurement: TL = 3.44 – 4.5 mm, BW = 2.06 - 2.5 mm, PL = 1.20 - 1.42 mm, PW = 1.9 - 2.15 mm, EL = 1.5 - 1.63 mm, HL = 0.82 - 0.9 mm, HW = 1.1 - 1.2 mm.

Materials examined: 3 exs. (1♂, AIM-B_ Co/Sc1000140 &1♀, AIM-B_ Co/Sc1000141), "India, Assam, Kohora, Kaziranga, N 26°34'46.47", E 93°24'27.73", Elev. 324ft., 27.X.2014" Coll: SNK"; 1♂ (Lectotype, BMNH(E) 1236994).

Distribution: India: Sikkim, Uttarakhand, Assam.

Type Depository: BMNH.

Remarks: This species was collected from a dead giant African snail, *Achatina fulica* Bowdich at a picnic spot near a stream in Kohora, Kaziranga, Assam.The specimens collected are smaller than the type (4 mm), the male specimen does not have horn and the process on the pronotum does not project over the head like in the type.

***Onthophagus igneus* Vigors**
(Plate 1, Image e)

Vigors, 1825 Zoological Journal 1: 409-418; 526-542 (description)

Diagnosis: Body broadly oval, deeply waisted, very convex; head flat, coarsely rugose, strongly angulate at the sides; black, with head (except anterior part of clypeus) and pronotum fiery crimson, pygidium deep blue or green, antennae bright orange-yellow; body thinly clothed with yellowish hair beneath; pronotum very convex, closely and evenly covered with not very minute oval granules, front angles blunt, lateral margins feebly sinuate in front, strongly behind, base obtusely angular in middle; elytra very finely striate, intervals flat, very minutely granular; pygidium very strongly and closely punctured; metasternum produced into a bluntly prominent process in front; almost smooth in the middle, fairly strongly punctured at sides.

Male: Clypeus little produced in front, narrowed, gently reflexed in middle, the posterior margin of the head is produced to a point in middle and curved gently upward; front margin of the pronotum with a small triangular excavation at the middle; club of antenna very large and broad.

Measurement: TL = 12.10 mm, BW = 6.67 mm, PL = 4.10 mm, PW = 6.35 mm, EL = 4.48 mm, HL = 3.28 mm, HW = 3.92 mm.

Material examined:1 exs. (1♂, AIM-B_ Co/Sc1000142), "India, Andhra Pradesh, Maredumilli, N 17°36'00.53", E 81°42'45.95" Elev. 1375 ft., July 2015, Coll. Ovee Thorat". 3 exs. Photographic evidence of the species feeding on snail was provided by Mr. Hariharan Subrahmanian from "India, Palakkad, Walayar, 09. VIII. 2012".

Distribution: India: Kerala, Karnataka, Tamil Nadu, Chhattisgarh.

Type Depository: BMNH

Remarks: This species was also collected from open cattle dung baits from BRT, Karnataka. In two other locations they were found feeding on unidentified dead snails.

***Onthophagus jwalae* Karimbumkara & Priyadarsanan sp. nov.**
urn:lsid:zoobank.org:act:54217E74-C226-42F3-AFC8-64A457948A5C
(Plate 2, Images a- g)

Description: Holotype, Male (Plate 2, Image a): Body oval, moderately convex, not very shining except for the pronotum and head which are slightly shining. Pronotum and head (Plate 2, Image c) bronzy- black, clypeus reddish; antennae and mouth organs reddish, antennal club yellow. Elytra black with yellow patches which extends from the 2nd interval to the 6th interval at the base and then curves upwards forming a hook which ends on the 7th interval thus leaving a black area encircled by yellow patch near the shoulder; yellow patch on the 4th interval extends almost half the length of elytra and bends towards the suture reaching upto 2nd interval; slight yellow streaks on 3rd to 6th intervals a little above the apical margin of the elytra. Head flat without any carina or horn; strong, large, close punctures on the vertex and ocular lobes, small, moderately close punctures on the clypeus. Clypeal margin parabolic, reflexed and slightly lobed in front. Pronotum closely granular with a smooth oblique area on both sides near the base. Pygidium (Plate 2, Image d) strongly convex, with rows of moderately close horizontally oval punctures. Metasternum (Plate 2, Image e) strongly and closely punctured, bluntly produced in front, small shallow punctures or rugosity in front angles. Sides of metasternum with scattered fine punctures with yellow setae. Both sexes look alike, except that the clypeus is transversely rugose in female (Plate 2, Image b), while it is moderately closely punctured in male.

Measurement: TL = 3.68 mm, BW = 2.12 mm, PL = 1.4 mm, PW = 1.84 - 1.88 mm, EL = 1.44 - 1.56 mm, HL = 0.8 mm, HW = 1 - 1.04 mm.

Genitalia (Plate 2, Images f, g): LP = 1.087 mm, Lp = 0.45 mm, BP = 0.434 mm, BpB = 0.37 mm, BpT = 0.33 mm.

Parameres 1/3 length of phallobase which is slightly curved, parameres almost straight above, joined from base to 3/4th its length, open in front with a thin rounded flap above, tip almost straight, broad, again joined in front as two rectangular lobes at the sides, with a sharp hook directed forward placed halfway from the base.

Type material: Holotype, male, "INDIA: Kerala, Njarackal, Kollam, N 08°56'29.6" E 076°36'20.5", Elev. 197 ft., 28. V. 2013, Coll. PDR" from millipede carcass of *Trigoniulus corallinus* (Spirobolida: Trigoniulidae), Reg. No. ZSI/ WGRS/ IR/ INV/ 7792a; Paratype, 1 female, same collection details as holotype, Reg. No. ZSI/ WGRS/ IR/ INV/ 7792b; deposited at ZSI-Calicut, Kerala, India.

Habitat: Collected on dead millipede from home garden.

Etymology:This species name '*jwalae*' comes from Sanskrit which means 'flame', and it is named so as there is a 'J or I'- shaped vertical marking on the elytra which is orangish- yellow or flame coloured.

Remarks: This species has been keyed out (Arrow, 1931: 184) to *Onthophagus coeruleicollis* Arrow, but *O. jwalae* is very different from the former and varies in the nature of pronotal granules, shape of the clypeus, size and colour; the fore tibia being longer in the former than the latter.

***Onthophagus malabarensis* Boucomont**
(Plate 1, Image f)

Boucomont, 1919: 314 (original description);
Arrow, 1931: 345 (key & description);
Balthasar, 1963: 429 (monograph)

Diagnosis: Female: Deep green or coppery, head and pronotum brighter green or blue, elytra bright orange, sutural line black, irregular post-median bar extending obliquely from side to side; abdomen and pygidium black, tarsi, antennae and mouth-organs reddish, body broadly oval, compact and convex, with a thin clothing of short erect yellowish setae; head not wide, clypeus slightly bilobed; transversely rugose, separated by gently curved carina from the well- punctured forehead, there is a straight carina behind the eyes; pronotum moderately strongly, evenly and closely punctured; front angles not very sharp; has a blunt tubercle in front on each side in the middle; elytra finely striate, intervals flat and finely but distinctly punctured in double series; pygidium shining and fairly strongly punctured; metasternum sparingly, unevenly and fairly strongly punctured.

Measurement: TL = 4 - 5 mm, BW = 2.5 - 3.08 mm, PL = 2.13 mm, PW = 2.74 mm, EL = 2.07 mm, HL = 1.12 mm, HW = 1.51 mm.

Material examined: 1 ex. (♀,AIM-B_ Co/ Sc1000143), "India, Kerala, Eranakulam, Bhoothathankettu, 22.X. 2010, Coll. SNK".

Distribution: India: Uttar Pradesh, Maharashtra, Kerala.

Type: MNHN.

Remarks: This species is a carrion feeder and was found feeding on dead millipede.

***Onthophagus pithankithae* Karimbumkara & Priyadarsanan sp. nov.**

urn:lsid:zoobank.org:act:6A4D8BEA-402A-4C97-A3C1-AF72369BA1B6

(Plate 3, Images a- g)

Description: Holotype, Male (Plate 3, Image a): Oval, deeply waisted, moderately convex. Body black, legs reddish black, mouthparts, antennae and tarsi reddish; head (Plate 3, Image c) and pronotum metallic green and elytra black with yellow patches - one on the sixth and seventh striae towards the angles of shoulder; an angulate band that extends from half of the outer margin to the inner margin, but does not touch the suture and continues to the elytral base between 3rd and 4th striae; a yellow patch near the inner margin at the tip of the elytra between first and fourth striae; and another one at the tip of the elytra starting after the fifth striae and extending to the outer margin in continuity with the middle band. Body with scattered pale setae; head shining with scattered strong punctures separated by a curved carina from the clypeus and there is a straight carina between the eyes. Clypeus bidentate, excised in front and the sides rounded, smooth in the middle, margin reflexed. Ocular lobes gently rounded with scattered punctures. Pronotum moderately closely and strongly punctured with scattered inconspicuous punctures in between the large punctures; front angles produced, rather blunt, lateral margins straight in front, strongly rounded in the middle, sinuate behind and gently rounded at the base. Elytra moderately strongly striate, punctures on striae not close to each other; intervals shining with punctures arranged in two rows closer to the striae. Pygidium (Plate 3, Image d) shining, deeply, uniformly and not very closely punctured. Metasternal shield (Plate 3, Image e) smooth in the middle with strong scattered punctures at the sides which are closer towards the front. Sides of the metasternum strongly but not very closely punctured. Fore-legs slender with four teeth, two in front very large and the fourth very small compared to the third tooth. Spur sharp, slender and slightly curved towards the tip.

Male: Horns absent. Pronotum without tubercle, clypeus smooth and shining with scattered punctures. Carina between the eyes and that which separates clypeus and the vertex are not very prominent. Clypeus strongly punctured at the sides, punctures finer towards the margin.

Measurement: TL = 2.8 - 3.28 mm, BW = 1.6 - 2.08 mm, PL = 0.92 - 1.32 mm, PW = 1.32 - 1.72 mm, EL = 1.04 - 1.28 mm, HL = 0.64 - 0.8 mm, HW = 0.72 - 0.92 mm.

Genitalia: (Plate 3, Images f, g) LP = 0.76 mm, Lp = 0.46 mm, BP = 0.304 mm, BpB = 0.304 mm, BpT = 0.065 mm.

Phallobase longer than parameres, almost double its length, slightly curved, parameres short, sharp and hooked at the tip, joined at the base, open in the middle, again meets in front but the tips apart giving it a bidentate appearance.

Female (Plate 3, Image b): Clypeus more strongly and rugosely punctured with smooth area in the middle. Frontal carina strongly curved, carina between the eyes straight and elevated; two slightly pointed tubercles present on pronotum which are not connected.

Type material: Holotype, male, "INDIA: Karnataka, Bannerghatta, Forest trail, Guddayyanadoddi, N 12°43.233', E 077°33.576', Elev. 905 m, 3. VI. 2010. Coll: SNK & PDR" from carcass of millipede *Phyllogonostreptus nigrolabiatus* (Spirostreptida: Harpagophoridae), Reg. No. ZSI/ WGRS/ IR/ INV/ 7793a, Paratype, 1 female, same collection

details as holotype, Reg. No. ZSI/ WGRS/ IR/ INV/ 7793b; deposited at ZSI-Calicut, Kerala, India.

Habitat: Found feeding on dead millipedes near the Forest trail camping ground.Vegetation type is tropical moist mixed forest.

Etymology: The species name '*pithankithae*' means 'yellow marked' in Sanskrit and this species is named so as their elytra has yellow patterns on it.

Remarks: *Onthophagus pithankithae* is closer to *O. ludio* Boucomont. The major differences between these two species are the former is smaller in size, the clypeus is smooth with few punctures. The male without horn (can be a minor male), elytra simply punctured and metasternum smooth in the middle; while *O. ludio* is larger, clypeus rugose, head is produced into a triangular lamina behind, the apex of which extends to a short pointed horn curving upwards; elytra is with aciculate punctures, and metasternum strongly punctured in the middle.

***Onthophagus pygmaeus* (Schaller)**
(Plate 4, Image a)

Scarabaeus pygmaeus (Schaller), 1783: 239 (original description);
Onthophagus pygmaeus Fabricius, 1792: 44 (description);
Arrow, 1931: 209 (key & description);
O. tigrinus Castelnau, 1840: 87 (synonym);
O. lucens Walker, 1858 (synonym);

Description: Shining blue, green, coppery or golden above, lower surface nearly black, elytra bright yellow, with black transverse bars and spots; body oval and convex, clothed above and beneath with pale setae; head not broad, sides rounded before the eyes, clypeus bilobed in front separated from forehead by a curved carina and a similar straight carina behind the eyes; pronotum rather strongly and closely punctured in its basal part, puncture changing to granules anteriorly; front angles rather sharp; elytra finely striate, intervals flat and fairly strongly punctured; pygidium very strongly and closely punctured with a clothing of long, close pale hairs; metasternal shield rather strongly sparingly punctured and sides of metasternum more closely.

Male: Head very smooth, shining, bears only a few scattered punctures; clypeus little produced, narrowed, strongly reflexed in front. Anterior margin of pronotum very smooth, a little hollowed on each side with two blunt lobes in front; front leg very long, tibia slender, feebly curved with very short and distant tooth, terminal spur long and curved. Female: Clypeus short and coarsely rugose; pronotal front margin with a broad, bituberculate prominence behind. Front tibia broad with rather strong external teeth.

Measurement: TL = 3.92 - 5.4 mm, BW = 2.5 - 3.36 mm, PL = 1.73 - 2.41 mm, PW = 2.24 - 3.08 mm, EL = 1.62 - 2.24 mm, HL = 0.95 - 1.23 mm, HW = 1.18 - 1.73 mm.

Material examined: 8exs. (1♂, AIM-B_Co/ Sc1000144), "India, Karnataka, Bannerghatta, Forest trail, Guddayyanadoddi, N 12°43.233', E 077°33.576', Elev. 905m, 3. VI. 2010. Coll: SNK & PDR", (1♂ & 1♀, AIM-B_ Co/Sc1000145- 146), "India, Kerala, Boothathankettu, 20.VII. 2011, Coll. SNK", (2♂&2♀, AIM-B_Co/Sc1000147- 150), "India, Kerala, Ernakulam, Valanthakkad island, 28.X. 2012, Coll. PDR"; 1♂, BMNH(E) 1237082).

Distribution: India: Kerala, Karnataka, Srilanka.

Type: In the Halle Museum?.

Remarks: Out of the seven specimens collected three were from millipede carcass while four were from goat droppings. This species was also collected from a dead lizard (Arrow, 1931).

***Onthophagus* (*Parascatonomus*) *rudis* Sharp**
(Plate 4, Image b)

Sharp, 1875: 58 (original description);
Boucomont, 1914: 271 (list);
Boucomont et Gillet, 1921: 41 (list);
Boucomont, 1924: 669 (list);
Boucomont, 1925: 153 (list);
Arrow, 1931: 184, 185 (keys & description);
Balthasar, 1935: 329 (monograph);
Paulian, 1945; 88, 102 (list);

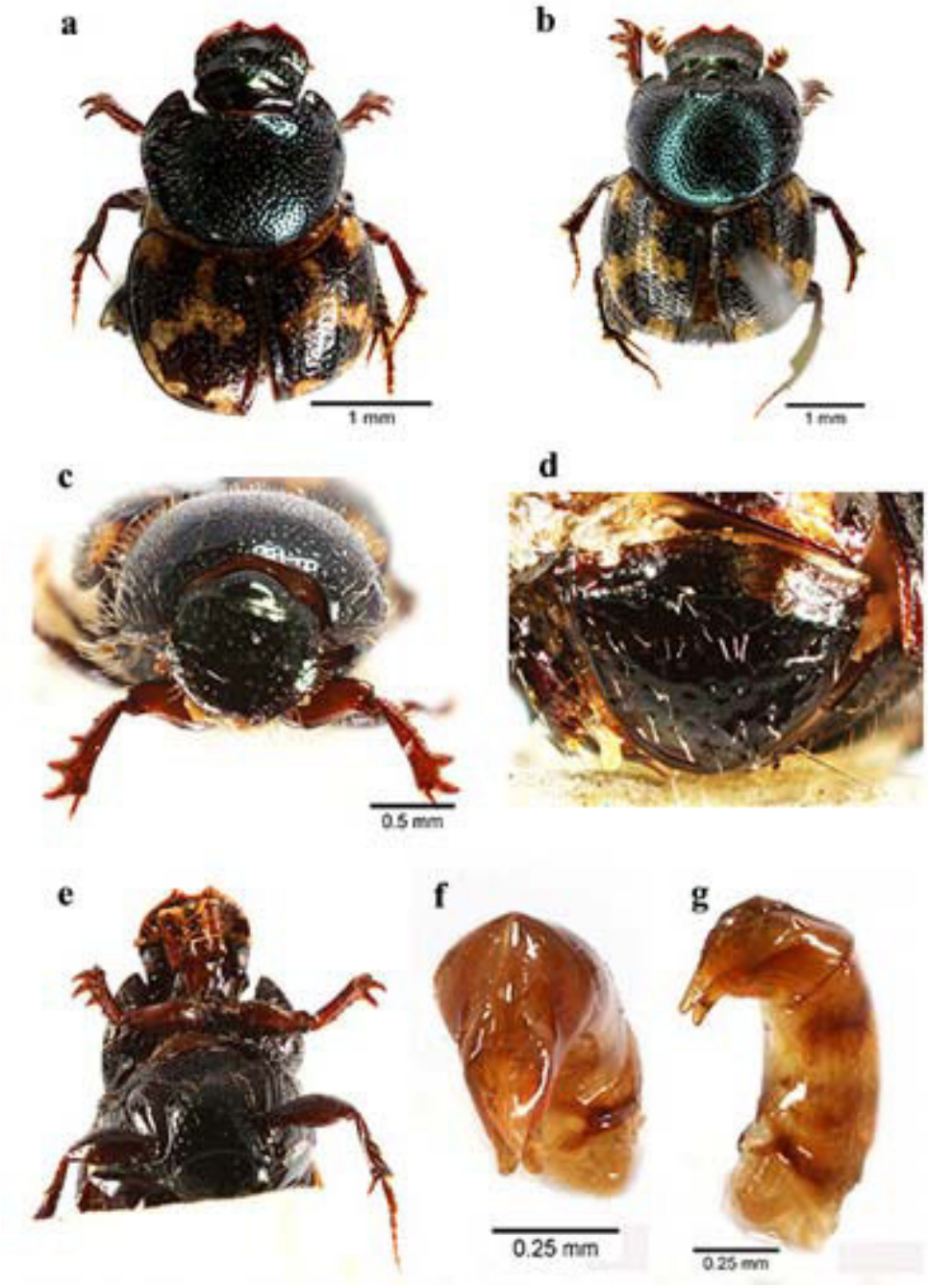

Plate 3. Image Holotype *Onthophagus pithankithae* sp. nov.
(a) Dorsal habitus, male (b) Dorsal habitus, female; Male (c) Head (d) Pygidium
(e) Ventral habitus; Genitalia- (f) apical view (g) lateral view

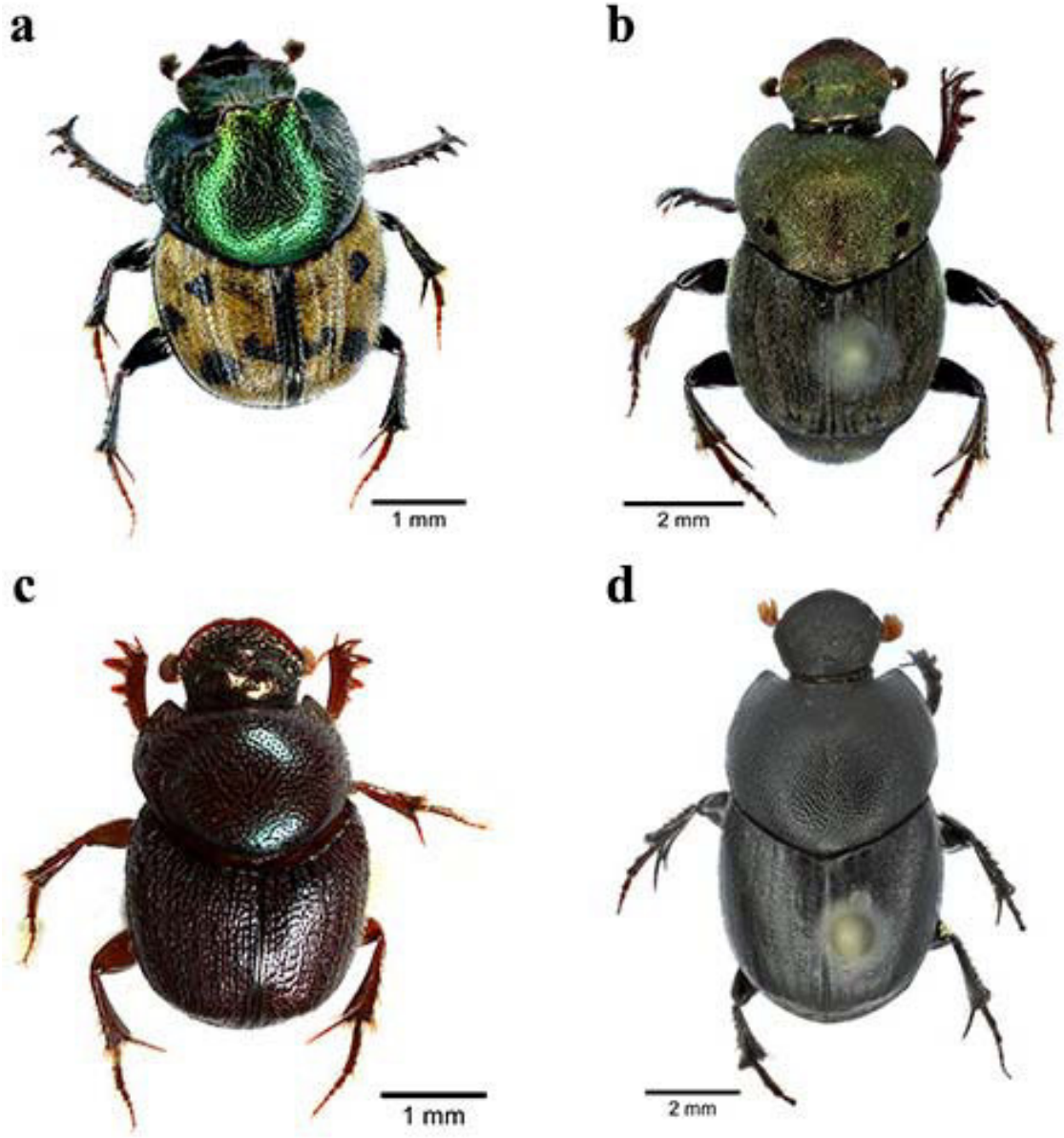

Plate 4. Image (a) ***Onthophagus pygmaeus*** **(b)** ***O. rudis*** **(c)** ***O. tritinctus*** **(d)** ***O. vultur***

Balthasar, 1963: 505 (monograph).
- *aper* Sharp, 1875: 59 (synonym);
- *foveolatus* Harold, 1877: 68 (synonym);

Diagnosis: Body slightly metallic, dark greenish brown, shining above, opaque below, covered with greyish setae; oval, not broad, very convex, strongly constricted at the waist. Head flat, closely and evenly rugulose, frontal carinae absent, clypeus little produced, blunt, reflexed in the middle; pronotum densely covered with fine oval granules, with a small smooth pit on each side near the hind margin and a slight depression in the middle of the base; front angles blunt, base produced backward and obtusely angular in the middle; elytra finely striate, intervals flat, closely covered with minute elongate granules; pygidium fairly closely covered with fine granules; metasternal shield evenly, fairly strongly punctured, narrowed and almost vertical in front; sides of metasternum more strongly and closely punctured.Male and female are alike except that the females are larger, have a broader head, front tibia has blunt teeth.

Type: MNHN.

Measurement: TL = 5 - 8 mm, BW = 3 - 4.5 mm, PL = 2.6 - 3.12 mm, PW = 3.3 - 3.9 mm, EL = 2.5 - 3.12 mm, HL = 1.5 - 2 mm, HW = 1.88 - 1.12 mm.

Material examined: 3 exs. (1♂&1♀, AIM-B_ Co/ Sc1000151- 152), "India, Kerala, Boothathankettu, 22.X. 2010, Coll. SNK" and (1♀, AIM-B_ Co/ Sc1000153), "India, Kerala, Ernakulam, Kunnathunad Taluk, Iringole kaavu, 9.VII.2011, Coll. SNK & PDR".

Distribution: India: Karnataka, Assam, Madhya Pradesh, Kerala; Mayanmar; Philippines; Indonesia; Sunda Islands; Java; Sumatra; Borneo; Nias; Thailand; North Vietnam; China.

Remarks: Out of the 3 specimens of *Onthophagus rudis* , those collected from Boothathankettu were found feeding on a live millipede and the other from a millipede carcass. Both the millipedes belongs to genus *Phyllogonostreptus.*

***Onthophagus tritinctus* Boucomont**
(Plate 4, Image c)

Boucomont, 1914: 217 (original description);
Arrow, 1931:263,266 (keys & description);
Balthasar, 1935: 338 (monograph);
Balthasar, 1963: 564 (monograph);
Paulian, 1945:89, 127 (description).

Diagnosis: Body black shining; head fiery- red, pronotum blue or green, antennae and mouth organs yellow, tarsi red, body broadly oval, compact, convex, clothed with yellow setae; head fairly strongly dilated at the sides, clypeal margin rounded, very feebly excised in the middle; clypeus separated by short transverse carina from the strongly but not closely punctured forehead which bears between the eyes a pair of blunt tubercles; pronotum evenly moderately strongly and closely punctured, front angles sharp; elytra finely striate, 7th stria straight, parallel with the 6th intervals fairly closely, not very finely punctured; pygidium fairly strongly and closely punctured; metasternal shield bears scattered, not very fine punctures, sides of the metasternum rather finer and more numerously punctured. Male: Clypeus shining, not closely rugose. Female: Clypeus closely rugose and not shining.

Type: MNHN.

Measurement: TL = 3.5 - 4.5 mm, BW = 1.98 - 2.5 mm, PL = 1.12 - 1.41 mm, PW = 1.72 - 2.02 mm, EL = 1.46 - 1.6 mm, HL = 0.77 - 0.86 mm, HW = 1.07 - 1.16 mm.

Material examined: 2 exs., (1♂, AIM-B_ Co/ Sc1000154), "India, Karnataka, Bangalore, Bannerghatta: Forest trail , 3.VI. 2010, Coll. SNK & PDR"; (1♂, AIM-B_ Co/Sc1000155), "India, Kerala, Njarackal, Kollam, 28. V. 2013, Coll. PDR".

Distribution: India: Maharashtra, Tamil Nadu, Karnataka; Srilanka, China.

Remarks: Both specimens were collected from millipede carcass.

***Onthophagus tharalithae* Karimbumkara & Priyadarsanan sp. nov.**

urn:lsid:zoobank.org:act:1D8A8886-7CA6-4724-8B1A-37C7DE766D1C

(Plate 5, Images a - g)

Description: Holotype, Male (Plate 5, Image a): Oval, moderately convex, slightly shining, blackish-brown; legs, antennal stalk and clypeus reddish, mouthparts and antennal club yellow; clypeal margin almost straight in front, lateral margins wavy; head (Plate 5, Image c) densely, unevenly punctate with a smooth, frontal carina represented by afeeble line and another straight, slightly elevated carina between the eyes. Pronotum densely, moderately strongly punctate, sides rounded in front, distinctly sinuate posteriorly, base rounded, front angles not very sharp; elytra with a single reddish spot on shoulder upon 6th and 7th intervals and similar spots spread on 4th to 6th in the apex. Elytral striae not very deep, striae moderately closely punctured, elytral intervals minutely, unevenly asperately punctured; Pygidium (Plate 5, Image d) strongly, moderately closely punctured; metasternal shield (Plate 5, Image b) smooth in the middle with uneven punctures at the sides, sides of metasternum with stronger punctures.

Measurement: TL = 3.5 - 4.54 mm, BW = 2 - 2.63 mm, PL = 1.68 mm, PW = 2.41 mm, EL = 1.96 mm, HL = 0.95 mm, HW = 1.46 mm.

Genitalia (Plate 5, Images e- g): LP = 1.05 mm, Lp = 0.65 mm, BP = 0.46 mm, BpB = 0.49 mm, BpT = 0.162 mm.

Phallobase longer than parameres, slightly curved; parameres triangular in appearance from above, joined at the base till the front end where they slightly superpose and elevates, then it curves forward and down, bifurcates and diverges towards the tip.

Female: Unknown

Type Material: Holotype, male, "INDIA: Assam, Golaghat, Kohora, N 26°34'46.47", E 93°24'27.73", Elev. 324 ft., 27.X.2014. Coll: SNK from a dead giant African snail (*Achatina fulica* Bowdich). Reg. No. ZSI/ WGRS/ IR/ INV/ 7794; deposited at ZSI-Calicut, Kerala, India.

Habitat: Collected on a dead snail which was found near a stream feeding along with a few *O. furcicollis*.

Etymology: This species gets the name *tharalithae* from Sanskrit which means undulating or wavy. It is named so, as the clypeus margin is undulating.

Remarks: *Onthophagus tharalithae* is similar to *O. pauliani* Frey in its size and the elytra having spots but differs in the clypeal margin being truncate and undulate, the antennal club being yellow; the front angles of pronotum being sharper and the red spots present only near the shoulder, while in *O. pauliani* clypeal margin is slightly emarginate, antennal club is dark and red spots are present at the base of 2nd and 4th striae in addition to the shoulder.

***Onthophagus vultur* Arrow**

(Plate 4, Image d)

Arrow, 1931: 197 (original description);
Balthasar, 1963: 588 (monograph)

Diagnosis: Black, opaque above, antennae and mouth- organs red, clothed with extremely minute inconspicuous setae above and fairly thick hairs at sides below; oval, very convex; head flat, closely punctate- rugose, sides bluntly angulate; clypeus produced to an obtuse distinct angle in front; fronto - clypeal carina absent, forehead with a slight median depression and a slight transverse elevation behind; pronotum closely and evenly covered with granules, front angles not very blunt; elytra lightly striate, intervals flat, bearing numerous minute granules; pygidium strongly, closely, partly confluently punctured; metasternal shield rather strongly punctured except in the middle where punctures are fine; sides of the metasternum strongly, closely punctured. Both sexes look alike.

Measurement: TL = 8 - 8.7 mm, BW = 4 - 4.7 mm, PL = 3.2 mm, PW = 4.5 mm, EL = 3.4 mm, HL = 1.6 - 1.7 mm, HW = 2.3 mm.

Plate 5. Image Holotype, Male- *Onthophagus tharalithae* sp. nov.
(a) Dorsal habitus (b) Ventral habitus (c) Head (d) Pygidium; Genitalia (e) lateral view (f) apical view (g) ventral view

Materials examined: 3 exs. (1♂, AIM-B_ Co/Sc1000156, 2♀, AIM-B_ Co/Sc1000157- 158), "India, Andhra Pradesh, Maredumilli, N 17°36'00.53", E 81°42'45.95" Elev. 1375 ft., Coll. RG".

Distribution: India: Maharashtra, Karnataka, Andhra Pradesh.

Type Depository: BMNH.

Remarks: *Onthophagus vultur* was originally described by Arrow (1931) based on a specimen collected by H.M. Lefroy found feeding on a dead locust from Igatpuri (now in Maharashtra state) and H.E. Andrews from Belgaum (now in Karnataka). RG collected 3 individuals of this species while feeding on a dead millipede. This is the rediscovery of the species after 85 years of its original description.

DISCUSSION

While most Scarabaeinae depend on mammalian dung or carcasses for feeding and breeding, many of them also take to unconventional resources like carcasses of invertebrates, decaying fruits and fungus. Hitherto absence of *O.vultur* from any later collections after its original description, points to specialisation of atleast some species to invertebrate carcasses. The reason why many of these species were rarely collected from dung bait traps can be attributed to their necrophagous or saprophagous behaviour or their affinity to specific cues, like the defensive secretion of the millipede. A single specimen of *O. coeruleicollis* was retrieved from a pitfall trap that was baited with live millipede. Even though they got easily trapped in baits with millipedes they were never found attracted to dung baited pitfall traps. More observations and studies needto be conducted to check whether the carrion specialist *O. rudis* (Hanski, 1983; Kikuta *et al.,* 1997, Brühl and Krell, 2003) predates and kills the millipede or were they just attracted to its defensive secretion (Kon *et al.,* 1998).

Most of dung beetles those feed on millipede carcasses were found to have similar morphological characteristics like absence of horns, small size, granular pronotum and in some case a lobed clypeus, which can be used in cutting open or prying through the millipede body. Their adaptation to sense the defensive secretion of millipedes are advantageous to these beetles as the quinonous secretions helps them in avoiding other necrophagous competitors and access to the fresh kill before it starts decomposing.

ACKNOWLEDGEMENTS

We are grateful to Dr. Max Barclay, Collection Manager, Coleoptera Section, BMNH, for permitting to study and photograph the dung beetle specimens in the Coleoptera Collection at the Natural History Museum, London and Dr. Jiri Hezek of National Museum Prague, Czech Republic (NMPC) (ex. Coll. V. Balthasar) for the holotype image of *Onthophagus pauliani*. Financial support provided by Schlingler Foundation, USA for the Western Ghats Insect Inventory Project is greatly acknowledged by DRP. SNK thanks EOL Rubenstein Fellowship funded by CRDF.

REFERENCES

Arrow G.J. (1907) Some new species and genera of Lamellicorn Coleoptera from Indian Empire. Annals and Magazine of Natural History, 7, XIX: 416- 439.

Arrow G.J. (1931) Fauna of British India including Ceylon and Burma. Coleoptera: Lamellicornia, Scarabaeidae, III. Coprinae; Taylor & Francis, London. 3: i-xii+ 428pp, 61 figs., 19 pls.

Balthasar V. (1935) Monographie der palaearktischen Faunengebietes. Monograph. Bestimmungstabelle. I. Coprinae, 1. Teil. Bestimmungstabellen der europ. Col. Heft 115. Opava (Troppau), p. 20-24.

Balthasar V. (1963) Monographie der Scarabaeidae und Aphodiidae der Palaeoarktischen und Orientalischen Region (Coleoptera: Lamellicornia). Verl. Tschechoslowakischen Akademie der Wissenschaften, Prague. Vol. II: pp. 1– 627, pls. 1–16. figs. 1– 226.

Bernon G. (1981) Species abundance and diversity of the Coleoptera component of a South African cow dung community, and associated insect predators. Ph.D. Thesis, Bowling Green State University, Bowling Green, OH.

Boucomont A. (1914) Les Coprophages de I'Archipel Malais.Annales de la Société Entomologique de France, LXXXIII, p. 238 bis 350.

Boucomont A. (1919) Coléoptères coprophages nouveaux d'Asie et de Malaisie. Annales de la Société Entomologique de France, LXXXVIII, p. 307- 320.

Boucomont A. and Gillet J. (1921) Faune entomologique de l'Indochine francaise. Famille Scarabaeidae Laparosticti (Coleopteres): Portail. Saigon 4:1-76.

Boucomont A. (1924) Lamellicornes coprophages d'Indochine. Bulletin de la Société entomologique de France, 210- 214.

Boucomont A. (1925) Lamellicornes coprophages nouveaux des Iles Philippines. Bulletin de la Société entomologique de France, 151- 154.

Brühl C. and Krell F.-T. (2003) Finding a rare resource: Bornean Scarabaeoidea (Coleoptera) attracted by defensive secretions of diplopoda. Coleopterists Bulletin 57: 51-55.

Cambefort Y. (1983) Étude écologique des coléoptères Scarabaeidae de Côte d'Ivoire. Thèse de Doctorat d'Etat ès-Sciences Naturelles. Université Pierre et Marie Curie, Paris 6, France, 294 pp.

Cambefort Y. (1991) From Sapropagy to Coprophagy. In Dung Beetle Ecology, Ch.2 (eds I, Hanski and Y. Cambefort), Princeton University Press. pp 22-35.

Cano E. B. (1998) *Deltochilum valgum acropyge* Bates (Coleoptera: Scarabaeidae): Habits and Distribution. Coleopterist Bulletin, 52: 174- 178.

Fabricius J. C. (1792) Entomologia systematica emendate et aucta (etc.), 4 Bände. Hafniae.

Frovlov A. V. (2014) Revision of the genus *Delopleurus* Boheman (Coleoptera: Scarabaeidae: Scarabaeinae) with description of new species from Africa. Journal of Natural History, 49(3-4): 129-154.

Gill B.D. (1991) Dung beetles in American Tropical Forest, p.211–229. In: Hanski, I. and Cambefort Y. (Eds.) Dung Beetle Ecology. Princeton, Princeton University Press, 481p.

Haacker U. (1974) Patterns of communication in courtship and mating behaviour of millipedes (Diplopoda). Sym. Zool. Soc. London, 32: 317-328.

Halffter G. and Matthews E. G. (1966) The natural history of dung beetles of the subfamily Scarabaeinae (Coleoptera, Scarabaeidae). Folia Entomolügica Mexicana, 12-14: 1-312.

Hanski I. (1983) Distributional ecology and abundance of dung and carrion- feeding beetles (Scarabaeidae) in tropical rain forests in Sarawak, Borneo. Acta Zoologica Fennica, 167: 1- 45.

Hanski I. and Cambefort Y. (1991) Dung Beetle Ecology. Princeton University Press. Princeton. xiii + 481 pp., pls.

Harold E. V. (1877) Ennumeration des Lamellicornes Coprophages rapportés de l'Archipel Malais par J. Doria, O. Beccari et d' Albertis. Annali del Museo Civico di Storia Naturale di Genova X, p. 38- 109.

Howden H. F. And Young O.P. (1981) Panamanian Scarabaeinae: Taxonomy, distribution, and habits (Coleoptera, Scarabaeidae). Contr. Amer. Entomol. Inst., 18:1- 204.

Janzen D.H. (1983). Insect at carrion and dung. In D.H. Janzen, ed., Costa Rican Natural History, Univ. of Chicago Press, Chicago. pp. 640-42.

Kikuta T., Gunsalam G., Kon M. and Ochi T. (1997) Altitudinal change of fauna, diversity and food preference of dung and carrion beetle on Mt. Kinabalu, Borneo. Tropics, 7: 123- 132.

Kon M., Ochi T., Nabhitabata J., Araya K. and Matsui M. (1998) Necrophagous scarab beetles (Coleoptera: Sacarabaeidae, Onthophagus) attracted to a diplopod copulating pair (Diplopoda) in Thailand. Elytra, 26: 347-349.

Krell F.-T. (2004). East African dung beetles (Scarabaeidae) attracted by defensive secretions of millipedes. Journal of East African Natural History, 93: 69–73 (2004)

Krell F.-T. (1999) Southern African dung beetles (Coleoptera: Scarabaeidae) attracted by defensive secretions of Diplopoda. African Entomology, 7: 287-288.

Krell F.-T., T. Schmitt T., Dembele A. and Linsenmair K.E.(1998) Repellants as attractants- extreme specialization in afrotropical dung beetles (Coleoptera: Scarabaeidae) as competition avoiding strategy. Zoology, Analysis of Complex Systems, 101, Supplement 1:12.

Krell F.-T., Schmitt T. and Linsenmair K.E. (1997) Diplopod defensive secretion as attractants for necrophagous scarab beetles (Diplopoda: Insecta, Coleoptera: Scarabaeidae). Entomologica Scandinavica Supplementum, 51: 281- 285.

Krell F.-T., Schmitt T. and Kramer F.(1996) Scarab beetles (Coleoptera: Scarabaeoidea) specialized on diplopod carcasses (Myriapoda: Diplopoda). Tenth International Congress of Myriapodology, Copenhagen, 29 July- 2 August 1996, Abstracts of lectures and posters: 35.

Larsen T. H., Lopera A., Forsyth A. and Génier F. (2009) From coprophagy to predation: a dung beetle that kills millipedes. Biology Letters, 5: 152- 155.

Laporte de Castelnau F. L. (1840) Histoire naturelle des Insectes Coléoptères (etc.), Tome I, II. Paris.

Masumoto K. (2001). A food habit of *Onthophagus penicillatus* Harold (Coleoptera: Scarabaeidae). Elytra, 29: 439.

Paulian R. (1934) Quelques Panelini asiatiques nouveaux ou peu connus. Bull Soc Ent Fr.,39:162–164.

Paulian R. (1945) Coléoptères Scarabéides de l'Indochine: Faune de l'Empire Français ed.Vol.III. Librairie Larose Paris, 1- 227.

Pereira F.S. and Martinez A. (1956) Os generis de Canthonini Americanos. Rev. Brasil. Entomol., 6:91- 192.

Philips T.K. (2011) The Evolutionary History and Diversification of Dung Beetles. In Ecology and Evolution of Dung Beetles, Ch. 2 (eds. Simmons, L. W. and Ridsdill-Smith, T. J.) pp. 21–46. John Wiley & Sons, Ltd, Chichester, UK.

Schaller J.G. (1783) Neue Insekten. Abhandl. Hallischen Naturf. Ges., I: 239.

Scheuern J. (1988) Sexual dimorphism of *Onthophagus furcicollis* Arrow (Coleoptera, Scarabaeidae). Entomologica Basiliensia, 12: 319-323.

Schmitt T., Krell F.-T. and Linsenmair K.E. (2004) Quinone mixture as attractant for necrophagous dung beetles specialized on dead millipedes. Journal of Chemical Ecology, 30:731- 740.

Sharp D. (1875) Descriptions of some new genera and species of Scarabaeidae from tropical Asia and Malaisia. Coleopterologische Hefte, 13: 33-54.

Smolanoff J., Demange J. M., Meinwald J. and Eisner T. (1975) 1,4- benzoquinones in African millipedes. Psyche, 82:78-80.

Villalobos F.J., Diaz A, and Favila M.E. (1998) Two species of *Canthon* Hoffmannsegg (Coleoptera: Scarabaeidae) feed on dead and live invertebrates. Coleopterists Bulletin, 52: 101- 104.

Walker F. (1858) Characters of some apparently undescribed Ceylon insects. Annals and Magazine of Natural History, (3)2(9): 202-209.

(Received 15 June 2016; accepted 22 September 2016.; published 31 December 2016)