Taxonomy of *Colophon* Gray (Coleoptera: Lucanidae): new species and a status change

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Abstract

Three new species of the Cape high-mountain stag beetle genus, *Colophon* Gray (Coleoptera: Lucanidae), from South Africa are described. They are C. *deschodti* new species, C. *switalae* new species, and C. *struempheri* new species. The new taxa fall within a species complex of geographically disjunct entities related to *Colophon stokoei* Barnard. Furthermore, the mitochondrial COI gene shows a high degree of sequence divergence, with pairwise genetic distances between the species ranging between 7.4-10.7%. The new species are illustrated by photographs. *Colophon eastmani nagaii* Mizuka- mi is raised to species level on the basis of geographic range and molecular differences between it and the nominate subspecies. This brings the total number of described species in the genus to 21. An updated checklist of the South African species of *Colophon* is also provided.

Key words: Cape high-mountain stag beetle, Cape Fold Mountains, flightlessness, mountain relicts

Introduction

Colophon Gray (Coleoptera: Lucanidae: Lucanini) is taxonomically unique and hypothesised to be a relict of an extinct Cretaceous temperate Gondwanan lineage (Switala *et al.* 2014; Kim & Farrell 2015). It is thought to have separated from its sister clade, represented by extant members of the Neotropical-Australasian Chiasognathini (Lucaninae) of which most are highland or montane forms. Two recent studies hypothesised this divergence at about 86 mya (Switala et *al.* 2014) and 87 mya (Kim & Farrell 2015). All the *Colophon* species are restricted to cool, high mountain peaks of the Fynbos biome of the southwestern Cape Province, South Africa to which they were possibly gradually driven by the northward drift of the continent and progressive warming of the area since the Pleistocene. The genus currently consists of 17 recognised species, as well as several subspecies and various “forms/varieties” which occur on disjunct mountain peaks and show small morphological differences. Males and females are strongly dimorphic with males having large mandibles, although these vary considerably within a species, apparently allometrically. All species are wingless and have very localised distributions on only those peaks that receive evening and morning summer fog. Various global change scenarios predict further drying of these peaks. Consequences for the beetles are likely to be severe.

Colophon is the only African insect group to be Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)-listed (Category III) although very little is known about the natural history of any of the species. The reasons for its listing revolve around the perceived rarity of the species and the astronomical amounts that the beetles command in the insect trade. However, the question of the rarity and need for protection of species in this genus have been emotionally driven since no study has attempted to determine any aspect of the natural history or population parameters of any of the species. The species are highly prized by collectors because of their putative rarity, and the recent CITES-listing has clearly increased their black-market value. Because of their remote distribution at high altitude in largely inaccessible areas, effective policing of collection of the species is difficult. An underground black market of sale of the species is

currently flourishing.

During a 10-year study of the species' genetic uniqueness, distribution, phylogenetic relationships, habitat- specificity, and population sizes (Switala *et al.* 2014, 2015), three undescribed species were discovered and information was gathered on differences between two subspecies that we believe justifies according them full species status. The results are set out in this paper and we trust that the information will contribute to appropriate management decisions for the continued protection of the species.

Material and methods

Specimens were examined using Zeiss dissecting microscopes. Images of set habitus specimens were taken with a Canon EOS 550D and 100 mm macro lens. Focus stacking was performed using the software Helicon Focus version 5.3. Male genitalia and components were photographed under a Leica M165 C microscope, using the Leica DMC 2900 digital camera.

Morphological terminology follows Endrody-Younga (1988). Despite their overall similarity, the males of all the entities in this species complex, which includes the new species described here, can be reliably distinguished from each other by the shape of the mentum, and by the sculpture on the head. For ease of identification these differences are presented in Table 1. Institutions to which new specimens or type material belongs or in which they have been deposited are abbreviated as follows:

ISAM Iziko South African Museum, Cape Town, South Africa (previously the South African Museum). TMSA Ditsong Museum of Natural History, Pretoria, South Africa (previously the Transvaal Museum).
UPSA Department of Zoology & Entomology, University of Pretoria, Pretoria, South Africa. DNA collection (specimens preserved in ethanol).

Because of the sensitivity of the locality information, we have refrained from providing data on precise locations where the new species may be found. *Bona fide* researchers will, however, be provided with the relevant information by the museums where the types are housed, after approval by the local conservation authorities has been obtained.

Colophon, Gray 1832

Type species. *Colophon westwoodi* Barnard, 1931

Colophon stokoei Barnard, 1929

(Figs. 1a-h; Table 1).

Colophon stokoei Barnard, 1929: 168; Endrody-Younga 1988: 393.

Type material examined. Paralectotype (1^): Hott.-Holl. [Hottentots Holland] Mts., 4 000ft. [4 000-5 000] ft. [= 1 220-1 524 m], Caledon C.C. [Cape Colony], Barnard, [January] 1916 (ISAM). Additional material examined: 62^, 3$ (ISAM); \0*f* (UPSA).

Diagnosis. *Colophon stokoei* is well represented in collections and is relatively easy to identify despite being superficially similar to C. *deschodti* **new species**, *C. switalae* **new species**, and *C. struempheri* **new species**. It is best characterised by a distinct tooth situated on the inner basal margin of the sickle-shaped mandible, which is small or obsolete in the male specimens of the other three species. The shape of the mentum is also diagnostic (Table 1).

Redescription. *Size:* Male: 21-27 mm, pronotal width: 9-12 mm (n = 53). Female: 18-22 mm, width: 9-11 mm (n = 3). *Body:* Convex, dull black (Fig 1a, b). *Head:* Transversely oblong, anterior lateral angle almost pointed; lateral margins straight, upper surface with a compressed tubercle on either side at the base of the mandible and an oblique ridge over the eye; internal subocular crests rounded but distinct, with tubercle at the

anterior inner end of each crest; frons surface pitted, evenly depressed between tubercles and arcuately slanting to clypeus; clypeus meets triangular labrum on the same level (Table 1). *Antennae:* Elbowed, antennomeres of club cannot be folded together. *Mandibles:* Short and simple, each nearly semicircular; dorsal surface of apical portion strongly furcate; inner basal margin of lower surface with a distinct tooth, which is prominently visible in dorsal as well as ventral view; yellow setae between mandibles (Table 1). *Mentum*: Thick and projecting prominently in lateral view; evenly elevating from base in lateral view, and forming a vertical line or surface anteriorly; transversely quadrangular in ventral view, evenly elevating from base in lateral view, and forming a vertical line or surface anteriorly; anterior surface large and deeply excavated; anterior margin transverse (Table 1). *Pronotum*: Lateral margins evenly arcuate, hardly and only slightly emarginate near posterior angle, in general appearance moderately enlarged. *Legs*: Protibia strongly curved and dilated towards the apex, ventral longitudinal crest distinct, but not sharply raised basally; apicoventral process long and narrow; apex externally bidentate, proximal to which is a semicircular excision, dorsal surface convex with a blunt median keel, ventral surface also keeled, distally concave, with a short forwardly directed tooth near insertion of tarsus (Fig. 1d). *Male genitalia*: Aedeagus symmetrical. Dorsal line of left paramere in lateral view emarginated in apical third, and forms an angle where it turns into the finely convex basal two-thirds (Fig. 1e-h). *Female*: Body convex, dull black; pronotum slightly narrower but similar in shape to that of the males; elytra similar to that of males; punctation on head, pronotum, and elytra much more distinct than in males; head and mandibles conspicuously small (Fig. 1c).

Distribution. Hottentots Holland Mountains, Western Cape Province, South Africa.

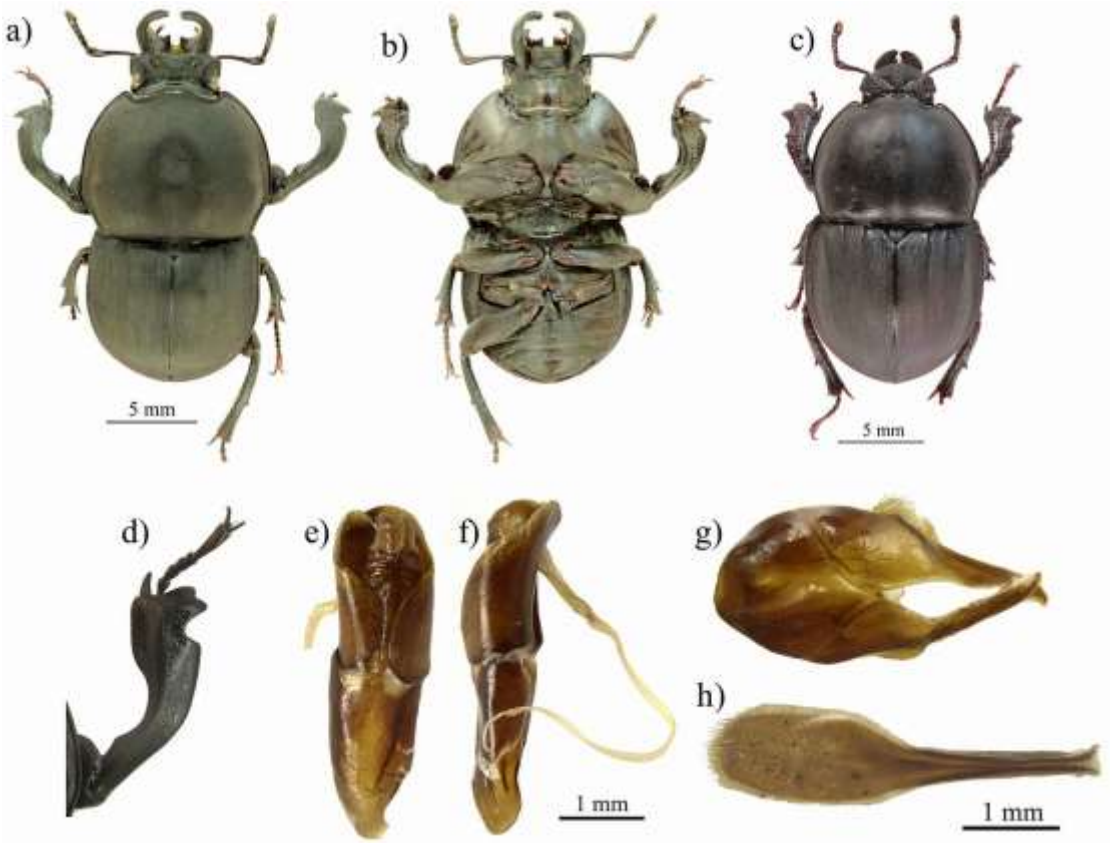

Figure 1. Adult habitus of *Colophon stokoei* Barnard: (a) male dorsal view; (b) male ventral view; (c) female dorsal view; (d) male protibia; (e) aedeagus dorsal view; (f) aedeagus lateral view; (g) ventral plate of genital mass; (h) dorsal plate of genital mass.

Colophon switalae **Jacobs & Scholtz, new species**

(Fig 2a-d; Table 1).

Type material. Holotype: (1$: ISAM); Paratypes: (10$: ISAM), (2$: TMSA), *(2$:* UPSA).

Diagnosis. *Colophon switalae* is distinguished from other members in the group by the shape of the mentum, which is characterised by a distinct concave ridge on the anterior margin of the head. It is the only species in the group with two distinct colour forms. The shape of the mentum is also diagnostic (Table 1). Pairwise genetic distance from *C. stokoei* is 8.4% for COI (Switala *et al.* 2014).

Holotype description. *Colour.* Black. *Size:* length 23.4 mm, pronotal width, 11.9 mm, mandible length: 3.1 mm. *Head:* Anterior margin with distinct concave ridge, straight to sinuate (Table 1). *Mandible:* Apex of mandible deeply impressed on upper surface as in *C. stokoei* (Table 1). *Mentum:* Attenuated anteriorly in ventral view; anterior margin rounded; anterior surface quadrangulate and excavated (Table 1). *Legs:* Protibia robust (Fig. 3c). *Male genitalia:* As in *C. stokoei.*

Variation. *Size:* length 17.0-21.0 mm, pronotal width 9.7-10.8 mm (n = 14). *Female:* Unknown.

Distribution. Hottentots Holland Mountains, Western Cape Province, South Africa.

Etymology. It is with great pleasure that we name this species after Angelika Switala, in recognition of her contribution to our knowledge of these rare mountain relicts.

Comment. The colour of the legs of the males shows two distinct forms, red and black, without any intermediates (Fig. 3d). The populations of the two colour forms appear to occur allopatrically and may represent novel lineages but this requires further investigation.

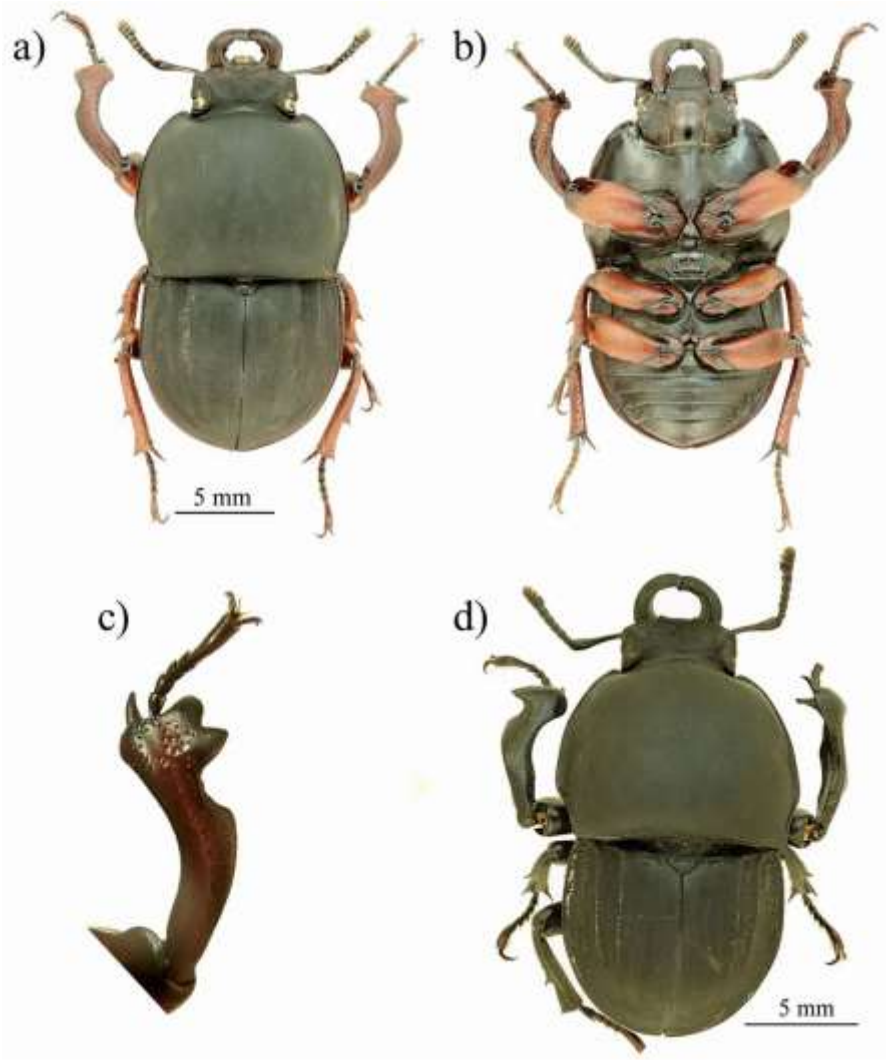

Figure 2. Adult habitus of *Colophon switalae* new species: (a) male dorsal view; (b) male ventral view; (c) male protibia; d) male dorsal view (red colour form).

***Colophon struempheri* Jacobs & Scholtz, new species**
(Fig 3a-d; Table 1).

Type material. Holotype: (1^: ISAM); Paratypes: (1^, 1$: UPSA).

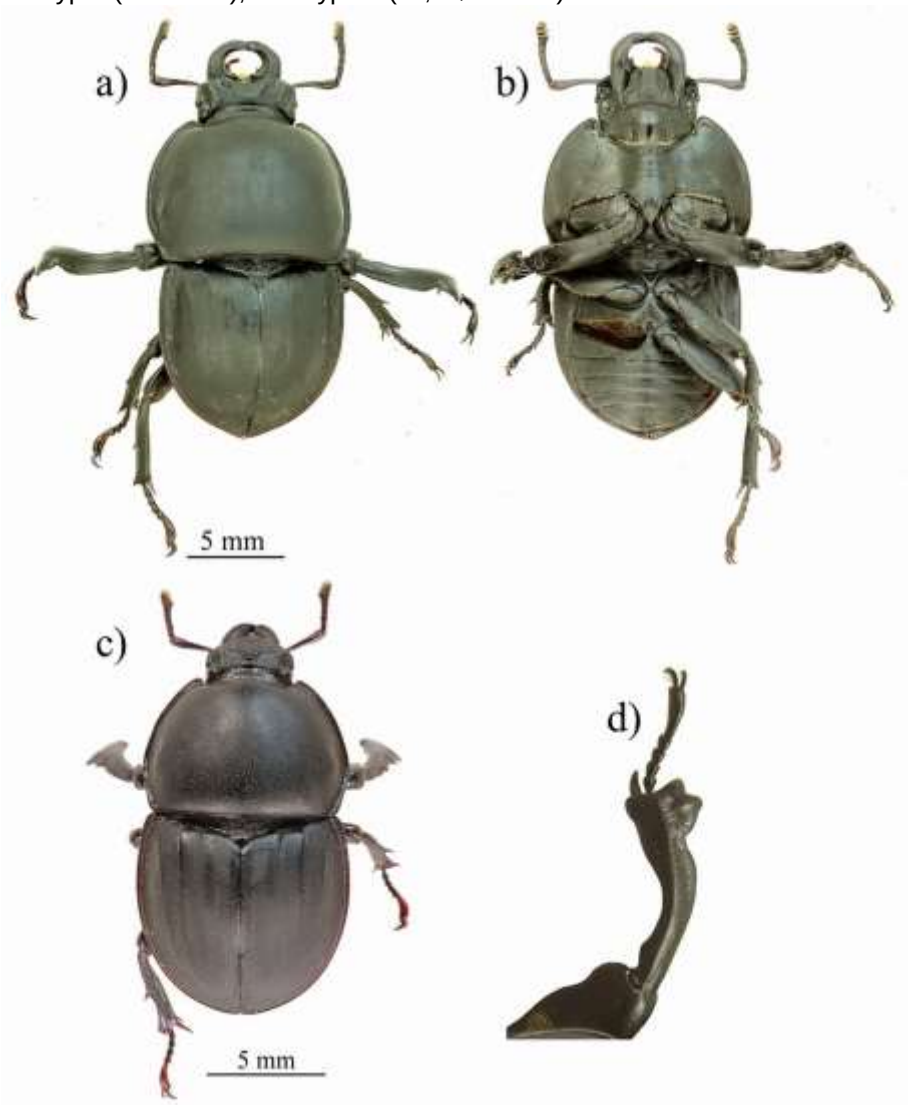

Figure 3. Habitus *Colophon struempheri* new species: (a) male dorsal view; (b) male ventral view; (c) female dorsal view; (d) male protibia.

Diagnosis. *Colophon struempheri* is most similar to C. *deschodti,* but can be distinguished from the latter by the lack of median point or protuberance on the anterior margin of the head. Furthermore, C. *deschodti* has the mentum distinctly bifid, whereas C. *struempheri* has the mentum narrow and slightly bifid. Pairwise genetic distance from *C. stokoei* is 7.4% for COI (Switala *et al.* 2014).

Holotype description. *Colour.* Black. *Size:* Male: length 19.8 mm, pronotal width: 10.3 mm, mandible length: 3.1 mm. Female: 15.6 mm, pronotal width: 8.7 mm. *Head:* Declivous in front but with a feeble indication of a definite anterior margin (Table 1). *Mandible:* Apex of mandible deeply impressed on upper surface as in *C. stokoei;* ventral process prominent, rectangular (Table 1). *Mentum:* Anterior surface narrow, not excavated; anterior margin simply bifid; ventral surface deeply impressed on either side of a projecting median ridge (Table 1). *Legs:* Protibia similar to *C. stokoei*, but less curved and less robust, the two apical teeth sharper and the extension is less deep (Fig. 3d). *Male genitalia:* As in *C. stokoei.*

Variation. *Size:* length 19.86-20.08 mm, pronotal width 10.29-10.70 mm (n = 2). *Female:* Description as for *C. stokoei* (Fig. 3c).

Distribution. Hottentots Holland Mountains, Western Cape Province, South Africa.

Etymology. The species is named after Werner P. Strumpher in recognition of his contribution to the

study of *Colophon*.

Table 1. Diagnostic features of the head, mentum, and mandibles to aid in the identification of *Colophon deschodti, C. stokoei, C. struempheri,* and C. *switalae.*

***Colophon deschodti* Jacobs & Scholtz, new species**
(Fig 4a-c; Table 1)

Type material. Holotype (1$: ISAM).

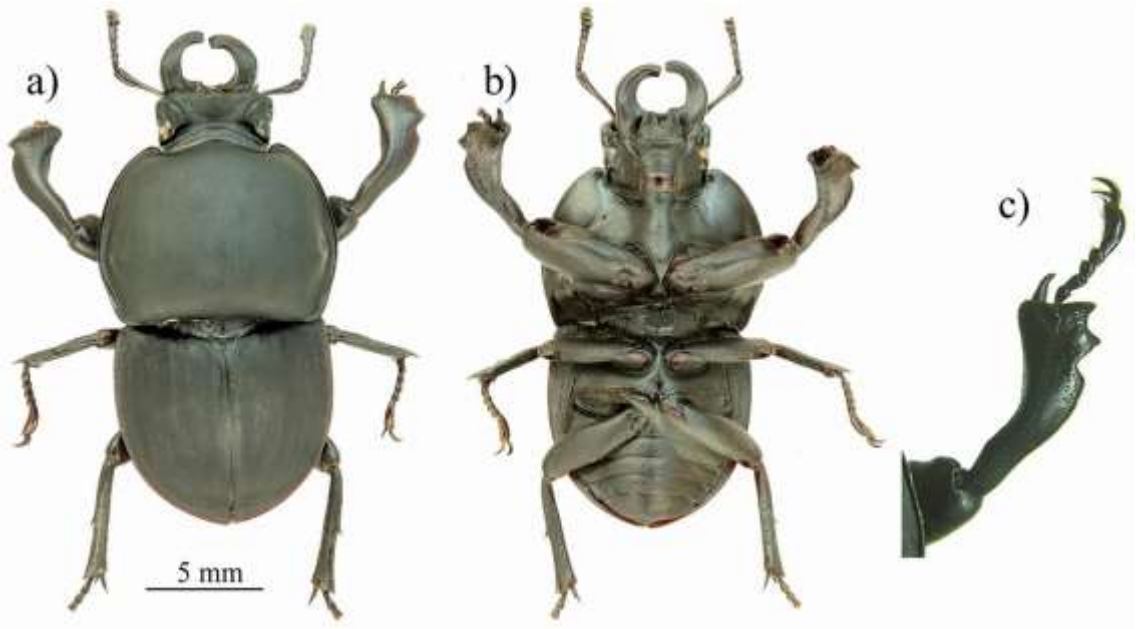

Figure 4. Adult habitus of *Colophon deschodti* new species: (a) male dorsal view; (b) male ventral view; (c) male protibia.

Diagnosis. *Colophon deschodti* is distinguished from other members in the group by the shape of the mentum, which is clearly divided into two projecting tubercles or ridges. *Colophon deschodti* lacks any tubercles on the head, but bears a median point on anterior margin of the head.

Holotype description. *Colour.* Black. *Size:* length 20.5 mm, pronotal width 10.4 mm, mandible length: 3.28 mm. *Head:* With a distinct anterior margin, which is concave with a median point and a strong oblique ridge over the eye, no tubercles present (Table 1). *Mandible:* Apex of mandible deeply impressed on upper surface as in *C. stokoei,* but with the tooth on the inner basal margin rounded and nearly obsolete (Table 1). *Mentum:* Anterior surface with two projecting ridges, causing it to appear distinctly bifid in front ventral view (Table 1). *Legs*: As in *C. struempheri* (Fig. 4c). *Male genitalia:* As in *C. stokoei.*

Distribution. Hottentots Holland Mountains, Western Cape Province.

Etymology. This species is named after Christian Deschodt in recognition of his contribution to the study of *Colophon*.

Colophon nagaii Mizukami, 1996, and *Colophon eastmani* Barnard, 1932, new status

Colophon eastmani eastmani Barnard, 1932: 174 *Colophon eastmani nagaii* Mizukami, 1996: 22

Comment. *Colophon eastmani* and *C. nagaii* are localised on mountain peaks of the same chain (Langeberg Mountains) about 30 km apart with no suitable habitat between. Although morphological differences between the two taxa are slight, albeit distinct, genetic distance between them is significant (pairwise distance of 9.6% for CO1; and in the same order, 8.1-10.7%, for well-defined related species (Switala *et al.* 2014). Consequently, we elevate *C. eastmani nagaii* to species level, as *C. nagaii and C. eastmani eastmani* to species level, as *C. eastmani.*

Check list of South African *Colophon* species

Genus *Colophon* Gray, 1832 *Colophon barnardi* Endrody-Younga, 1988 *Colophon berrisfordi* Barnard, 1932 *Colophon cameroni* Barnard, 1929 *Colophon cassoni* Barnard, 1932 *Colophon deschodti* Jacob & Scholtz, 2015 *Colophon eastmani* Barnard, 1932 *Colophon endroedyi* Bartolozzi, 2005 *Colophon haughtoni* Barnard, 1929 *Colophon izardi* Barnard, 1929 *Colophon kawaii* Mizukami, 1997 *Colophon montisatris* Endrody-Younga, 1988 *Colophon nagaii* Mizukami, 1997 *Colophon neli* Barnard, 1932 *Colophon oweni* Bartolozzi, 1995 *Colophonprimosi* Barnard, 1929 *Colophon stokoei* Barnard, 1929 *Colophon struempheri* Jacob & Scholtz, 2015 *Colophon switalae* Jacob & Scholtz, 2015 *Colophon thunbergii* Westwood, 1855 *Colophon westwoodii* Gray, 1832 *Colophon whitei* Barnard, 1932

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