

On colour morphs of the millipede, *Chondromorpha kelaarti* (Humbert, 1865) (Polydesmida: Paradoxosomatidae)

О цветовых морфах многоножки-диплоподы *Chondromorpha kelaarti* (Humbert, 1865) (Polydesmida: Paradoxosomatidae)

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КЛЮЧЕВЫЕ СЛОВА: цветовой полиморфизм, гонопод, таксономия, изменчивость.

ABSTRACT. Three colour morphs of *Chondromorpha kelaarti* (Humbert, 1865) are recognised: morph A with a brownish-black body colouration, morph B with a pale brown, and morph C with a black one. Morphometry of the three morphs is provided and variations in gonopod structure are discussed.

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РЕЗЮМЕ. Выделены три цветовые морфы многоножки *Chondromorpha kelaarti* (Humbert, 1865): морфа А с коричневатой-черной окраской, морфа В со светло-бурой и морфа С с черной окраской. Представлена морфометрия всех трех морф и обсуждена изменчивость строения их гоноподов.

Introduction

Colour polymorphism, a widespread biological phenomenon that refers to the coexistence of two or more discrete colour phenotypes/morphs within a species or population [White, Kemp, 2016], is not very uncommon among millipedes. Several millipede species have been reported to exhibit colour polymorphism. For example, see Evsyukov [2016]; Wesener & Conrad [2016]; Marek *et al.* [2018]; Reip & Wesener [2018]. A remarkable colour polymorphism in both sexes of the South Asian polydesmidan millipede, *Chondromorpha kelaarti* (Humbert, 1865), is put on record here.

Material and methods

All measurements are in millimetres (mm). Drawings were made with the aid of a drawing tube attached to a microscope. The specimens examined are deposited in a reference collection housed at the Division of Arachnology,

Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala, India (ADSH).

Taxonomy

Polydesmida Pocock, 1887
Paradoxosomatidae Daday, 1889
Chondromorpha Silvestri, 1897
Chondromorpha kelaarti (Humbert, 1865)
Figs 1–15.

Polydesmus Kelaarti (sic!) Humbert, 1865: 25 (for complete list of references, see Sankaran & Sebastian [2017]).

MATERIAL EXAMINED. INDIA: Kerala: Kottayam, Pala, Areppara in Edappady (9°42'35.62"N, 76°42'48.42"E, 27 m alt), M.S. Pradeep leg., 9 July 2016, from ground, by hand: 2 ♂♂, 2 ♀♀ (morph A) (MILLI-ADSH-0001), 6 ♂♂, 11 ♀♀ (MILLI-ADSH-0014), 12 August 2020, otherwise same as before; Trivandrum, Ponmudi, Kallar, way to Meenmutty waterfalls (8°43'4"N, 77°7'37"E, 90 m alt), M.S. Pradeep & A.V. Mathew leg., 23 February 2018, from forest floor, by hand: 5 ♂♂, 3 subadult ♀♀ (morph B) (MILLI-ADSH-0015), 3 ♂♂, 4 ♀♀ (morph C) (MILLI-ADSH-0016), 5 December 2019, otherwise same as of morph B.

DESCRIPTION. For description and illustrations of the species, see Sankaran & Sebastian [2017].

COLOUR MORPHS. Three colour morphs can be distinguished in *C. kelaarti*, as follows.

MORPH A (Figs 1–2, 7, 10, 13).

Body uniformly brownish-black (♂, ♀), with 20 segments; antennae uniformly brownish-black; angular part of paranota yellowish; legs yellowish-brown; sternites straw coloured. Length ca 28–31 mm (♂) and 34–37 mm (♀), width of midbody pro- and metazonae 1.6–1.9 mm and 2.1–2.3 mm (♂) or 2.3–2.4 mm and 3.8–4.1 mm (♀), respectively.

MORPH B (Figs 3–4, 8, 11, 14).

Body uniformly pale brown (♂, ♀), with 20 segments; antennae uniformly pale brown; angular part of paranota pale brown; legs pale brown; sternites pale brown. Length ca 38–40 mm (♂), width of midbody pro- and metazonae 3.8–4.0 mm and 4.1–4.5 mm (♂), respectively.

MORPH C (Figs 5–6, 9, 12, 15).

Body uniformly black (♂, ♀), with 20 segments; antennae uniformly black; angular part of paranota black; legs black; sternites pale black. Length ca 57–58 mm (♂) and



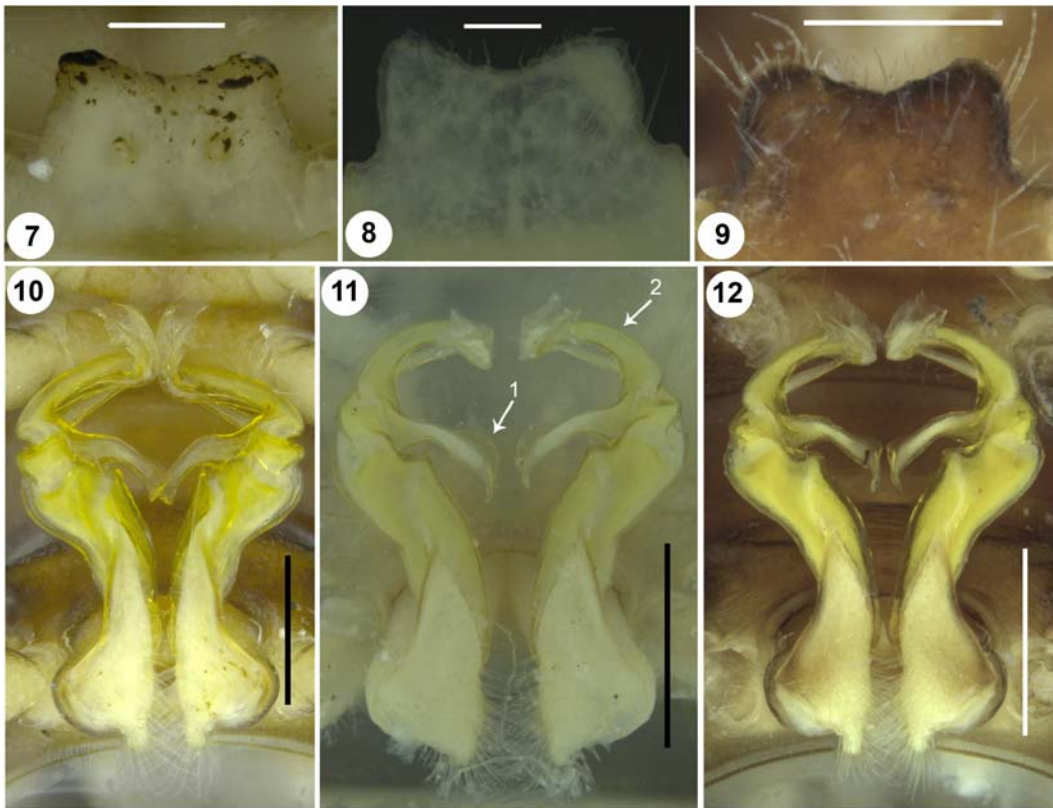
Figs 1–6. Field photographs of the colour morphs of *Chondromorpha kelaarti* (Humbert, 1865). 1–2 — morph A, 3–4 — morph B, 5–6 — morph C. 1, 3, 5 — males; 2, 4, 6 — females. Figs 1 and 2 reproduced from Sankaran & Sebastian [2017]. Photo courtesy 1, 2 — Jimmy Paul; 3–6 — Aneesh V. Mathew.

Рис. 1–6. Полевые фотографии цветовых морф *Chondromorpha kelaarti* (Humbert, 1865): 1–2 — морфа А, 3–4 — морфа В, 5–6 — морфа С. 1, 3, 5 — самцы; 2, 4, 6 — самки. Рис. 1 и 2 воспроизведены из Sankaran & Sebastian [2017]. Фотографии любезно предоставлены: 1, 2 — Jimmy Paul; 3–6 — Aneesh V. Mathew.

60–61 mm (♀), width of midbody pro- and metazonae 4.1–4.2 mm and 4.7–4.8 mm (♂) or 5.1–5.2 mm and 8.5–8.6 mm (♀), respectively.

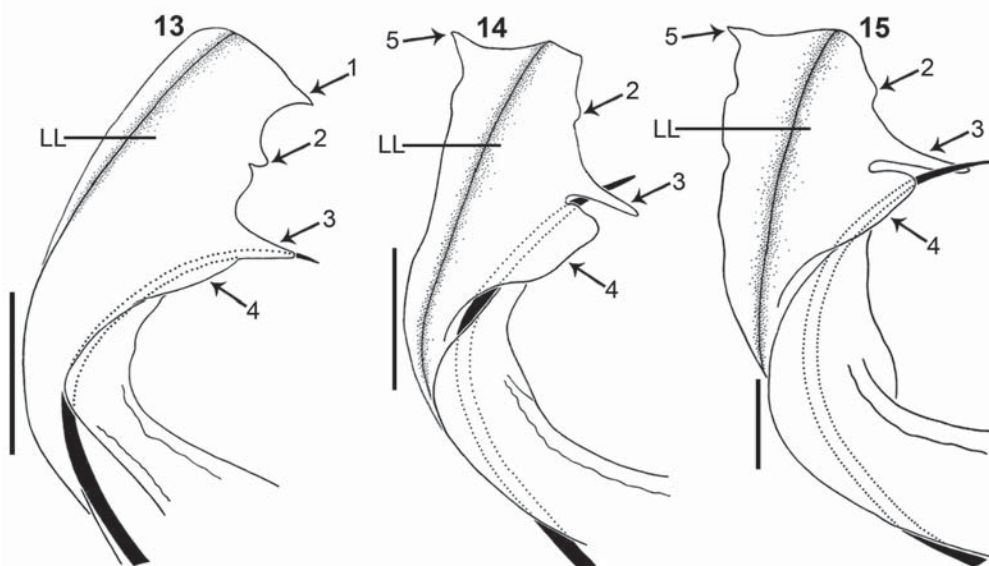
DISCUSSION. *Chondromorpha kelaarti* can easily be identified by the trapezoid sternal lamella with paired anterior processes between ♂ coxae 4 [Sankaran, Sebastian, 2017: figs 2C, 3M]. All three morphs show such a sternal lamella, indicating that all belong to *C. kelaarti* [cp. Figs 7–9 with Sankaran & Sebastian, 2017: fig. 2C]. The three morphs exhibit leg modifications as described in Sankaran & Sebastian [2017]. Among the three morphs, morph B lives in sympatry with morph C and both were collected from forest areas, whereas morph A is common in synanthropic areas. Even though the three morphs were collected from an altitude of less than 100 m, morph A is smaller in body size than morphs B and C, the latter two being larger (Figs 1–6). Because morphs B and C were collected from forest areas, this increased body size may be attributed to habitat and food quality available in forest areas in comparison with the areas of human settlements [Enghoff, 1992]. However, the three morphs show no difference in the number of body segments, as all have 20 body segments. The three morphs

show certain morphological differences in gonopod structure as well. The basal postfemoral process is distally wider in morph B than in morphs A and C (Figs 10–12, arrow 1). The solenophore of morph B is semi-circular in ventral view with a vertically oriented distal lappet, vs a less strongly semi-circular or nearly straight solenophore with a horizontally oriented lappet in morphs C and A, respectively (Figs 10–12, arrow 2). The lamina lateralis in morph A has a well-developed apico-mesal spine-like extension and an anterior tooth, whereas these in morphs B and C are less evident (Figs 13–15, arrows 1 and 2). In morphs B and C, the lamina lateralis mesally has a posterior lamellate extension that is clearly separated from the median tooth and has an apico-lateral pointed extension, vs a less strongly developed mesal lamellate extension that is not separated from the median tooth and the absence of an apico-lateral pointed extension in morph A (Figs 13–15, arrows 4 and 5). The lateral margins of the lamina lateralis in morphs A and C are smooth, vs with ridges in morph B (Figs 13–15). In fact, all these variations in gonopod characters are clinal and merely intraspecific, not warranting the recognition of these three morphs into separate species or subspecies.



Figs 7–12. Sternal lamella and gonopods of the colour morphs of *Chondromorpha kelaarti* (Humbert, 1865). 7, 10 — morph A, 8, 11 — morph B, 9, 12 — morph C. Figs 7 and 10 reproduced from Sankaran & Sebastian [2017]. Arrows indicate postfemoral process (1) and solenophore (2). Scale bars: 7–8 — 0.2 mm, 9–10 — 0.5 mm, 11–12 — 1 mm.

Рис. 7–12. Стерральная пластинка и гоноподы цветовых морф *Chondromorpha kelaarti* (Humbert, 1865). 7, 10 — морфа А, 8, 11 — морфа В, 9, 12 — морфа С. Рис. 7 и 10 воспроизведены из Sankaran & Sebastian [2017]. Стрелки указывают на постфеморальный отросток (1) и солонофор (2). Масштаб: 7–8 — 0,2 мм, 9–10 — 0,5 мм, 11–12 — 1 мм.



Figs 13–15. Right gonopod of the colour morphs of *Chondromorpha kelaarti* (Humbert, 1865), oblique dorsal view. 13 — morph A, 14 — morph B, 15 — morph C. Abbreviation: LL — lamina lateralis. Arrows indicate apico-mesal spine-like extension (1), anterior tooth (2), median tooth (3), mesal lamellate extension (4) and apico-lateral spine-like extension (5). Scale bars: 13–14 — 0.5 mm, 15 — 0.2 mm.

Рис. 13–15. Правый гонопод цветовых морф *Chondromorpha kelaarti* (Humbert, 1865): косо сверху. 13 — морфа А, 14 — морфа В, 15 — морфа С. Обозначение: LL — lamina lateralis. Стрелки указывают на вершинно-внутренний шиповидный выступ (1), передний зуб (2), внутренний зуб (3), внутренний пластинчатый выступ (4) и вершинно-боковой выступ (5). Масштаб: 13–14 — 0,5 мм, 15 — 0,2 мм.

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Conflict of Interest: The author declares that he has no conflict of interest.

Ethical approval: No ethical issues were raised during this research.

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