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Species composition of dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) in the coffee plantation of Nilgiri Biosphere Reserve of the Western Ghats, India

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ABSTRACT: Analysis of species composition of dung beetles in the shaded coffee plantations of Nilgiri Biosphere Reserve of south Western Ghats revealed a checklist of 38 species. The presence of many endemic species, very primitive rare old world tribe *Canthonini* (represented by the genus *Ochicanthon*), the first report of *Onthophagus lilliputanus* and the presence of two species (*O. truncaticornis* and *O. discedens),* which were deemed as extinct from the natural forests of the Western Ghats make the dung beetle assemblage in the coffee plantation unusual. The study showed species composition of dung beetles in the shaded coffee plantation with a comparatively smaller area had no major differences with the nearby natural forests in the Nilgiri Biosphere Reserve. Higher species richness and presence of some unique species in the coffee plantation belt compared to other agricultural habitats highlights the significance of shaded coffee plantations as an important nested habitat in the forest-agriculture land matrix of the moist Western Ghats.

KEY WORDS: Species check list, rare old world tribe, first report, nested habitat

INTRODUCTION

The dung beetles are a highly specialized trophic group (Scarabaeinae: Scarabaeidae: Coleoptera), mainly adapted to dung and organic debris consumption at both the adult and larval stages (Hanski and Cambefort, 1991). They play a key role in the forest and agricultural ecosystem as they recycle faecal material, fertilize and aerate the soil, recycle nitrogen, organic carbon and other nutrients, protect seeds from predation, aid in seed dispersal, parasite suppression, serve as a food source for birds and mammals (Hanski and Cambefort, 1991; Nichols *et al.,* 2008). Scarabaeid dung beetles belong to three distinct taxonomic groups: Scarabaeinae, Geotrupinae and Aphodiinae (Baraud, 1985). Among these subfamilies, Scarabaeinae is the only group that is predominantly coprophagous (faeces eating), while the majority of Aphodiinae and Geotrupinae are saprophagous (eaters of decaying organic matter) and not true dung beetles (Halffter and Mathews, 1966).

Tropical rain forests are the most species-rich and functionally significant terrestrial ecosystems supporting more than half of global biodiversity (Myers *et al.,* 2000). The Western Ghats, a biodiversity hotspot in southern India is scattered

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with plantations that were once tropical rain forests (Dolia *et al.,* 2008). Conversion of original forests to smaller fragments of variable size and agricultural farmlands and plantations of tea, coffee, rubber and cardamom in the south Western Ghats peaked in the 1980s (Daniels, 1992; Daniels *et al.,* 1990) and led to considerable biodiversity loss in the south Western Ghats (Nair, 1991). One of the most important plantation crop is coffee and it is predominantly grown at high altitudes regions of southern states of India (Velmourougane, 2016). Indian coffee industry which had plantation coverage of 270,821 ha in 1990-1991 has increased to 340,306 ha by 1999-2000 (25.7%), almost entirely in the Western Ghats region of southern India (Coffee Board, 2001; Raman, 2006).

Studies on the biodiversity in coffee plantations of the Western Ghats have recorded high biodiversity for birds, mammals, butterflies, amphibians and bats (Bali *et al.,* 2007; Dolia *et al.,* 2008; Anand *et al.,* 2008; Rathod and Rathod, 2013; Wordley *et al*., 2017). But there is no study towards assessment of dung beetles diversity in the shaded coffee plantations of the Western Ghats region. Many studies from the Neotropical region have demonstrated that coffee agroecosystems with complex forest-like vegetation structures (shaded) have significantly high biodiversity (Perfecto *et al.,* 1996; Greenberg *et al.,* 1997; Moguel and Toledo, 1999; Johnson, 2000; Perfecto *et al.,* 2003; Perfecto and Armbrecht, 2003; Somarriba *et al.,* 2004), particularly dung beetle diversity (Moron, 1987; Pineda *et al.,* 2005; Horgan, 2005, 2009). Studies from cocoa agroforestry also showed similar results of higher species richness of dung beetles and provided suitable habitat for forest-dependent species (Harvey *et al*., 2006; Shahabuddin *et al.,* 2010). However, no data exists on the status of the dung beetles from the shaded coffee plantations of the Western Ghats. Also no records on how far the coffee habitat modification might have lead to the decline and disappearance of many rare and endemic dung beetle species reported earlier by Arrow (1931) in the Western Ghats. Hence the present study was undertaken to assess the dung beetle species composition in the coffee plantation belts of south Wayanad in the Nilgiri Biosphere Reserve (NBR) of the south Western Ghats.

MATERIALS AND METHODS

Specimens were collected from a coffee plantation belt of NBR of the south Western Ghats (Fig. 1) using pitfall traps from January to December 2015. Specimens were identified with the aid of keys available in Arrow (1931) and Balthasar (1963a, b) and by comparing with type specimens available in the research centre and Zoological Survey of India, Western Ghats regional station, Calicut. Verified specimens were curated in the insect collections of Tamil Nadu Agricultural University, Coimbatore and in the national insect collections of Zoological Survey of India, Western Ghats regional station, Kozhikode. Images were captured using microscope Leica M205C Stereo zoom and measured with Leica LAS V4.5 software. Abbreviations and markings used**:** ORR - Oriental Region; PAR - Palaearctic Region; IAR - Indo-Australian Region

RESULTS

Order: Coleoptera: Family: Scarabaeidae: Subfamily: Scarabaeinae

Tribe- Sisyphini

Genus 1. *Sisyphus* Latreille, 1807

Sisyphus Latreille, 1807; Gory, 1833; Lacordaire, 1856; Reitter, 1892, 1893; Péringuey, 1901; Arrow, 1927, 1931; Balthasar, 1935a, 1963a; Haaf, 1955.

1. *Sisyphus* (s.str.) *longipes* Olivier, 1789 Fig. 2 (1)

Sisyphus (s.str.) *longipes* Olivier, 1789; Arrow, 1927, 1931; Haaf, 1955; Balthasar, 1963a.

Distribution: ORR- India (West Bengal; Maharashtra; Odisha; Karnataka; Tamil Nadu: Ooty, Nilgiri Hills; Kerala: Wayanad, Thekkady), Myanmar, Sri Lanka, Thailand.

Tribe- Canthonini

Genus 2. ***Ochicanthon* Vaz-de-Mello, 2003**

Ochicanthon Vaz-de-Mello, 2003; Boucomont, 1914a; Arrow, 1931; Paulian, 1945; Balthasar, 1963a.

2. *Ochicanthon laetus* Arrow, 1931 Fig. 2 (2)

Ochicanthon laetus Arrow, 1931; Balthasar, 1963a; Vaz-de-Mello, 2003; Latha *et al.,* 2011.

Distribution: ORR-India (Kerala: Nilgiri hills, Wayanad, Malampuzha), Thailand.

3. *Ochicanthon tristis* Arrow, 1931 Fig. 2 (3)

Ochicanthon tristis Arrow, 1931; Balthasar, 1963a; Vaz-de-Mello, 2003; Latha *et al.,* 2011.

Distribution*:* ORR-India (Tamil Nadu; Kerala: Nilgiri Hills, Silent valley, Thirunelli).

Tribe- Coprini

Genus 3. ***Catharsius* Hope, 1837**

Catharsius Hope, 1837; Burmeister, 1846; Péringuey, 1901; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935a, 1963a; Paulian, 1945.

4. *Catharsius molossus* Linnaeus, 1758 Fig. 2 (4)

Catharsius molossus Linnaéus, 1758; Harold, 1877; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935a, 1963a; Paulian, 1945.

Distribution: ORR-Afghanistan, Cambodia, India (Andaman Islands; Assam; Bihar; Odisha; West Bengal; Karnataka; Kerala: Wayanad, Nelliyampathy, Thekkady), Laos, Malaysia, Sri Lanka, Sunda Islands, Thailand, Vietnam. PAR-India (Sikkim; Uttarakhand), China, Nepal, Taiwan.

5. *Catharsius sagax* Quenstedt, 1806 Fig. 2 (5)

Catharsius (s.str.) *sagax* Quenstedt, 1806; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935a, 1963a.

Distribution: ORR-Bangladesh, India (West Bengal; Bihar; Punjab; Mumbai; Madhya Pradesh; Tamil Nadu: Nilgiri Hills, Palani Hills; Kerala: Peerumedu, Travancore, Wayanad).

Genus 4. *Copris* Geoffroy, 1762

Copris Geoffroy, 1762; Burmeister, 1846; Reitter, 1892, 1893; Péringuey, 1901; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1933, 1935a, 1936a; Janssens, 1939; Paulian, 1945.

6. *Copris* (s.str.) *repertus* Walker, 1858 Fig. 2 (6)

Copris (s.str.) *repertus* Walker, 1858; Gillet, 1911; Arrow, 1931; Balthasar, 1933, 1935a, 1963a.

Distribution: ORR-India (Bihar; Maharashtra: Mumbai; Madhya Pradesh; Chattisgarh; Karnataka; Tamil Nadu: Nilgiri Hills, Anamalai Hills; Kerala: Malabar, Nelliyampathy, Palghat, Thekkady, Wayanad), Sri Lanka, Thailand PAR-China.

Genus 5. *Paracopris* Balthasar, 1939

Paracopris Balthasar, 1939, 1963a; Paulian, 1945; Löbl and Smetana, 2006; Sabu *et al.,* 2011.

7. *Paracopris davisoni* Waterhouse, 1891 Fig. 2 (7)

Paracopris davisoni Waterhouse, 1891; Arrow, 1931; Balthasar, 1963a; Löbl and Smetana, 2006; Sabu *et al.,* 2011.

Distribution: ORR-India (Karnataka; Tamil Nadu: Nilgiri Hills, Palani Hills; Kerala: Nelliyampathy, North Malabar, Peerumedu, Travancore, Thekkady, Wayanad).

Tribe- ONTHOPHAGINI

Genus 6. *Caccobius* Thomson, 1863

Caccobius Thomson, 1863; Harold, 1867; Jekel, 1872; Waterhouse, 1875; Reitter, 1892, 1893; D'Orbigny, 1898, 1913; Péringuey, 1901, 1908; Boucomont and Gillet, 1921; Arrow, 1931; Portevin, 1931; Porta, 1932; Matsumura, 1936; Paulian, 1945; Balthasar, 1949, 1963a.

-subg. *Caccophilus* Jekel, 1872; D'Orbigny, 1898, 1913; Balthasar, 1935c, 1949.

8. *Caccobius* (*Caccophilus*) *meridionalis* Boucomont, 1914 Fig. 2 (8)

Caccobius (*Caccophilus*) *meridionalis* Boucomont, 1914a; Arrow, 1931; Balthasar, 1949, 1963a.

Distribution: ORR-India (Maharashtra; Karnataka; Tamil Nadu: Anamalai Hills, Nilgiri Hills; Kerala: Mahe, Nelliyampathy, Thekkady, Wayanad), Sri Lanka.

9. *Caccobius* (*Caccophilus*) *ultor* Sharp, 1875 Fig. 2 (9)

Caccobius (*Caccophilus*) *ultor* Sharp, 1875; Balthasar, 1963a.

Distribution: ORR-India (Maharashtra: Mumbai, Khandesh; Punjab, Rajasthan, Uttar Pradesh, Haryana: Kanneri; Karnataka: Budipadaga; Kerala: Nelliampathi, Ranipuram).

10. *Caccobius* (*Caccophilus*) *unicornis* Fabricius, 1798 Fig. 2 (10)

Caccobius (*Caccophilus*) *unicornis* Fabricius, 1798; Boucomont, 1914a; Arrow, 1931; Balthasar, 1933, 1949, 1963a; Paulian, 1945.

-*nitidiceps* Fairmaire, 1893; Boucomont, 1914a; Boucumont and Gillet, 1921.

-*yamauchii* Matsumura, 1936.

Distribution: ORR-India (Tripura; Assam; West Bengal; Madhya Pradesh; Kerala: Silent valley, Wayanad), Indonesia (Borneo, Java, Sumatra), Malay Peninsula, Myanmar, Sri Lanka, PAR-Taiwan, China. IAR - Philippines.

Genus 7. *Onthophagus* Latreille, 1802

Onthophagus Latreille, 1802; Mulsant, 1842; Erichson, 1848; Lacordaire, 1856; Mulsant and Rey, 1871; Reitter, 1892, 1893; D'Oribgny, 1898, 1913; Peringuey, 1901, 1908; Reitter, 1909; Bedel, 1911; Boucomont, 1914b; Boucomont and Gillet, 1921; Boucomont, 1924; Arrow, 1931; Portevin, 1931; Porta, 1932; Balthasar, 1935b, 1963a; Savchenko, 1938; Paulian, 1941, 1945; Endrödi, 1956; Tesar, 1957.

-subg. *Proagoderus* Lansberge, 1883; D'Oribgny, 1913; Boucomont, 1914a; Marcus, 1917; Balthasar, 1963a.

-*Tauronthophagus* Shipp, 1895.

-subg. *Serrophorus* Balthasar, 1935b; Paulian, 1945; Balthasar, 1963a.

-subg. *Micronthophagus* Balthasar, 1935b; Paulian, 1945.

-subg. *Colobonthophagus* Balthasar, 1935b; Paulian, 1945; Balthasar, 1963a.

-subg. *Paraphanaeomorphus* Balthasar, 1959, 1963a.

-subg. *Matashia* Matsumura, 1938.

-subg. *Macronthophagus* Ochi, 2003.

11. *Onthophagus* (s.str.) *amphicoma* Boucomont, 1914 Fig. 2 (11)

Onthophagus (s.str.) *amphicoma* Boucomont, 1914a; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Tamil Nadu: Nilgiri Hills; Kerala: Mahe, Nelliampathi, Travancore, Thekkady)

12. *Onthophagus* (s.str.) *andrewesi* Arrow, 1931 Fig. 2 (12)

Onthophagus (s.str.) *andrewesi* Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Karnataka; Tamil Nadu: Anamalai Hills, Nilgiri Hills; Kerala: Nelliyampathy, Thekkady, Wayanad).

13. *Onthophagus* (*Paraphanaeomorphus*) *bifasciatus* Fabricius, 1781 Fig. 2 (13)

Onthophagus (*Paraphanaeomorphus*) *bifasciatus* Fabricius, 1781; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Assam; Bihar; West Bengal; Sikkim; Tamil Nadu: Nilgiri Hills; Kerala: Wayanad, Thekkady), Myanmar.

14. *Onthophagus* (s.str.) *bronzeus* Arrow, 1907 Fig. 2 (14)

Onthophagus (s.str.) *bronzeus* Arrow, 1907; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Maharashtra: Mumbai; Karnataka; Tamil Nadu: Nilgiri Hills; Kerala: Nelliyampathy, Thekkady, Wayanad).

15. *Onthophagus* (s.str.) *cervus* Fabricius, 1798 Fig. 2 (15)

Onthophagus (s.str.) *cervus* Fabricius, 1798; D'Orbigny, 1898; Boucomont, 1914b; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Madhya Pradesh; Maharashtra; West Bengal; Karnataka; Tamil Nadu: Coimbatore; Puducherry; Nilgiri Hills; Kerala: Calicut, Wayanad, Thekkady), Sri Lanka PAR- India (Uttarakhand).

16. *Onthophagus* (*Colobonthophagus*) *dama* Fabricius, 1798 Fig. 2 (16)

Onthophagus (*Colobonthophagus*) *dama* Fabricius, 1798; D'Oribgny, 1898; Arrow, 1931; Balthasar, 1963a; Löbl & Smetana, 2006.

-*Onthophagus cervicornis* Kirby, 1825; Rossini *et al.,* 2014: 111–115

Distribution: ORR-India (Maharashtra; Sikkim; Bihar; West Bengal, Karnataka; Tamil Nadu: Anamalai Hills, Nilgiri Hills; Kerala: Nilambur, Wayanad, Thekkady), Sri Lanka. PAR-India (Uttarakhand), Nepal, Bhutan.

17. *Onthophagus* (s.str.) *devagiriensis* Schoolmeesters and Thomas, 2006 Fig. 2 (17)

Onthophagus (s.str.) *devagiriensis* Schoolmeesters and Thomas, 2006.

Distribution: ORR-India (Kerala: Wayanad, Ranipuram).

18. *Onthophagus* (*Parascatonomus*) *discedens* Sharp, 1875 Fig. 2 (18)

Onthophagus (*Parascatonomus*) *discedens* Sharp, 1875; Boucomont, 1914a; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935b, 1963a; Paulian, 1945.

-*ssp. laotianus* Boucomont, 1919; Boucomont and Gillet, 1921; Balthasar, 1935b.

Distribution: ORR-Myanmar, Siam, Indo-China, Malay Peninsula, India (Bengal; Uttar Pradesh; Tamil Nadu: Nilgiri hills; Sikkim).

19. *Onthophagus* (*Gibbonthophagus*) *duporti* Boucomont, 1914 Fig. 2 (19)

Onthophagus (*Gibbonthophagus*) *duporti* Boucomont, 1914a; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935b, 1963a; Paulian, 1945; Löbl and Smetana, 2006*;* Kabakov and Shokhin, 2014.

Distribution: ORR-India (Arunachal Pradesh; Bihar; West Bengal; Karnataka; Tamil Nadu: Nilgiri Hills; Kerala: Thekkady), Laos, Myanmar, Vietnam: Tonkin.

20. *Onthophagus* (s.str.) *fasciatus* Boucomont, 1914 Fig. 2 (20)

Onthophagus (s.str.) *fasciatus* Boucomont, 1914a; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Madhya Pradesh; Maharashtra: Mumbai; Karnataka; Kerala: Nelliyampathy, Thekkady, Wayanad; Tamil Nadu: Anaimalai Hills, Madhura, Nilgiri Hills; West Bengal) PAR-India (Uttarakhand).

21. *Onthophagus* (s.str.) *faveri* Boucomont, 1914 Fig. 3 (2)

Onthophagus (s.str.) *faveri* Boucomont, 1914a; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Karnataka; Kerala: Nelliyampathy, Thekkady, Wayanad; Tamil Nadu: Coimbatore, Nilgiri Hills), Sri Lanka.

22. *Onthophagus* (s.str.) *furcillifer* Bates, 1891 Fig. 3 (22)

Onthophagus (s.str.) *furcillifer* Bates, 1891; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Assam; Punjab, Kerala: Nelliyampathy, Thekkady, Wayanad). PAR-India (Kashmir; Uttarakhand).

23. *Onthophagus* (s.str.) *insignicollis* Frey, 1954 Fig. 3 (23)

Onthophagus (s.str.) *insignicollis* Frey, 1954; Balthasar, 1963a.

Distribution: ORR-India (Bihar; Kerala: Wayanad, Nelliampathi, Ranipuram).

24. *Onthophagus* (s.str.) *kchatriya* Boucomont, 1914 Fig. 3 (24)

Onthophagus (s.str.) *kchatriya* Boucomont, 1914a; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Karnataka; Kerala: Nilambur, Thekkady; Tamil Nadu: Anamalai Hills, Nilgiri Hills, Yercaud).

25. *Onthophagus* (s.str.) *lilliputanus* Lansberge, 1883 Fig. 3 (25)

Onthophagus lilliputanus Lansberge, 1883; Boucomont, 1921a; Arrow, 1931.

Distribution: ORR-India (West Bengal; Maharashtra: Mumbai; Tamil Nadu: Madras; Coimbatore), Myanmar; Indonesia: Java, Borneo; PAR-India (Kashmir; Punjab); IAR-Philippines.

***26. Onthophagus (s.str.) ludio* Boucomont, 1914 Fig. 3 (26)**

Onthophagus (s.str.) *ludio* Boucomont, 1914a; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-India (Maharashtra: Belgaum, Mumbai, Nagpur; Kerala: Nilgiri hills), Sri Lanka.

27. *Onthophagus* (s.str.) *pacificus* Lansberge, 1885 Fig. 3 (27)

Onthophagus (s.str.) *pacificus* Lansberge, 1885; Boucomont, 1914a; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-Bangladesh, India (Assam; West Bengal; Karnataka; Tamil Nadu: Nilgiri Hills; Kerala: Nelliyampathy, Thekkady, Wayanad), Indonesia: Borneo, Java, Sumatra; Myanmar, Malaysia, Sunda Islands, Thailand, Laos, Vietnam. PAR-India (Uttarakhand), China.

28. *Onthophagus* (s.str.) *socialis* Arrow, 1931 Fig. 3 (28)

Onthophagus (s.str.) *socialis* Arrow, 1931.

Distribution: ORR-India (Maharashtra: Mumbai; Karnataka: Belgaum, Coorg; Tamil Nadu: Nilgiri hills)

29. *Onthophagus* (s.str.) *tnai* Nithya and Sabu, 2012 Fig. 3 (29)

Onthophagus (s.str.) *tnai* Nithya and Sabu, 2012.

Distribution: ORR-India (Kerala: Silent valley, Panathady).

30. *Onthophagus* (s.str.) *truncaticornis* Schaller, 1783 Fig. 3 (30)

Onthophagus (s.str.) *truncaticornis* Schaller, 1783; Harold, 1870, 1880; Arrow, 1931; Balthasar, 1963a.

-*forcipatus* Harold, 1873; Arrow, 1931.

Distribution: ORR-India (Maharashtra: Mumbai; Tamil Nadu: Nilgiri hills; Karnataka: Mangalore).

31. *Onthophagus* (s.str.) *turbatus* Walker, 1858 Fig. 3 (31)

Onthophagus (s.str.) *turbatus* Walker, 1858; Boucomont, 1914b; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1963b.

Distribution: ORR-India (Maharashtra; Karnataka; Tamil Nadu: Puducherry, Nilgiri Hills; Kerala: Mahe, Malabar, Nelliyampathy, Thekkady, Wayanad), Sri Lanka.

32. *Onthophagus* (s.str.) *unifasciatus* Schaller, 1783 Fig. 3 (32)

Onthophagus (s.str.) *unifasciatus* Schaller, 1783; Fabricius, 1792; Arrow, 1931; Balthasar, 1963a.

-*prolixus* Walker, 1858; Harold, 1869.

Distribution: ORR-India (Maharashtra: Mumbai; Bengal; Bihar; Tamil Nadu: Coimbatore, Madras; Kerala: Nilgiri Hills), Sri Lanka (Colombo, Kandy).

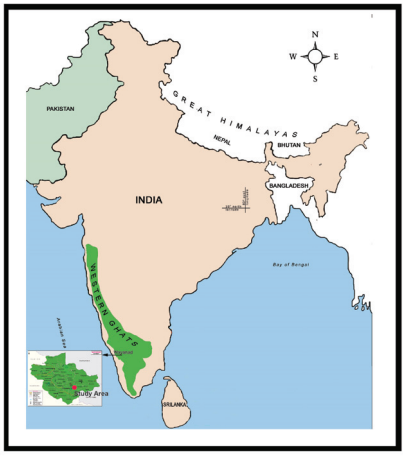

Fig. 1 Coffee plantation belt of Nlgiri Biosphere Reserve of south Western Ghats

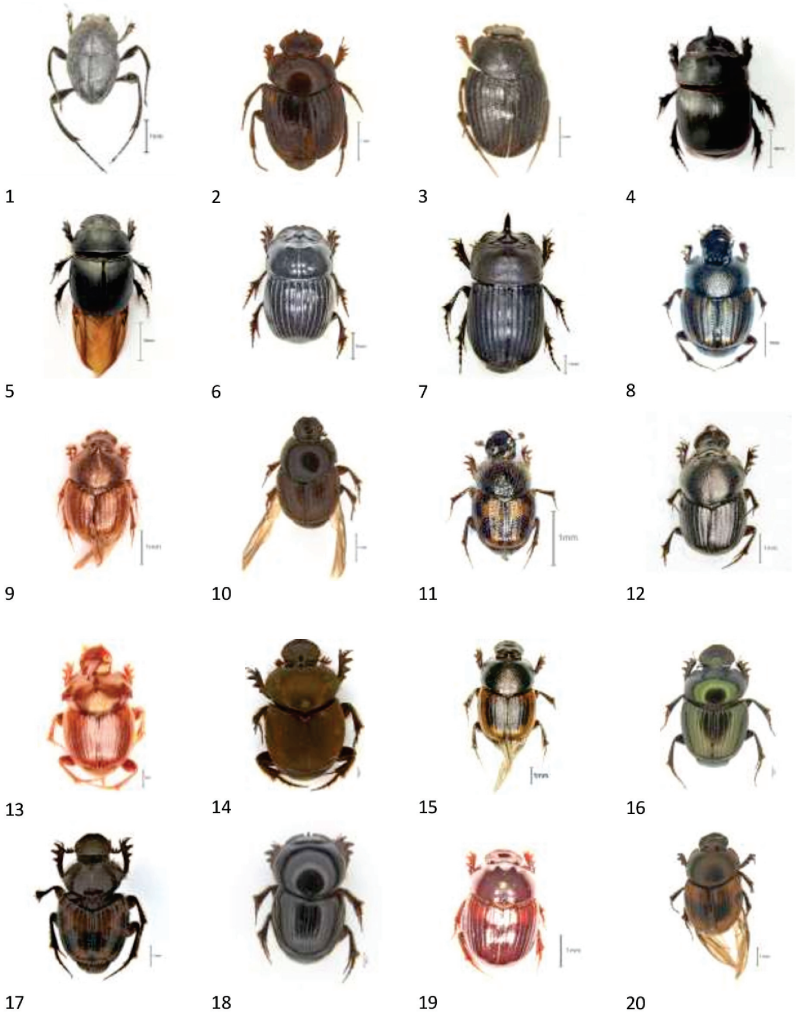

Fig. 2 (1) *Sisyphus longipes* (2) *Ochicanthon laetus* (3) *Ochicanthon tristis* (4) *Catharsius molossus* (5) *Catharsius sagax* (6) *Copris repertus* (7) *Paracopris davisoni* (8) *Caccobius meridionalis* (9) *C. ultor* (10) *C. unicornis* (11) *Onthophagus amphicoma* (12) *O. andrewesi* (13) *O. bifasciatus* (14) *O. bronzeus* (15) *O. cervus* (16) *O. dama* (17) *O. devagiriensis* (18) *O. discedens* (19) *O. duporti* (20) *O. fasciatus*

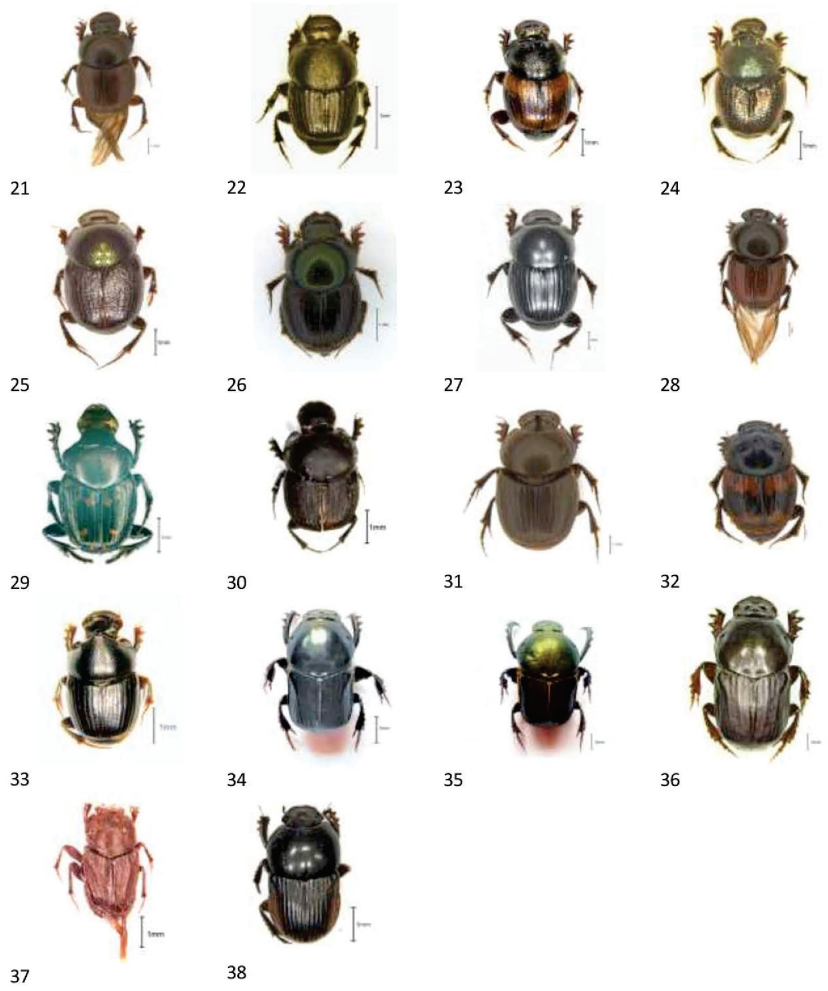

Fig. 3 (21) *Onthophagus faveri* (22) *O. furcilifur* (23) *O. insignicollis* (24) *O. kchatriya* (25) *O. lliputanus* (26) *O. ludio* (27) *O. pacificus* (28) *O. socialis* (29) *O. tnai* (30) *O. truncaticornis* (31) *O. turbatus* (32) *O. unifasciatus* (33) *O. urellus* (34) *Onitis falcatus* (35) *O. subopacus* (36) *O. virens* (37) *Tibiodrepanus setosus* (38) *Oniticellus cinctus*

33. *Onthophagus* (*Coloboniphagus*) *urellus* Boucomont, 1919 Fig. 3 (33)

Onthophagus (*Coloboniphagus*) *urellus* Boucomont, 1919; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1963a.

Distribution: ORR-Myanmar, India (Tamil Nadu: Nilgiri Hills; Kerala: Wayanad).

Tribe- Onitini

Genus 8. *Onitis* Fabricius, 1798

Onitis Fabricius, 1798, 1801; Castelnau, 1840; Lacordaire, 1856; Lansberge, 1875; Bedel, 1892; Reitter, 1892, 1893; Peringuey, 1901; Arrow, 1931; Balthasar, 1935a, 1963a; Janssens, 1937; Paulian, 1945.

34. *Onitis falcatus* Wulfen, 1786 Fig. 3 (34)

Onitis falcatus Wulfen, 1786; Lansberge, 1875; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935a, 1963a; Janssens, 1937; Paulian, 1945.

-*hymalajicus* Redtenbacher, 1848.

-*sphinx* Herbst (nec Fabricius), 1789.

Distribution: ORR-Vietnam: Tonkin, Laos, Myanmar, Thailand, India (West Bengal; Karnataka;

Kerala: Mahe, Malabar; Wayanad), PAR-India (Uttarakhand), China, Taiwan, IAR-Philippines.

35. *Onitis subopacus* Arrow, 1931 Fig. 3 (35)

Onitis subopacus Arrow, 1931; Balthasar, 1935a, 1963a; Janssens, 1937.

-*philemon* Lansberge (nec Fabricius), 1875; Boucomont, 1914a; Boucomont and Gillet, 1921.

Distribution: ORR- India (Madhya Pradesh; West Bengal; Assam; Bihar; Tamil Nadu: Anamalai Hills; Kerala: Nelliampathi, Wayanad), Myanmar, Sri Lanka, Sunda Islands, Thailand, Vietnam. PAR-India (Kashmir; Uttarakhand), Afghanistan, Nepal, China.

36. *Onitis virens* Lansberge, 1875 Fig. 3 (36)

Onitis virens Lansberge, 1975, 1875; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935a, 1963a; Paulian, 1945.

-*amplectens* Lansberge, 1875.

Distribution: ORR - Myanmar, North Vietnam, Laos, Thailand, India (Bihar; West Bengal; Maharashtra; Karnataka; Tamil Nadu: Nilgiri Hills, Anamalai Hills; Kerala: Peerumedu, Travancore, Wayanad). PAR-India (Uttarakhand), China.

Tribe- Oniticellini

Genus 9. *Tibiodrepanus* Krikken, 2009

Tibiodrepanus Krikken, 2009; Kirby, 1828; Castelnau, 1840; Lacordaire, 1856; Péringuey, 1901; Boucomont and Gillet, 1921; Boucomont, 1921b; Arrow, 1931; Balthasar, 1935a, 1963a; Paulian, 1945; Janssens, 1953.

-*Ixodina* Roth, 1851.

-*Cyptochirus* Lesne, 1900.

-*Drepanochirus* Peringuey, 1901; Boucomont, 1921b.

37. *Tibiodrepanus setosus* Wiedemann, 1823 Fig. 3 (37)

Drepanocerus setosus Wiedemann, 1823; Arrow, 1931; Janssens, 1953; Balthasar, 1963a; Krikken, 2009.

Distribution: ORR-India (Maharashtra; Madhya Pradesh; Kerala: Nilambur, Nelliyampathy, Thekkady, Wayanad), Sri Lanka. PAR-India (Uttarakhand)

Genus 10. *Oniticellus* Dejean, 1821

Oniticellus Dejean, 1821; Lacordaire, 1856; Reitter, 1892, 1893; Péringuey, 1901; Boucomont and Gillet, 1921; Boucomont, 1921b; Arrow, 1931; Portevin, 1931; Porta, 1932; Balthasar, 1935a; Paulian, 1941, 1945; Janssens, 1953.

38. *Oniticellus cinctus* Fabricius, 1775 Fig. 3 (38)

Oniticellus (s. str.) *cinctus* Fabricius, 1775; Boucomont, 1914a; Boucomont and Gillet, 1921; Arrow, 1931; Balthasar, 1935a, 1963b; Paulian, 1945; Janssens, 1953.

-*serratipes* Drury, 1770.

Distribution: ORR - Malaysia, Java, south China, Thailand, India (Madhya Pradesh; Maharashtra; West Bengal; Karnataka; Tamil Nadu: Nilgiri Hills; Kerala: Wayanad). PAR- India (Uttarakhand).

DISCUSSION

Among the thirty-eight species of dung beetles recorded from the shaded coffee plantation of south Wayanad, eight species, (*Ochicanthon laetus, O. tristis, Onthophagus andrewesi, O. amphicoma, O. bronzeus, O. devagiriensis, O. tnai*, *Paracopris davisoni*) were endemic to the Western Ghats and two species, *Onthophagus truncaticornis* and *O. discedens* were recorded as extinct species in the checklist of dung beetles from the moist south Western Ghats (Sabu *et al.,* 2011). The record of two species of the genus *Ochicanthon* [*O. tristis* (Arrow, 1931) and *O. laetus* (Arrow, 1931)] from the study site is significant, since *Ochicanthon* belonged to the very primitive and rare old world tribe Canthonini and all known *Ochicanthon* species are moist forest dwellers of the Indo-Pacific bioregion and in the Indian subcontinent, they are confined to the moist forests of south-

western and north-eastern India and absent from the vast intervening stretches of central India (Krikken and Huijbregts, 2007; Latha *et al.,* 2011). The presence of *Ochicanthon* species in the coffee plantation belts indicates that the recent habitat modifications in the Western Ghats have not wiped out the relict old world dung beetles (primitive groups) from the coffee plantations. The first report of *Onthophagus lilliputanus* from the moist south Western Ghats indicates that further studies from vaster areas of coffee plantations of the Western Ghats highlight the chance of revealing new additions to the species list of the Nilgiri Biosphere Reserve of the South Western Ghats.

The current study recorded many rare and endemic dung beetle species reported earlier by Arrow (1931) from the Western Ghats region. This supports the findings of Nearctic and Neotropical studies that shaded coffee plantations show higher abundance of coprophagous dung beetles similar to native forests (Moron, 1987; Estrada *et al.,* 1998; Arenallo *et al.,* 2005; Horgon, 2005, 2009; Pineda *et al.,* 2005; Halffter *et al.,* 2007; Sarges *et al.,* 2012) and also serve as refuges for many forest dung beetle species (Perfecto *et al.,* 1996; Moguel and Toledo, 1999; Arellano *et al.*, 2005).

The present study showed that species composition of dung beetles in the shaded coffee plantation with a comparatively smaller area had no major differences with that of the nearby natural forests of Thirunelli (North Wayanad Forest Division) and Thariode (South Wayanad Forest Division) in Wayanad (Vinod, 2009), which is an integral part of the Nilgiri Biosphere Reserve. Further similar studies in other coffee plantation belts of the South Western Ghats (Anamalais, Baba Budan giri, Chikmagalur, Coorg) are needed to understand the trends at much broader scale in the Western Ghats. Non-record of the genus *Liantogus* belonging to the dweller functional guild from the coffee plantations and abundant in the regional forests is attributed to the requirement for undisturbed large dung pads of megaherbivores like elephants and gaur for dwellers in general (Vinod and Sabu, 2007; Vinod, 2009). Thirty eight species collected from the coffee plantation of a small size is not very low in comparison with the 46 species recorded from a larger forest region in Wayanad (Vinod, 2009); Twelve out of 38 species were exclusively found in the coffee plantation, namely, *Caccobius ultor, C. unicornis, Onthophagus amphicoma, O. discedens, O. duporti, O. kchatriya, O. lilliputanus, O. ludio, O. socialis, O. tnai, O. truncaticornis, and O.unifasciatus*. Twenty one out of 46 species reported from the forest region (Vinod, 2009) were not recorded from the coffee site.

Higher species richness and presence of some unique species in the coffee plantation belt compared to other agricultural habitats with 28 species recorded from the agriculture belt of Wayanad (Vinod, 2009), 26 species from the semiurban agricultural belt in the Malabar Coast (Simi *et al.,* 2012), 25 species from the agriculture belt of Nelliampathi (Latha, 2011), and 31 species recorded from the agriculture fields of North Malabar (Simi, 2014) highlights the significance of shaded coffee plantations as an important nested habitat in the forest-agriculture land matrix of the moist western Ghats.

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