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Notes on the genus *Dactyloceras* Mell, 1927, with description of the preimaginal instars of *Dactyloceras richinii* Berio, 1940 (Lepidoptera, Brahmaeidae)

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Abstract

The complete life cycle of *Dactyloceras richinii* Berio, 1940 from Ethiopia is described and figured in detail. It is the first time that a *Dactyloceras* Mell, 1927 species was reared successfully from ovum to imago. A short overview about history of the genus *Dactyloceras* is presented, including an updated checklist for the genus, and some information on *D. richinii* in detail is given. The few other known preimaginal stages of *Dactyloceras* are figured for comparision, including photos of larvae of *D. lucina* (Drury, 1782) for the first time.

Key words: Brahmaeidae, *Dactyloceras*, early instars, Ethiopia.

Bemerkungen zur Gattung *Dactyloceras* Mell, 1927 mit Beschreibung der Präimaginalstadien von *Dactyloceras richinii* Berio, 1940 (Lepidoptera, Brahmaeidae)

Zusammenfassung

Die komplette Zucht von *Dactyloceras richinii* Berio, 1940 aus Äthiopien wird beschrieben und im Detail abgebildet. Es ist das erste Mal, dass ein Vertreter der Gattung *Dactyloceras* Mell, 1927 vom Ei bis zum Falter erfolgreich gezüchtet werden konnte. Es wird eine kurze Übersicht zur Gattung *Dactyloceras* samt aktualisierter Checkliste aufgeführt und *D. richinii* etwas ausführlicher behandelt. Die wenigen anderen bisher bekannten Präimaginalien der Gattung *Dactyloceras* werden zum Vergleich abgebildet, inclusive bisher unpublizierter Raupenfotos von *D. lucina* (Drury, 1782).

Introduction

The family Brahmaeidae Swinhoe, 1892 contains medium to large sized taxa distributed in Asia, Europe and sub-Saharan Africa. Except for *Lemonia* Hübner, 1820 ("1816"), all species are of a dark greyish brown ground colour and bear a typical pattern with lighter outer border and, in most species, rows of transverse wavy lines on both fore- and hindwings. The antennae are bipectinate in both sexes, the proboscis is moderately developed or partly vestigial. Male genitalia structures show obvious overall similarities, with a strong uncus and a large, medially echinate gnathos. Eggs are hemispherical, with a smooth chorion. In all or most instars, larvae show at least two well-developed scoli on both the second and third thoracic segments, which in some cases can be very long and contorted, plus a dorsal central one on the eighth abdominal segment. Pupation takes place in the soil without a genuine cocoon. Minet (1994) and Lemaire & Minet (1999) mention several more characters and give extensive notes on the phylogeny of the family and its position within Bombycoidea. Historically, in Africa two genera were represented: *Dactyloceras* Mell in Hering in Seitz (ed.), 1927 from most African areas except the extremely South and the arid Northwestern parts, and *Spiramiopsis* Hampson, 1901 from Southern Africa (Oberprieler & Duke 1994). By synonymizing Lemoniidae with Brahmaeidae, Zwick (2008) included also *Lemonia* and *Sabalia* Walker, 1865 as further African Brahmaeidae genera due to phylogenetic characters. *Lemonia* occurs in Europe and only in the northernmost parts of Africa, while *Sabalia* is restricted to the tropical and subtropical parts of eastern Africa.

The genus *Dactyloceras*

Nomenclatural notes on *Dactyloceras* were published by Brosch et al. (2002), where also the situation with homonyms of several taxa within the genus was pointed out. Bouyer (2002) separated a new subgenus *Shinocksiceras* with type species *Brahmaea bramarbas* Karsch, 1895 for all taxa aside of *D. lucina* (Drury, 1782), *D. tridentatum* (Conte, 1911), and *D. nebulosum* Brosch et al., 2002. In an entomological note Naumann et al. (2005) reported about the origin of the word *Dactyloceras* and explained the reasons why this taxon is of neuter gender and not, as imagined and widely in use previously and even today, of feminine gender. According to the rules of the Code (ICZN 2000: art. 31), some taxa thereby have to be emendated in a way different to general use (*D. maculatum* [Conte, 1911], *D. tridentatum* Hering in Seitz, 1927, *D. widenmanni conjunctum* Hering in Seitz, 1927, and *D. nebulosum* Brosch et al., 2002). A brief overview of the genus was given in a work on Kakamega Forest, Kenya, by Naumann (2008) but since then some more taxa have been described so that here an updated list of taxa of the genus *Dactyloceras* can be presented; they are cited in chronological order of their descriptions, and their type localities are mentioned, and in some cases, where necessary, the actual geographic situation is added. This overview does not include the interpretation of the taxonomic status, so no synonymies are cited here prior to more conclusive taxonomic work on the genus.

D. lucina (Drury, 1782) – type locality: "Sierra Leone".

D. swanzii (Butler, 1871) – type locality: "Fantee, West Coast of Africa" [probably from the tribal area of the Fanti in south-western Ghana].

D. neumayeri (Pagenstecher in Fischer, 1885a - Mittheilungen der Geographischen Gesellschaft in Hamburg, [5] 1882-83) with its junior primary homonym *D. neumayeri* (Pagenstecher in Fischer, 1885b - Das Massai-Land) – type locality: "[Ost-Äquatorial-Afrika:] Ssigirari" [Tanzania, slopes of Mt. Kilimandjaro].

D. ocelligera (Butler, 1889) – type locality: "about 50 miles from Mombaza" [Mombasa, Eastern Kenya].

D. bramarbas (Karsch, 1895) – type locality: "Barombi-Station am Elefantensee in Kamerun" [Southwest Cameroon].

D. catenigera (Karsch, 1895); holotype figured as *B. catenaria* [sic] in Grünberg (1909: pl. XI, fig. 5) – type locality: "Ssósswe, S.W. Victoria Nyansa." [Tanzania, southwest coast of Lake Victoria.

D. widenmanni (Karsch, 1895) – type locality: "lowermost part of the agricultural area of the Kilimandjaro, Moschi, 1150 m" [Moshi, Tanzania].

D. maculatum (Conte, 1911) with its junior primary homonym *D. maculatum* (Conte, 1919) – type locality: "Usambara" [Northeastern Tanzania].

D. tridentatum (Conte, 1911) with its junior primary homonym *D. tridentatum* (Conte, 1919) – type locality: "Congo supérieur" [northern R. D. Congo].

D. barnsi (Joicey & Talbot, 1924) – type locality: "Ruanda district, Lake Kivu, Rugege Forest, 7000 – 8000 feet" [Rwanda].

D. ostentator Hering (in Seitz), 1927a with its junior primary homonyms *D. ostentator* Hering (in Seitz), 1927b and *D. ostentator* Hering in Seitz, 1943 (see Brosch et al., 2002) – type locality: "Kamerun (Yaundestation)" [Yaoundé, Cameroon].

D. widenmanni arrogans Hering (in Seitz), 1927a with its junior primary homonyms *D. widenmanni arrogans* Hering (in Seitz), 1927b and *D. widenmanni arrogans* Hering in Seitz, 1943 (see Brosch et al., 2002) – type locality: "Deutsch-Ost-Afrika; Kilimandjaro" [Tanzania].

D. widenmanni conjunctum Hering (in Seitz), 1927a – type locality: not given, but most likely originating from D.-O.-Afrika (Armani) [Tanzania].

D. richinii Berio, 1940 – type locality: "Eritrea: Adi Abuna" [Ethiopia, Tigray Region].

D. canui Bouyer, 2002 – type locality: "Île de Bioko, Lago Esa, 1000 m" [Equatorial Guinea].

D. ducarmei Bouyer, 2002 – type locality: "R. D. Congo, Uele, Paulis" .

D. karinae Bouyer, 2002. – type locality: "Cameroun Nord-Ouest, Mt. Oku (lac), 6°13'N 10°29'E, 2200 m".

D. nebulosum Brosch, Naumann, & Meister, 2002 – type locality: "Cameroon: Yaoundé environment".

D. vingerhoedti Bouyer, 2005 – type locality: "Tanzania, Masenghetis forest, Morogoro".

D. noellae Bouyer, 2006 – type locality: "Kenya, Mt. Meru, >2000 m".

D. cadioui Bouyer, 2008 – type locality: "Tanzanie, Rukwa reg., Mbizi Mts. F.R., 2252 m".

D. collinsi Bouyer, 2008 – type locality: "R.D. Congo, Kivu N., Matumbi".

D. minettii Bouyer, 2008 – type locality: "Tanzanie, Kilimandjaro N.P., Mt. Kilimandjaro West, 2547 m".

D. tanzaniensis Bouyer, 2008 – type locality: "Tanzanie, Njombe".

D. vandeweghei Bouyer, 2008 – type locality: "Rwanda, forêt de Nyungwe, 1850 – 2500 m".

D. murphyi Bouyer, 2012 – type locality: "N. Malawi, Nyika N.P., km 30 Chiunda – Juniper rd., 2440 m, 10°42'S 33°57'E".

In 2015 the Brahmaeidae collection of T. Bouyer was purchased by one of the authors (S. N.); this famous collection contains representatives of all described African taxa, in total more than 800 specimens, including the holotypes of all *Dactyloceras* species described by Bouyer except that of *D. ducarmei*, plus some specimens of *Spiramiopsis comma* Hampson, 1901, *Sabalia*, and Palaearctic Brahmaeidae. For about 280 specimens DNA barcoding results already exist. The collection will be incorporated with the entire collection of S. N. in the Rainer Seegers Foundation and eventually into the collections of Museum für Naturkunde in Berlin, to present there an almost complete Brahmaeidae collection.

In this paper we report on the first successful rearing of a *Dactyloceras* species, namely *D. richinii,* from Ethiopia. In that country so far two species of the genus are recorded (most probably *D. ocelligera* and the widespread *D. richinii*). The holotype of *D. richinii* (Figs. 21-23) in the Museo civico di Storia naturale "Giacomo Doria" in Genova, Italy,

was examined from a photo; the type locality, as given in the original description, is "Eritrea: Adi Abuna" which today is found in northern Ethiopia, Tigray Region, near Adwa and the border with Eritrea, so the identity of the reared species could be verified. Records of this widespread Ethiopian species in the collection of S. N. are from some localities in the northern Ethiopian Amhara Region, which is bordered by Tigray Region to the north, and from many localities in the southern Ethiopian Oromia and SNNPR Regions, but are missing from the arid eastern and central parts of the country. No records from outside Ethiopia exist so far. The species is generally common when on the wing, in single nights sometimes 50 or more specimens were attracted to light traps. Observed flight activity phases of the male (personal observation, S. N.) are from 21.00 to 0.30h in southern and central Ethiopia, with a peak around 22.00h. We figure here a reared female, a freshly collected pair plus male genitalia to complete all stages (Figs. 24-29).

Some additional information is given on early instars of *D. lucina*, kindly provided by M. Jagelka who also has made some photos available. Both taxa, *D. richinii* and *D. lucina*, were reared on various species of *Asclepias*.

While larvae of most Asian and European species of the family Brahmaeidae have been reared on various species of Oleaceae, few foodplant records exist for the African representatives. Schultze (1914, 1931) noted three *Dactyloceras* species to feed on Apocynaceae. He found *D. bramarbas* feeding on *Tylophora sylvatica* Decne., *D. lucina* on "*Ceropegia conraui* K. Sch."[*C. conrathii* Schlechter.], and most probably *D. tridentatum* on another unidentified *Ceropegia* species. He described the morphology of the larvae very well and gave notes on their behaviour. The full-grown larvae and pupae of two of the species were figured in his papers; those figures are shown here again for comparison (Figs. 18-20). A further record of a larval foodplant exists for *D. swanzii* which was found to feed on *Byrsocarpus coccineus* Thoun ex Schumach. (Connaraceae) (Forsyth, 1966). The somewhat distinctive *Spiramiopsis comma* was reared successfully on *Secamone alpini* Schultes and *S. gerrardii* Harv. ex Benth. (Apocynaceae), and the larva and assignment of the species within Bombycoidea was discussed extensively by Oberprieler & Duke (1994). There generally is seen a predilection of woody vines (Apocynaceae, formerly in Asclepiadaceae) and milkweed (Asclepiadaceae) as larval foodplants in the African Brahmaeidae representatives

Rearing report

The mother female was collected around 500 km south of Addis Abeba in the SNNPR Region, Northern Omo Zone, near Dorze (N6°10'8.38'' E37°34'7.93''), in an altitude of about 2400m in the period of 7th to 21st April 2013 by M. Ströhle, and oviposition took place while in Ethiopia. The ova were sent after return to Germany to A. R., who gave part of them to U. W. who then undertook the successful rearing. Due to the few known foodplant records for other *Dactyloceras* species, several species of *Asclepias* (Asclepiadaceae; partly in the internet listed today as Apocynaceae, Asclepiadoideae) were offered to the caterpillars, all of which were accepted immediately. As only limited quantities of leaves were available, the plant species were changed from time to time, but in all cases leaves were accepted very well. The first two instars were reared on *A. incarnata*

L., third and early fourth instar larvae on watered twigs of *A. curassavica* L., and for late fourth and last instar twigs in water of *A. speciosa* TORR. from outdoor were used, all plants originating from North America.

Rearing took place inside at day room temperatures from 20 to 24°C and night temperatures from 18 to 20°C. Larvae were kept in early instars in small boxes, from third instar on in larger glass cages. All instars were non-gregarious, and ingestion took place only from sunset to dawn, during daytime they completely rested on their foodplant without movement. In this resting position the three thoracic legs and the anal prolegs with body are raised off from the ground, and sometimes those parts were hanging like dead structures to the side. In all instars the larvae were quite sensitive when being disturbed, even with light concussion they immediately stopped feeding but showed no defence behaviour such as heavy movement, noise caused by their mandibles or joining the dorsal eighth abdominal scolus to the dorsum as e.g. described by Karsch (1915: 121) for larvae of *D. lucina*. When removed from their foodplant, larvae form immediately the shape of a circle. Before pupation they did not change their colour, and dug very fast into the ground without wandering around for long time. Pupation took place in small holes in white turf-like medium, each caterpillar in a half-filled 5 litre jar.

Table with rearing data, data always for first specimen

First instar	29.iv.2013
Second instar	07.v.2013
Third instar	11.v.2013
Fourth instar	16.v.2013
Fifth instar	24.v.2013
End of feeding	05.vi.2013
Pupa	11.vi.2013
Imago	11.v.2014

Description of preimaginal instars

Ovum (Fig. 1): We have only the hatched ova available for study, which have a diameter of about 1.4 mm and a height of 1.0 mm. Almost circular in dorsal view, not laterally flattened, thereby most probably usually deposited in upright position. Hatching larvae nibble a ring-like aperture into the shell and press the top upwards to emerge. Transparent after hatching. There unfortunately exist no observations on oviposition, as all ova were deposited in a small paper envelope.

First instar (Fig. 2): Of entirely black colour, getting a little shiny and fading to dark greyish in older age. Complete body with black scoli, covered with short black bristles. The dorsolateral scoli of second and third thoracic segments and the central dorsal one on eighth abdominal segment little larger, with longer bristles. Head capsule shiny black.

Second instar (Figs. 3, 4): The larvae are more colourful in this instar, the body of dark greyish brown colour with whitish ochreous longitudinal wavy lines on dorsolateral and sometimes, especially in older larvae, also on lateral side. Scoli of ochreous to dark yellow colour with hairs, those of seventh to ninth abdominal segments more shining yellow, the same ones as in first instar more prominent. Head capsule black.

Third instar (Figs. 5, 6): Now of lighter, greyish brown ground colour, with lots of creamy white longitudinal lines. Again prominent dorsolateral scoli of second and third thoracic segments and the central dorsal one on eighth abdominal segment, generally all scoli of ochreous brown colour, covered with short black bristles. Head capsule black.

Fourth instar (Figs. 7, 8): Larva of greyish to ochreous brown ground colour, longitudinal lines now ochreous, on dorsal side from third to seventh abdominal segment a dark brown "saddle". Tubercles now of brown colour with a violet shade, the prominent dorsal one of eighth abdominal segment covered with black verrucae, all others with creamy white verrucae, all verrucae with short black bristles on the top. Head capsule ochreous brown.

Fifth instar (Figs. 9, 10, 11, 12): Larva again in greyish brown ground colour, but with a quite plain, little shining cutis. The whole body with tiny longitudinal creamy wavy lines, again with darker brown "saddle" on dorsum. Tubercles much reduced, all without any prominent verrucae, only the dorsal ones of second and third thoracic segments and the central dorsal one on eighth abdominal segment more prominent, with a lighter tip and very short bristles on the top. Head capsule dark blackish brown. At end of the last instar, the anal proleg is raised up only a little. When ready for pupation, larvae reached a length of 55 to 60 mm.

Pupa (Figs: 13, 14): Colour dark brownish black, of smooth and shiny surface texture, length around 30 to 32 mm, maximum diameter 11.5 to 12.0 mm.

Some eggshells, head capsules and larvae are preserved in alcohol in the collection of S. N.

Further notes on *Dactyloceras* preimaginal stages

We are obliged to M. Jagelka who kindly presented us some further photos of *Dactyloceras* caterpillars, namely *D. lucina*, which he took during an expedition to Cameroon in March and April 2005 (Figs. 15-17). We cite here some of his notes which he forwarded:

In March and April 2005 *D. lucina* was very common in rain forests in southeastern Cameroon at Mintoum, Dja & Lobo Province. Many males were attracted to light every night, but only few females arrived generally around one hour after sunset. About 10 females were caught at this place, and oviposition easily took place in mesh cages. Ova are big, round, and of yellow colour, they turn to brown colour before hatching which took place about seven days after oviposition. Several available plants were offered, but larvae accepted only leaves of a small creeper which climbed on the bottom of some tree trunks and emitted milk when cut. A second foodplant was also a climbing species with harder leaves, also with milk emerging when cut. Jagelka identified both plants as Asclepiadaceae, but an exact determination was impossible. Few details of the leaves can be seen in the figures.

Larvae grew fast, and already after 10 days they were ready to moult for the last time. At this time Jagelka had to travel back to Slovakia where he could not find any Asclepiadaceae, so larvae taken along died after few days. No other plants were accepted in Europe.

The photo of the premature larva of *D. lucina* provided by Jagelka (Fig. 17) fits very well with the figure in Schultze (1931) which he identified as *D. lucina* or *D. tridentatum* (Fig. 19). Interestingly, both larvae use all their legs to hold themselves on the twigs, even in resting position. Both species (if even different, Schultze could not identify his stock reliably) are members of the subgenus *Dactyloceras.* All few known larvae of the subgenus *Shinocksiceras* hold their thoracic legs and the anal proleg plus body raised off from the underground, as shown in this rearing report and also by Schultze (1914) for *D. bramarbas,* figured here for comparison (Fig. 18). This behaviour is also not known from other Asian Brahmaeidae (e.g. Nässig & Paukstadt, 1990).

It would be interesting to get some more rearing results in *Dactyloceras* and *Shinocksiceras*. Together with some significant characteristics such as consistent genitalia structures or wing form and venation it could be an indication that *Shinocksiceras* has to be raised to genus level in future.

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Table 1

Figures 1 – 15: preimaginal instars of *Dactyloceras richinii*;

Fig. 1: ova;
Fig. 2: First instar larva;
Fig. 3: Second instar larva;
Fig. 4: Two second instar larvae;
Fig. 5: Third instar larva;
Fig. 6: Third instar larva;
Fig. 7: Fourth instar larva;
Fig. 8: Fourth instar larva;

Table 1

Table 2
Fig. 9: Fifth instar larva;
Fig. 10: Fifth instar larva;
Fig. 11: Fifth instar larva;
Fig. 12: Fifth instar larva, shortly before pupation;
Fig. 13: Male pupa, ventral view;
Fig. 14: Male pupa, dorsal view;

Figures 15 – 17: preimaginal instars of *Dactyloceras lucina*;

Fig. 15: first instar larva;
Fig. 16: Third instar larva;

Table 2

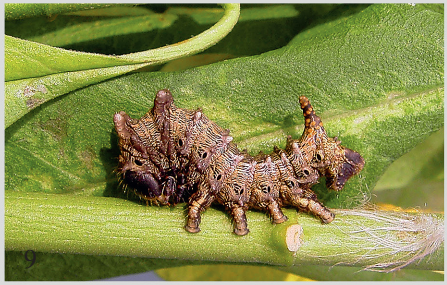


Table 3

Fig. 17: Fourth instar larva;

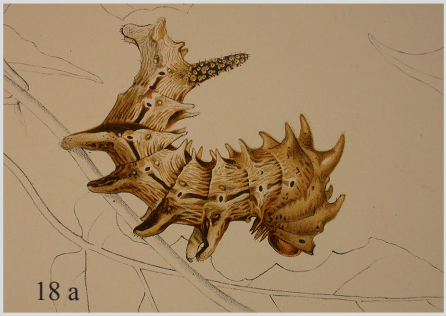
Figures 18 – 20: preimaginal instars of *Dactyloceras*, scanned images from literature:

Fig. 18: Two fullgrown larvae of *Dactyloceras bramarbas*, figured by SCHULTZE (1914, pl. IV);
Figs. 18a & b: details from this plate (SCHULTZE, 1914, pl. IV);
Fig. 19: Fullgrown larva of *Dactyloceras lucina* or *tridentatum*, figured by SCHULTZE (1931, pl. 3, fig. 3);
Fig. 20: pupa of *Dactyloceras lucina* or *tridentatum*, figured by SCHULTZE (1931, fig. 1);

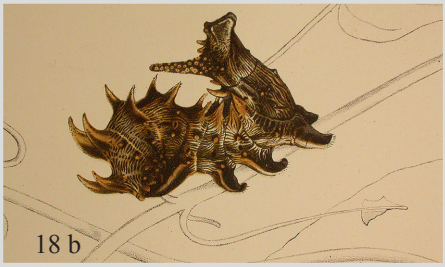
Table 3

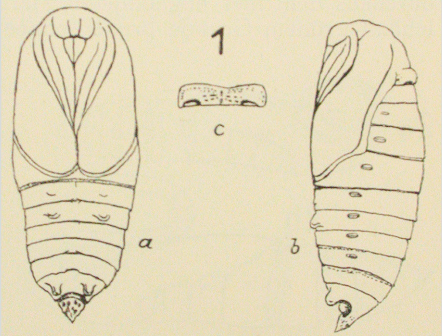

17


18


18 a

19


18 b

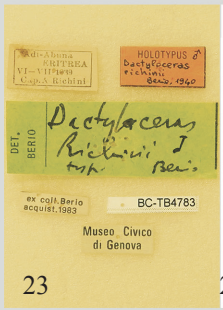


20 Fig. 1. Puppe von *Dactyloceras*. a Ventralseite, b Seitenansicht, c Metathoraxnabe. — Natürliche Größe.

Table 4

Fig. 21: Holotype male of *Dactyloceras richinii*, Museo civico di Storia naturale, Genova;
Fig. 22: Same specimen, ventral view;
Fig. 23: Data labels of the holotype specimen;
Fig. 24: Male genitalia structures of *D. richinii*, genitalia no. 1043/04 Naumann;
Fig. 25: Reared female of *Dactyloceras richinii*, SNNPR region, Dorze env., dorsal view, coll. U. Weritz;
Fig. 26: Wild collected male of *Dactyloceras richinii*, dorsal view, Amhara Region, Bahar Dar env., coll. S. Naumann;
Fig. 27: same specimen, ventral view;
Fig. 28: Wild collected female of *Dactyloceras richinii,* dorsal view, Oromia Region, Bale Mts., Harenna Forest, coll. S. Naumann;
Fig. 29: same specimen, ventral view;

Table 4



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